Guyana

Third National Communication

To the United Nations Framework Convention on Climate Change

August 2024

Publication title

Third National Communication of Guyana to the United Nations Framework Convention on Climate Change.

Publication information

This publication has been prepared by the Government of Guyana with support from the Global Green Growth Institute (GGGI) and Gauss International Consulting.

Date of publication

August

2024

Citation

Government of Guyana, (2024). Third National Communication to the United Nations Framework Convention on Climate Change. Government of Guyana, Georgetown, Guyana.

Foreword

The Government of Guyana is pleased to present Guyana's Third National Communication to the United Nations Framework Convention on Climate Change, following the reporting provisions contained within Decision 17/CP.8, Annex: Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention.

Gratitude is extended to the individuals and organisations whose substantial contributions played a pivotal role in the successful completion of Guyana's Third National Communication. Special recognition goes to the United Nations Environment Programme, the Global Green Growth Institute (GGGI) and Gauss International Consulting for their support.

Through the submission of this Third National Communication to the United Nations Framework Convention on Climate Change, Guyana provides updated information on national circumstances, greenhouse gas (GHG) inventories, a vulnerability and adaptation assessment, mitigation assessment, financial resources and transfer of technology, and education, training and public awareness. This transparently highlights the continuous endeavours of the country in implementing the Convention.

Acronyms and Abbreviations

ACP FORENET	African Caribbean Pacific Forest Research Network
ACTO	Amazon Cooperation Treaty Organisation
AD	Activity Data
AF	Adaptation Fund
AFOLU	Agriculture, Forestry, and Other Land Use
AR5	Fifth Assessment Report
ART-TREES	Architecture for REDD+ Transactions The Environmental Excellence Standard
ASGM	Artisanal and Small-Scale Gold Mining
BA&EF	Barrier Analysis and Enabling Framework
BIOPAMA	Biodiversity and Protected Areas Management
BOD	Biochemical Oxygen Demand
BUR	Biennial Update Report
C	Confidential
CARe	Coastal Adaptation and Resilience
CARICOM	Caribbean Community
CARPHA	Caribbean Public Health Agency
CCAP	Climate Change Adaptation Programme
CCCCC	Caribbean Community Climate Change Centre
CCORAL	Caribbean Climate Online Risk and Adaptation Tool
CCRI	Children Climate Risk Index
CDB	Caribbean Development Bank
CDC	Civil Defence Commission
CDEMA	Caribbean Disaster Emergency Management Agency
CDM	Comprehensive Disaster Management
CFT	Conference Framework for Teachers
CGCM2	Canadian General Circulation Model 2

CHP	Combined Heat and Power
CI Guyana	Conservation International Guyana
CIF	European Union Caribbean Investment Facility
CIFSRF	Canadian International Food Security Research Fund
CIMH	Caribbean Institute for Meteorology and Hydrology
CMIP6	Sixth Coupled Model Intercomparison Project
COP	Conference of the Parties
CORDEX	Coordinated Regional climate Downscaling Experiment
CREWS	Climate Risk and Early Warning
CRRBF	Caribbean Regional Resilience Building Facility
CRSAP	Climate Resilience Strategy and Action Pan
CSBD	Centre for Study for Biological Diversity
CWP	Country Work Programme
CYEN	Caribbean Youth Environmental Network
DANA	Damage Assessment and Needs Analysis
DECC	Department of Environment and Climate Change
DOC	Degradable Organic Carbon
DoE	Department of Environment
DRM	Disaster Risk Management
DRMP	Disaster Risk Management Policy
DRR	Disaster Risk Reduction
EDWC	East Demerara Water Conservancy
EF	Emission Factor
EFI	European Forest Institute
EFITAP	European Forest Institute Technical Assistance Project
EIMMS	Environmental Information Management and Monitoring System
EMGL	ExxonMobil Guyana Limited’s
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
ESD	Education for Sustainable Development

ESE	Environmental and Sustainability Education
ETK	Ecological Traditional Knowledge
EUTR	European Union's Timber Regulation
EW4A	Early Warning for All
EWS	Early Warning System
EXIM	Export-Import Bank US
FAO	Food and Agriculture Organisation
FCDO	UK Foreign, Commonwealth Development Office
FEES	Faculty of Earth and Environmental Sciences
FLEG-VPA	Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement
FOD	First Order Decay
FPIC	Free Prior and Informed Consent
FPSO	Floating Production Storage and Offloading
FRM	Flood Risk Management
GCAA+	Global Climate Change Alliance Plus
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEA	Guyana Energy Agency
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GGGI	Global Green Growth Institute
GHFS	Green Heritage Fund Suriname
GHG	Greenhouse Gas
GII	Gender Inequality Index
GIS	Geographic Information System
GLDA	Guyana Livestock Development Authority
GLSC	Guyana Land Surveys Commission
GMA	Georgetown Metropolitan Area
GMCS	Guyana Marine Conservation Society
GoG	Government of the Cooperative Republic of Guyana

GPL	Guyana Power and Light
GRA	Guyana Revenue Authority
GRDB	Guyana Rice Development Board
GRIF	Guyana REDD+ Investment Fund
GTA	Guyana Tourism Authority
GUYSUCO	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
GWP	Global Warming Potential
HadCM3	Hadley Circulation Model 3
HDI	Human Development Index
HECI	Hinterland Electrification Company Inc
HFLD	High Forest Cover Low Deforestation Rate
Hydromet	Hydrometeorological Service of Guyana
ICT	Information, Communication, and Technology
ICZM	Integrated Coastal Zone Management
IDB	Inter-American Development Bank
IDRM	Integrated Disaster Risk Management
IE	Included Elsewhere
IFAD	International Fund Agricultural Development
IIC	Iwokrama International Centre
IPCC	Intergovernmental Panel on Climate Change
IPLC	Indigenous Peoples and Local Community
IPPU	Industrial Processes and Product Use
IRI	Internal Roughness Index
IsDB	Islamic Development Bank
ISIC	Industrial Classification of all Economic Activities
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
J-CCCP	Japan-Caribbean Climate Change Partnership
JICA	Japanese International Cooperation Agency

LCDS	Low Carbon Development Strategy
LDF	Logging Damage factor
LED	Light-Emitting Diode
LEDS	Low Emission Development Strategy
LEG	Least Developed Countries Expert Group
LNG	Liquified Natural Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
M&E	Monitoring and Evaluation
MAST	Monitoring, Analysing, Sharing, and Taking Action
MCF	Methane Correction Factor
MITICA	Mitigation-Inventory Tool for Integrated Climate Action
MMA	Mahaica Mahaicony Abary
MNR	Ministry of Natural Resources
MoA	Ministry of Agriculture
MoAA	Ministry of Amerindian Affairs
MoE	Ministry of Education
MoF	Ministry of Finance
MoH	Ministry of Health
MoU	Memorandum of Understanding
MRV	Monitoring Reporting and Verification
MRVS	Monitoring Reporting and Verification System
MSW	Municipal Solid Waste
NA	Not Applicable
NAAEE	North American Association for Environmental Education
NAP	National Adaptation Plan
NAREI	National Agricultural Research and Extension Institute
NAS	National Agrometeorological System
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategy and Action Plan

NC	National Communication
NCC	National Climate Change Committee
NCCPAP	National Climate Change Policy and Action Plan
NCD	Nature Conservation Division
NCERD	National Centre for Educational Resource Development
NDC	Nationally Determined Contribution
NDIA	National Drainage and Irrigation Authority
NDMAP	National Drought Mitigation and Adaptation Plan
NE	Not Estimated
NEAP	National Environmental Action Plan
NEEPAS	National Environmental Education and Public Awareness Strategy
NEOC	National Emergency Operations Centre
NEP	National Environmental Policy
NFEWS	National Flood Early Warning System
NFP	National Forest Policy
NFP	National Focal Point
NFPRP	National Flood Preparedness and Response Plan
NFPS	National Forest Policy Statement
NGO	Non-Governmental Organisation
NIDRMP	National Integrated Disaster Risk Management Plan
NLTS	National Land Transport Strategy
NLUP	National Land Use Plan
NMHPRP	National Multi-Hazard Disaster Preparedness and Response Plan
NO	Not Occurring
NOAU	National Ozone Action Unit
NORAD	Norwegian Agency for Development Cooperation
NPAS	National Protected Areas System
NPC	National Parks Commission
NRF	Natural Resource Fund
NTC	National Toshaos Council

OCC	Office of Climate Change
ODS	Ozone Depleting Substances
OLADE	Latin-American Energy Organization
PAC	Protected Areas Commission
PAMs	Policies and Measures
PATF	Protected Areas Trust Fund
PEFC	Program for Endorsement of Forest Certification
PHDI	Palmer Hydrological Drought Index
PICSA	Participatory Integrated Climate Services for Agriculture
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RCP	Representative Concentration Pathways
RE-ACT	Resilient Action Guyana
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RRB	Caribbean Regional Resilience Building Facility
SAIFI	System Average Interruption Frequency Index
SAR	synthetic Aperture Radar
SBA	School Based Assessment
SDG	Sustainable Development Goal
SIDS	Small Island Developing State
SLM	Sustainable Land Management
SOFF	Systematic Observational Financing Facility
SWDS	Solid Waste Disposal Site
TAP	Technology Action Plan
TNA	Technology Needs Assessment
TNC	Third National Communication
UAE-CREC	United Arab Emirates Caribbean Energy Development Fund
UGGI	University of Guyana Green Institute
UNCBD	United Nations Convention on Biological Diversity

UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework for Climate Change Convention
UNICEF	United Nations International Children's Emergency Fund
UNITAR	United Nations Institute for Training and Research
USAID	United States Agency for International Development
VMAC	Victoria Mangrove Action Committee
VSP	Village Sustainability Plans
WB	World Bank
WCMC	Wildlife Conservation and Management Commission
WM	With Measures
WMO	World Meteorological Organization
WUA	Water Users Associations
WWF	World Wildlife Fund
YLC	Youth Learning Centre

Chemical Species

CFCs	Chlorofluorocarbons
CH_4	Methane
CO_2	Carbon Dioxide
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
NF_3	Nitrogen Trifluoride
N_2O	Nitrous Oxide
PFCs	Perfluorocarbons
SF_6	Sulphur Hexafluoride

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Executive Summary

Chapter 1 – National Circumstances

A parliamentary democracy geographically situated in South America, Guyana shares deep cultural and historical ties with the Caribbean, underscored by its role as a founding member of the Caribbean Community (CARICOM). Guyana is part of the Guiana Shield and the Amazon Biome. It is bordered by Venezuela to the West, Brazil to South, Suriname to the East, and Atlantic Ocean stretching along the North.

Due to its geographic location, Guyana features a diverse natural heritage and is rich in natural resources including minerals such as gold and bauxite, ample arable land, and rich hydrological resources. The country boasts a remarkable 85% forest coverage, and a unique flora and fauna, placing the country as an ecotourism and biodiversity hotspot. The large carbon sequestration potential of its forests makes the country a sink of greenhouse gas (GHG) emissions, and the ongoing protection of this key natural resource and the ecosystem services it provides remains a key national priority using innovative financing models based on performance-based payments for ecosystem services provided by these lands.

Named for its abundant hydrological resources, Guyana features an abundance of freshwater across its coastal artesian basins, river and creek network, conservancies, and wetlands. However, its low-lying topography below mean sea level and abundance in water also places the population and its key economic sectors highly vulnerable to the risks of flooding. This vulnerability is exacerbated by the fact that 90% of the population resides in coastal urban centres and most economic activity takes place in the thin coastal strip already below mean sea level and at the mouth of key river deltas, dependent on an aging system of sea defences and drainage and irrigation networks.

Experiencing fluctuations in population size and growth rate over the past decades, Guyana's population has increased steadily over the past decades and the country is poised for continued growth and development. Guyana's population is a tapestry of multi-ethnicity, including numerous Amerindian communities maintaining traditional ways of life in the Hinterland.

Guyana currently stands as one of the fastest-growing economies in the world attributed to the expansion of offshore oil production since 2019, coupled with substantial sustained growth in the non-oil economy including a significant scale-up of infrastructure investment to support growth in other industries. Guyana’s historical economy was based in agriculture (both subsistence-based and export of sugarcane, rice, shrimp, rum, and molasses) and mining (primarily of gold and bauxite extraction and exports), as well as timber production and exports, in addition to services and ecotourism concentrated primarily in the Hinterland due to Guyana´s rich flora and fauna. A significant shift occurred in 2019 with the discovery of substantial offshore oil deposits, leading to a pivotal role for the oil sector since 2020, while capitalizing on its benefits to continue driving growth in traditional sectors.

Guyana's energy sector relies predominantly on imported fossil energy sources, despite the increasing domestic production of oil since the offshore discovery in 2019, a significant portion of the country's petroleum-based product needs are still met through imports. Within the realm of fuel consumption, transport and electricity generation account for the highest usage, followed by agriculture, forestry, and fishing sectors. Guyana has an ambitious strategy to reduce dependence on fossil fuels, with natural gas and renewable energy sources displacing the use of Heavy Fuel Oil in the near term. Guyana's Low Carbon Development Strategy 2030 (LCDS 2030) sets out how the economy will continue to grow but greenhouse gas emissions from the energy sector will decrease overall.

The expansion of the national oil and gas sector in recent years has spurred remarkable economic growth, with a 63.3% real GDP growth rate in 2022 to constant 2012 prices.

Guyana's abundant natural resources and remarkable economic development have set the country on a path of growth, yet they also come with responsibilities in the fight against climate change. It is therefore crucial to intensify efforts to safeguard the extensive forest resources while also managing the oil and gas sector in a responsible fashion and ensuring the domestic low carbon economy expands.

While capitalizing on the expanding economic strength, it is imperative to adopt prudent measures that support ongoing and sustainable growth. Balancing economic progress with environmental preservation is key to ensuring a harmonious and resilient future for Guyana.

Guyana has responded to significant climate changes by establishing a climate change policy and institutional framework aligned with international and regional environmental agreements. Guyana's strategic policies, spearheaded by the Low Carbon Development Strategy (LCDS 2030), serve as the backbone of Guyana´s innovative financing model for low-carbon and climate resilient development.

Chapter 2 – National Greenhouse Gas Inventory

In this Third National Communication (TNC), Guyana presents a revised greenhouse gas (GHG) inventory spanning the period 1990-2022. The inventory utilizes the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (referred to as the 2006 IPCC Guidelines) and the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories (referred to as the 2019 Refinement). The recalculated time series from 1990 to 2016 and the newly calculated time series from 2017 to 2022 incorporate recent guidelines, additional available information, and methodological improvements. The GHG inventory spans 32 years, from the base year 1990 to the inventory year 2022, covering four sectors outlined in the 2006 IPCC Guidelines: energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU), and waste.

The GHG emissions inventory is conducted under the centralized leadership and coordination of the Department of Environment and Climate Change (DECC) within the Office of the President. Employing a sector-based approach, the inventory ensures accurate data collection, avoiding double counting or omission, with sectoral data collection forms distributed to relevant data providers within each sector. Gauss International Consulting, an international technical consultancy, was enlisted to handle data processing, emission estimation, and quality assurance and quality control procedures.

Guyana's national GHG inventory covers seven GHGs emitted to or removed from the atmosphere within the national territory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

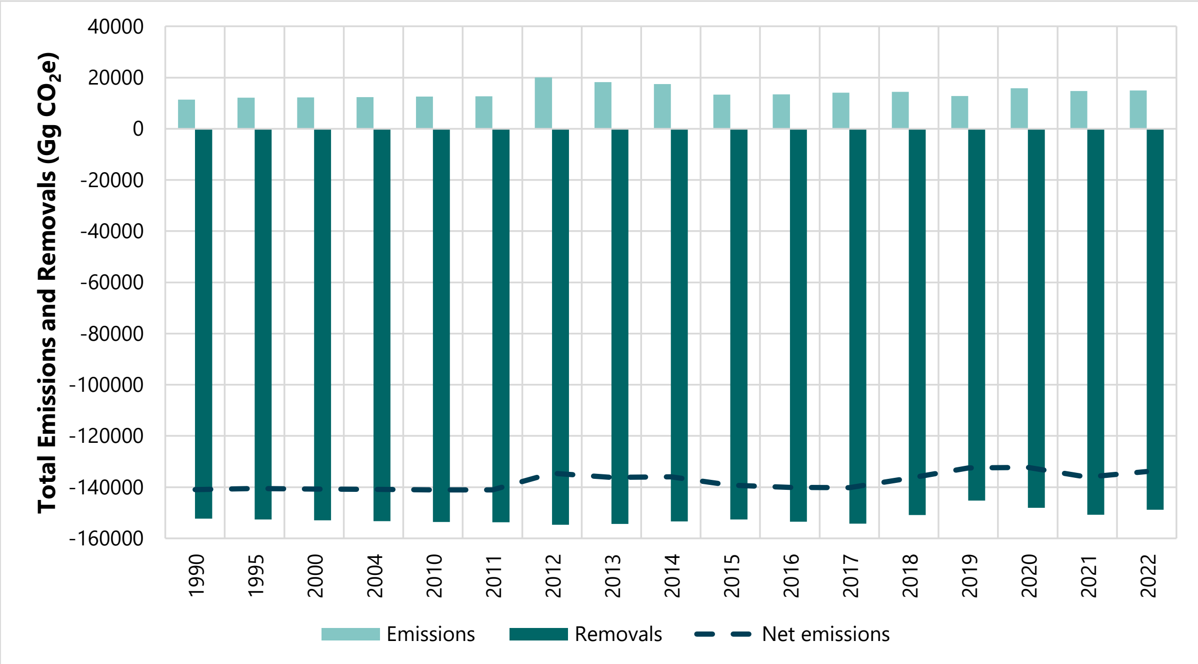
As previously mentioned, the four sectors covered in the national GHG inventory are energy, IPPU, AFOLU, and waste. The inventory is organized by numerical designations, followed by categories (indicated by capital letters), sub-categories (identified by numbers), and emissions sources (denoted by small letters).

Guyana's national GHG inventory spans the entire national territory, covering a geographic area of 214,970 km^2, which includes four biophysical regions: Coastal Plain, Hilly Sand and Clay, Forested Highland, and Interior Savannahs. The inventory comprises 196,850 km^2 of land and 18,120 km^2 of water, featuring a 430-kilometer Atlantic coastline to the northeast and extending continentally for about 724 km.

The GHG inventory follows Tier 1 methodologies from the 2006 IPCC Guidelines, with most Key Categories estimated using advanced methodologies (Tier 2/Tier 3). To address data gaps, notation keys (NO, NE, NA, IE) are employed.

Quality is maintained throughout the inventory compilation, adhering to the good practice principles defined by the 2006 IPCC Guidelines and 2019 Refinement. The inventory complies with the TACCC principles: Transparency, Accuracy, Completeness, Consistency, and Comparability. Country-specific emission factors and official activity data are prioritized, supplemented by default values when necessary.

Guyana's GHG emissions are strongly influenced by its extensive national forest cover, which has a remarkable ability to absorb CO_2 from the atmosphere. With continued low deforestation rates through sustainable use and management of lands and the ongoing removal of CO_2 by the stable forest cover, Guyana has remained a predominant and vast net carbon sink. . As a result, Guyana has maintained a negative emission level, surpassing -130 Mg of CO_2-eq for the entire period from 1990 to 2022.



GHG emissions and removals of Guyana – 1990-2022.

In the latest inventory year, the major contributors to the country's emissions include deforestation (category 3B6b – accounting for 37% of national emissions), fugitive emissions from fuels (category 1B2 – contributing to 21% of national emissions), road transport (category 1A3b – responsible for 8% of national emissions), energy industries (1A1 – contributing 6% to national emissions), and fuel consumption in the residential, commercial, and institutional sectors (category 1A4 – making up 6% of emissions). In terms of gases, the distribution by sectors makes CO_2 the main GHG emitted due to the high contribution from the energy and the Forestry and Other Land Use sectors. CO_2 contributed to 86% of total GHG emissions in 1990, slowly increasing to a peak 89% by 2012, and subsequently decreasing to 69% by 2022.

Following the methodologies and good practices of the 2006 IPCC Guidelines and its 2019 Refinement, the national GHG inventory provide a detailed picture of the GHG emissions of the energy, IPPU, AFOLU, and the waste sectors. The following table shows the GHG emissions calculated by sector for year 1990, 2000, 2010, 2020 and 2022.

Sectoral GHG emissions and removals of Guyana – 1990-2022 (Gg CO_2-eq).

Sector/category	1990	2000	2010	2020	2022
Energy	1266	1768	1850	4905	6116
Agriculture	1123	1570	1797	2253	1927
FOLU	-143718	-144381	-145044	-139804	-142407
Waste	351	358	354	428	445
Total	**-140 977**	**-140 685**	**-141 043**	**-132 218**	**-133 919**

Chapter 3 – Adaptation to Climate Change

Guyana faces challenges in efforts to address climate change impacts. Nine climate change scenarios have been developed under representative concentration pathways (RCPs 2.6, 4.5, and 8.5), projecting temperature, precipitation, and sea level rise trends as follows:

- Mean and maximum temperature increases are already underway, leading to more frequent heat waves, particularly affecting the Central and Southern regions of the country. Results also indicate a disparity in temperatures between coastal and inland Guyana throughout different periods of the year, which will contribute to intensified torrential rains as hotter humid air clashes with cooler air in the various regions of the country.
- Projected precipitation trends suggest an intensification of rainfall periods within a five-year cycle of increasing and decreasing precipitation trends in line with el Niño Southern Oscillation (ENSO), causing severe flooding risks throughout the country and particularly in Central and Coastal Guyana, while inflicting severe drought risk in Central and Southern portions of the country. Wildfire risks are expected to rise, especially in the Rupununi savannahs and coastal urban zones, in line with drought projections.
- Sea level rise is perhaps one of the most concerning threats posed by climate change on the country as 90% of Guyana´s population and the majority of economic activity is concentrated in the narrow coastal strip already several meters below current mean sea level and dependent on an aging system of sea defines and drainage networks in dire need of rehabilitation and upgrading. Including the impact of storm surge, sea level could rise over 6m under worse-case scenarios, causing massive coastal flooding and saltwater intrusion in Guyana´s coastal aquifer system serving as the primary potable water source. Coastal flooding is further exacerbated by the combined effect of fluvial flooding, as coastal urban areas lie at the mouth of key river deltas and are found downstream of water conservancies also at risk of seepage and overtopping.

The ongoing and projected changes in climate are already inflicting a series of slow onset extreme acute impacts for Guyana including extreme heat, fires, drought, storm, strong winds, fluvial flooding, coastal flooding, water pollution, and pests and diseases, all of which will increase in frequency, intensity, and extent in the future. Climate change uniquely affects the country´s nine priority adaptation sectors according to their respective vulnerabilities as follows:

- Agriculture and food security: Climate change significantly threatens Guyana's agriculture, critical for food security, poverty reduction, and employment. Decreased precipitation, droughts, increased temperatures, humidity, and intensified storms lead to water scarcity, pest and disease proliferation, wildfires, and flooding. These impacts reduce crop yields, particularly for staples like dasheens, cassavas, eddoes, sugarcane, and rice, and harm livestock. Sea level rise and saltwater intrusion further degrade arable land. The agriculture sector, mainly composed of small-scale farms, faces limited resources and technical knowledge to adopt climate-resilient practices, disproportionately affecting women and exacerbating socioeconomic disparities.
- Water resources: Guyana's water resources are essential for agriculture, forestry, mining, manufacturing, infrastructure, and settlements. However, climate change poses significant risks through increased precipitation intensity and drought. Decreased rainfall leads to water deficits, particularly impacting domestic and industrial supply in Southern Guyana. Furthermore, severe flooding from heightened precipitation and sea level rise threaten the low-lying coastal areas. Rising temperatures also exacerbate water demand. Therefore, effective water management and infrastructure upgrades are crucial to mitigate these impacts and ensure sustainable water availability.
- Coastal zones: Coastal zones, housing 90% of the population and the majority of Guyana´s agricultural activity, are particularly vulnerable to flooding and erosion due to Guyana´s low-lying topography already below mean sea level and dependent on aging sea wall and drainage infrastructure under maintenance and repair needs. Overtopping of sea defences and drainage malfunctions thus severely jeopardize livelihoods. Coastal mangroves are essential coastal flooding and erosion protection but are impacted from both human pressures as well as temperature increases and shifting precipitation patters.
- Health: The health sector´s response capacity will be hindered by climate change, as the need for ongoing and acute medical care will increase, through augmented incidences of vector-borne and water-borne diseases, heat stress, dehydration, and malnutrition, all of which will stretch current healthcare limitations in the country. Moreover, the reliability and security of healthcare delivery will be threatened by infrastructure damage and communications restrictions.
- Education: Extreme weather events such as flooding, heat waves, fires, and droughts damage school infrastructure, disrupt learning schedules, and affect educational outcomes through school closures, health risks, reduced productivity, psychosocial stress, and absenteeism, all among students and teachers.

- Ecosystems and biodiversity: Incremental climate change and extreme events cause shifts in ecosystem boundaries, changes in natural habitats, land degradation, and sharp increases in extinction rates and biodiversity loss beyond anthropogenic strains already observed from mining, agriculture, and infrastructure development. Guyana´s economy and social well-being is closely tied to forest and mangrove ecosystem services such as soil erosion control, flooding control, coastal flooding control, water filtration, sustainable timber products, ecotourism, and raw materials.
- Energy security: Heavy rainfall and flooding damage electricity generation and transmission infrastructure, leading to prolonged power outages, while heat waves strain the electric grid by increasing cooling demands beyond current generation capacities and challenging aging infrastructure. Dependence on imported fuels for electricity generation exposes the sector to supply disruptions and price volatility.
- Land use, infrastructure, settlements and services: Infrastructure and public services across Guyana faces increased maintenance costs and disruptions from extreme weather events, exacerbating housing, communications, water, sanitation, and transport disparities beyond Guyana´s densely populated coastal urban centres, while risking trade connectivity and operational functionality. Combined coastal and fluvial flooding from intensifying storms and sea level rise is particularly concerning as the majority of Guyana's population resides in coastal urban centres, posing a risk of permanent internal migration inland.
- Amerindian and Hinterland development: The traditional livelihoods of Amerindian communities are particularly affected by all the above-mentioned climate hazards, as their ways of life are traditionally tied to the well-being of the natural environmental and the ecosystem services they provide, coupled by heightened vulnerabilities to prepare for and withstand the impacts of climate change.

The socioeconomic consequences of these impacts are detrimental and already being felt in Guyana. For example, the 2005 and 2021 floods caused substantial losses and damages equivalent to 60% and 12% of the national gross domestic product (GDP), respectively. To respond to these challenges, Guyana has built robust strategic adaptation planning framework seeking to both detect and access key climate change vulnerabilities. The framework is comprised of policies, strategies, and plans at the national and sectoral level which are both explicitly dedicated to climate change adaptation, and mainstream adaptation considerations into development priorities.

Climate change adaptation and resilience planning in Guyana are spearheaded by the Low Carbon Development Strategy (LCDS) 2030 which builds on an innovative financing model for building climate resilient agriculture systems, conducting climate risk assessments and insurance, coastal green-grey infrastructure enhancement and maintenance, mangrove restoration and expansion, drought and flood management, building a more reliable, affordable, and resilient energy mix, building an education system resilient to the impacts of climate change, adapting public health to climate change, and strengthening emergency response to extreme events.

Aligned with the predecessor to the LCDS 2030, in 2016, Guyana submitted its first nationally determined contribution (NDC) with the overarching goal to transition towards a resilient, low-carbon, socially inclusive economy that provides a better quality of life for all within the ecological limits of the planet. Guyana´s first NDC established the country's international conditional and unconditional commitments for climate change adaptation to 2025.

A central element of the NDC is the preparation and implementation of the Climate Resilience Strategy and Action Pan (CRSAP) acting as the key comprehensive framework for adaptation and resilience building in Guyana, through sea defense enhancement and maintenance, drainage and irrigation systems, climate-resilient agriculture, public health adaptation, and flood control management.

Over the past decade, Guyana has been actively engaging in a variety of initiatives, projects, and programmes to reduce vulnerability and enhance resilience against climate change, both on a nationwide scale and in particular regions of the country for each of the ten priority adaptation sectors of Guyana, as follows:

Summary of Guyana´s adaptation actions by status and sector.

Sector	Priority Focus	Action	Status
Agriculture and food security	Enhancing the resilience of low-income and indigenous small-scale farmers in rural and coastal communities, promoting the links between increased productivity, environmental protection, and family nutrition.	Sustainable Livelihoods and Community Economic Growth	Complete
		Hinterland Environmentally Sustainable Agricultural Development Project	Ongoing
		Sustainable Agricultural Development Programme	Complete
		Caribbean Small Island Developing States (SIDS) Multicounty Soil Management Initiative for Integrated Landscape Restoration and Climate-Resilient Food Systems	Ongoing
		RE-ACT (Resilient Action Guyana)	Planned
		Building Resilience through Climate Smart Agriculture while Promoting a Healthier Environment	Ongoing
		Safeguarding Food Security in Kwakwani by Adopting Climate Smart Agricultural Practices	Ongoing
		Capacity Building and Protected Agriculture Demonstration for Farmers in Guyana	Complete
		Climate Resilient Actions for Food Security for Persons with Disabilities	Ongoing
		Grow Up Internship through Sustainable Agricultural Practices in Region 10	Complete
		Restoring the Productivity of Cash Crop Farmers in Fyrish/Gibraltar, Region 6 to their Pre-flood Levels	Ongoing
		Climate Smart Agriculture for Food Security- Vertical Farming in Plaisance Village	Complete
		Improving Farming in Mahaicony River by Adapting to Climate Change and the Environment	Complete
Water resources	Investing in drainage control	Conservancy Adaptation Project	Complete
		Rehabilitation of the East Demerara Water Conservancy (EDWC) Dam	Complete

Sector	Priority Focus	Action	Status
	infrastructure for flood prevention in low-lying areas and empowering integrated water resource management.	Flood Risk Management	Complete
		Cunha Canal Rehabilitation Project	Complete
		EWDC Drainage Pump Installation	Complete
		Resilient, Green and Inclusive Flood Investment Baseline for Georgetown	Ongoing
		Guyana Coastal Adaptation and Resilience (CARe) Project	Planned
		Water Resource Management in Hinterland Communities to Protect Aquifer Recharge Zones in the Upper Takatu Region	Ongoing
Coastal zones	Investing in sea defence mechanisms using both green (mangrove) and grey (sea wall/dike) infrastructure.	Sea and River Defence Resilience Project	Complete
		Guyana Mangrove Restoration Project	Complete
		Community led Mangrove Restoration: Towards Sustainable Management of Guyana´s Mangrove Forest	Complete
		Conservation of Coastal Mangrove Forest Resource to Support Brackish Water Aquaculture for Enhancement of Community Socio-economic Benefit and Food Security	Ongoing
		Securing the Future of the Barima Mora Passage Mangrove Ecosystems and its Peoples	Ongoing
		Unlocking the Potential of Guyana's Mangrove Forests to Build Resilience to Climate Change	Planned
Health	Expanding a climate-smart healthcare service delivery network.	SMART Health Care Facilities Caribbean Project	Complete
		Expansion of Healthcare Service Delivery Network	Ongoing
Education	Building climate-compatible education facilities to promote energy and water security, while withstand extreme weather events	Development of the National Risk Management Policy for the Education Sector	Complete
Ecosystems and biodiversity	Improving gold mining techniques to protect biodiversity and maintaining ecosystem functionality and improving the bioeconomy and ecosystem services in the Amazon rainforest.	Sustainable Gold Mining and Mercury Reduction to Enhance Biodiversity and Reduce Land Degradation	Ongoing
		Measurement of Climate Change Impacts and Ecosystem Services in Iwokrama	Complete
		Leveraging Natural Capital in Guyana's Rupununi	Complete
		Developing a Sustainable Tourism Circuit in South Rupununi	Ongoing
		Amazon Bioeconomy Fund	Ongoing
		Securing a Living Amazon through Landscape Connectivity in Southern Guyana	Ongoing
Energy	Finding the right balance between energy security and climate security through the climate-resilient expansion and diversification of Guyana´s	Refer to energy sector mitigation projects for further details	-

Sector	Priority Focus	Action	Status
	electricity generation, transmission and distribution system.		
Disaster risk management	Operating the national and regional integrated multi-hazard disaster risk management systems and enhancing early warning systems.	Preparation of the National Integrated Disaster Risk Management Plan (NIDRMP)	Complete
		Strengthening Disaster Management Capacity of Women in the Cooperative Republic of Guyana	Complete
		Climate Risk and Early Warning (CREWS)	Complete
		Early Warning for All Initiative (EW4A)	Ongoing
Land use, infrastructure, settlements, and services	Actively mainstreaming land use management, transport infrastructure, and urban development components supporting the ongoing biggest infrastructure transformations in Guyana´s history.	Capacity Development and Mainstreaming for Sustainable Land Management in Guyana	Complete
		Mainstreaming Sustainable Land Development and Management	Ongoing
		Climate-Resilient Adequate Housing and Urban Accessibility in Georgetown	Complete
		Program to Support Climate Resilient Road Infrastructure Development	Ongoing
		Support for Climate Resilient Road Infrastructure	Ongoing
		Paris Agreement Alignment Studies for the Guyana-Brazil Integration Corridor for Sustainable Development	Ongoing
		Integrated Transport Corridors Project	Planned
Amerindian and Hinterland Development	Supporting communities in planning and implementing their sustainability plans contributing to self-defined resilient development priorities.	Village Sustainability Plans	Ongoing
		Support to Village Planning and Implementation as part of Guyana's REDD+ Programme	Ongoing

Adaptation is the essence of resiliency, and it is clear that Guyana is making efforts to ensure the future of the country even when presented with numerous challenges and barriers at the national and sectoral level which impede the country´s adaptive capacity. These translate into capacity support needs across six critical dimensions, namely: informational, institutional, human, financial, technological and regulatory, for which support mechanisms and active cooperation and partnership approaches will be fundamental to successfully adapt to and build resilience against the variety of climate change impacts expected for Guyana.

Chapter 4 – Measures to Mitigate Climate Change

Under the strategic vision set out by Guyana´s nationally determined contribution (NDC) and Low Carbon Development Strategy (LCDS) Guyana has actively engaged over the past fifteen years in a range of actions to mitigate climate change, both nationwide and at a regional scale, towards low-emission socioeconomic development. Such mitigation actions encompass activities within the energy and forestry sector, where the majority of the nation´s current and historic emissions are produced, in addition to some cross-cutting actions.

Guyana´s LCDS was originally developed in 2009, being the first developing country to publish a strategy of its kind based on (i) payments for forest climate services model enabling (ii) investments in the country's emerging low carbon economy. Later updated in 2013, and subsequently updated in 2022 following an extensive national stakeholder consultation process, Guyana´s updated LCDS 2030 outlines the country's plans to continue advancing Guyana's payment for forest climate services model and expanding vision to include Guyana's other globally significant ecosystem services taking into consideration the new national circumstances.

The LCDS 2030 therefore establishes a unique world-class financing model that seeks to avoid deforestation and maintain forest cover, while at the same time growing the economy five-fold over 10 years and keeping energy emissions flat or decreasing; investing in urban, rural, and Amerindian sustainable development; protecting the coast and hinterland through adaptation to climate change; creating jobs in a suite of low carbon sectors; aligning the education and health sectors with low carbon development; and integrating Guyana's economy with the global economy.

Regarding energy, Guyana has implemented various solar photovoltaic (PV) and hydroelectric infrastructure and capacity-building developments to increase the coverage and penetration of renewable energy sources across the country. Furthermore, the country has developed several actions to increase energy efficiency and promote sustainable transportation.

Summary of Guyana´s mitigation actions by status and sector.

Mitigation Action	Status	Sector
Pilot Rice Husk Biogas Power Plant	Complete	Energy
EcoMicro Guyana	Complete	Energy
Expanding Bioenergy Opportunities in Guyana	Complete	Energy
Enhancing Guyana's Access to Transition to Renewable Energy	Complete	Energy
Amaila Falls Hydroelectric Project Preparation Studies	Complete	Energy
Solar PV Public Buildings Program	Complete	Energy
Promotion of Private Solar PV Rooftop Systems	Complete	Energy
Promoting Energy Efficiency Measures in Manufacturing and Service Sectors	Complete	Energy
Introduction of Renewable Energy and Improvement of Power System	Complete	Energy
Sustainable Business Models for Rural Electrification and Energy Access	Complete	Energy
Power Utility Upgrade Program	Complete	Energy
Sustainable Operation of the Electricity Sector and Improved Quality of Service	Complete	Energy
Power Sector Support Program	Complete	Energy
Strengthening Capacity in Energy Planning and Supervision	Complete	Energy
Mabaruma 0.4MWp Solar PV Farm	Complete	Energy
Caribbean Renewable Energy Development Programme	Complete	Energy
Moraikobai Micro-grid PV System	Complete	Energy

Mitigation Action	Status	Sector
Guyana Utility Scale Solar Photovoltaic Program	Ongoing	Energy
Sustainable Energy Program for Guyana	Ongoing	Energy
Energy Matrix Diversification & Department of Energy Institutional Strengthening	Ongoing	Energy
Wakenaam 0.75MWp Solar Farm	Ongoing	Energy
Small Hydropower Project for the Cooperative Republic of Guyana	Ongoing	Energy
Solar Home Systems	Ongoing	Energy
Solar PV Mini-grids	Ongoing	Energy
Gas to Energy Project	Ongoing	Energy
Leguan 0.6MWp Solar PV Farm	Planned	Energy
Hinterland Solar PV Farms	Planned	Energy
Institutional Strengthening LCDS 2030 Implementation under REDD+ Partnerships	Complete	Forestry
Forest Carbon Partnership Facility Project in Guyana	Complete	Forestry
Guyana-EU FLEGT-VPA	Ongoing	Forestry
Guyana REDD+ Monitoring Reporting & Verification System (MRVS)	Ongoing	Forestry
Securing a Living Amazon through Landscape Connectivity in Southern Guyana	Ongoing	Forestry
Amerindian Development Fund	Complete	Cross-cutting
Supporting Micro & Small Enterprise & Vulnerable Low-Carbon Livelihoods	Complete	Cross-cutting
Strengthened Environmental Regulations in Guyana's Gold Mining Sector	Complete	Cross-cutting
Amerindian Land Titling	Ongoing	Cross-cutting
ICT Access and E-services for Hinterland, Remote, and Poor Communities	Ongoing	Cross-cutting
Village Sustainability Plans	Ongoing	Cross-cutting

Guyana has developed and reports ‘with measures’ (WM) projections of all GHG emissions and removals across the five IPCC sectors: energy, Industrial Processes and Product Use (IPPU), agriculture, Land Use, Land-Use Change and Forestry (LULUCF), and waste. These projections, with a reference year 2022 based on the latest national GHG inventory, extend to 2035. The Mitigation-Inventory Tool for Integrated Climate Action (MITICA) is used for developing these projections, employing both bottom-up and top-down approaches to ensure consistency and accuracy.

Key assumptions for these projections include macroeconomic proxies like GDP and population, and sectoral proxies such as energy demand, indigenous energy supply, oil production levels, deforestation, and forest cover. MITICA integrates these factors into the projections, reflecting historical trends and future expectations.

The projections aim to reflect the mitigation actions' impacts and align with national climate policies, including the NDC and the LCDS. According to the latest GHG inventory, in 2022, national GHG emissions without LULUCF were 8,488.06 Gg CO_2eq, which are projected to peak at 20,210.66 Gg CO_2eq in 2031 and decrease to 16,096.96 Gg CO_2eq by 2035. With LULUCF, national GHG emissions were -133,919.14 Gg CO_2eq in 2022, projected to be -122,843.04 Gg CO_2eq by 2035, reflecting the significant CO_2 absorption by Guyana's forests.

The oil and gas sector is the largest contributor to the projected increase in GHG emissions until 2035, correlating with the rapid expansion of oil production since 2020. For the energy sector, emissions are projected to increase from 6,166.10 Gg CO_2eq in 2022 to 17,086.19 Gg CO_2eq in 2030 and then decrease to 12,843.68 Gg CO_2eq by 2035. Guyana is implementing substantial PAMs in the energy sector to transition from a fossil-dependent to a clean energy matrix.

Guyana's forests play a critical role in carbon sequestration, with GHG removals in the LULUCF sector projected to decrease slightly from -142,407.20 Gg CO_2eq in 2022 to -138,940.00 Gg CO_2eq by 2035. The country is implementing conservation and sustainable forest management strategies to maintain and improve the carbon sequestration capacity of its forests.

Projected GHG emissions from the agriculture and waste sectors are limited, with agriculture emissions expected to rise to 2,825.54 Gg CO_2eq by 2035 due to the growing livestock population and waste emissions to 427.73 Gg CO_2eq by 2035 due to increased waste generation. The IPPU sector in Guyana is minimal, with no ongoing industrial activities and limited data availability, thus no projected emissions are estimated.

Over the past fifteen years, Guyana has implemented various climate change mitigation measures but faces challenges across six key areas: technical, financial, institutional, social, political, and regulatory. Technical issues include outdated infrastructure and a lack of expertise, while financial barriers stem from limited access to funding and high costs. Institutional challenges involve coordination and data management, and social obstacles include low public awareness and socio-economic pressures. Political challenges revolve around governance and policy continuity, and regulatory issues pertain to outdated legislation and a continuous need for modernisation of land-use policies. These challenges impact the energy and forestry sectors, requiring comprehensive support mechanisms, including effective policy frameworks, financial instruments, capacity building, and technical assistance to ensure the continuation of effective mitigation efforts.

Chapter 5 – Other Information

Guyana's efforts towards sustainable development are significantly bolstered by research and systematic observation. Key initiatives enhance local academic programmes and advance climate risk management through cutting-edge tools for monitoring mangrove forests and agricultural practices. These collaborations have yielded valuable insights into mangrove conservation and crop resilience, crucial for addressing climate impacts. Although there is progress, systematic observation, particularly in agriculture and water management, faces challenges due to limited access to data and technology. Strengthening this area through better coordination and technology transfer is essential.

Capacity-building efforts have focused on improving agricultural practices, disaster management, and climate change adaptation. Notable activities include training programmes for farmers on irrigation, community-based mangrove restoration workshops, and the development of climate tools. Guyana also engages with international and regional organizations to enhance its environmental governance and conservation efforts. These collaborative efforts, while impactful, highlight the ongoing need for systematic observation and technological advancement to support the country’s sustainable development goals (SDGs).

Furthermore, Guyana has made significant strides in advancing environmental education, training, and public awareness through various international and national frameworks. Nationally, Guyana's Constitution and strategies such as the Low Carbon Development Strategy (LCDS) and National Climate Change Adaptation Strategy support these efforts. Initiatives include the establishment of the International Center for Biodiversity Research, the University of Guyana Green Institute's environmental programmes, and community-focused projects like the Sandwatch Initiative and mangrove camps. Despite progress, challenges persist, including addressing teacher shortages and improving inclusiveness for vulnerable populations. These efforts aim to enhance climate preparedness and resilience across the country.

At the international level, Guyana has engaged in various educational initiatives and collaborative projects to address climate change and environmental issues. Key efforts include the development of Guyana's monitoring, reporting, and verification (MRV) system with NORAD and the GFC, and the implementation of the REDD+ Strategy, which involved capacity building and stakeholder engagement across indigenous communities and other sectors. Regionally, initiatives such as those by CCCCC and EU-funded programmes aim to build climate resilience, with campaigns like “I deserve a #BetterClimate4MyHealth” engaging youth across CARIFORUM countries. Local efforts include educational projects by the Bina Hill Institute and the CYEN network.

The assessment of Guyana’s current needs and level of awareness in climate change and environmental education reveals significant progress and ongoing challenges. The nation's public awareness of climate change has notably improved, with increased understanding of its causes, impacts, and necessary mitigation actions. Studies show a growing trend in climate change knowledge across various regions, but challenges remain, especially in integrating environmental education into curricula and enhancing teacher training. Key needs include the continuous integration of environmental education at all educational levels, improved curriculum content, and enhanced teacher training. Additionally, addressing disparities in digital and physical infrastructure and increasing inclusivity for vulnerable groups are essential. Recommendations focus on expanding teacher training, improving curriculum integration, and enhancing public awareness through various channels. These steps aim to bolster Guyana's capacity to manage climate change impacts and support sustainable development

Chapter 6 – Constraint, Gaps and Needs

Guyana, similar to other countries, faces challenges in the implementation of effective climate action. These challenges stem from resource limitations, technological barriers as well as from institutional and technical capacities. However, despite these challenges, Guyana is advancing climate action at a fast pace, most notably through the highly important and ambitious protective measures of the vast forest resource which acts as a major carbon sink.

To further enhance the countries ambitions and to crucially improve the resilience of its natural environment and its people against the adverse impacts of climate change, substantial resources need to be mobilised to finance activities across sectors. These resources can be partially sourced from the national budget and from the increasing return on the oil and gas production, however the financial need outweighs the national financial capacity. Therefore, additional funding is required to support Guyana's efforts to stabilise the concentrations of CO_2 in the atmosphere and to improve the country's resilience against climate change impact.

The emissions reductions efforts are focused on the energy and forestry sector representing the priority sectors outlined in Guyana's Nationally Determined Contribution and Low Carbon Development Strategy. The Low Carbon Development Strategy (LCDS) estimates costs in the range of $6.5 billion for implementation of the ambitious strategy. Seeking to reduce its vulnerabilities vis a vis the adverse impacts of climate change, Guyana moreover invests and mobilises substantial funding in key sectors such as infrastructure, health, agriculture, water resources and human settlements with the overarching objective to make these sectors resilient against the increasingly detrimental effects of climate change. In the nationally determined contribution (NDC), the total required financial support for implementing the envisioned adaptation measures accrue to $1.6 billion. Additionally, operational support for fulfilling reporting obligations under the UNFCCC and to enhance decision-making for climate change action is mobilised.

In this context, Guyana receives funding from international sources dedicated to finance numerous projects across mitigation and adaptation priority sectors. To unfold a lastingly positive impact, the majority of these projects involves capacity-building and to a somewhat lesser extent technology transfer which contributes to a retention of technology and know-how in the country. Notably, large investments seek to strengthen the transfer of technology to improve the renewable capacity and energy efficiency in the country.

While the overall level of committed support falls short of the overall need, recent trends underscore an increasing mobilisation of the private sector and innovative market instruments such as the ART-TREES credits disbursed for forest conservation and sustainable management. This shows a progression from the previously stronger pronounced dependence on the disbursement of grants and concessional loans from bilateral partners and from multilateral development banks. The table below displays the total amount of support committed or received by Guyana by target climate change area disaggregated by support already disbursed or anticipated.

Summary of total support committed split by amounts disbursed and anticipated.

Target area of funding	Support disbursed (USD)	Support anticipated (USD)
Mitigation	477.108.217,00	2.972.650.452,00
Adaptation	120.443.643,00	411.801.392,00
Cross-cutting	63.341.604,00	110.388.838,00
Total	**660.893.464,00**	**3.494.840.682,00**

1 National Circumstances

1. Introduction

Situated in South America, Guyana shares deep cultural and historical ties with the Caribbean, underscored by its role as a founding member of the Caribbean Community (CARICOM).

Guyana's abundant natural resources and remarkable economic development have set the country on a path of growth committed to exemplary responsibility in the fight against climate change. While capitalizing on the expanding economic strength, Guyana is adopting ambitious measures that support ongoing socioeconomic growth that protects and benefits from the array of benefits provided by the protection of its vast forest coverage spanning 85% of its national territory.

Named for its abundant hydrological resources, Guyana features an abundance of freshwater across its coastal artesian basins, river and creek network, conservancies, and wetlands. However, its low-lying topography below mean sea level and abundance in water also places the population and its key economic sectors highly vulnerable to the risks of flooding, for which the country emphasises climate change adaptation and disaster risk management as an integral part of development planning.

Guyana has responded to significant climate changes by establishing a climate change policy and institutional framework aligned with international and regional environmental agreements. Guyana's strategic policies, spearheaded by the Low Carbon Development Strategy (LCDS) 2030, serve as the backbone of Guyana´s innovative financing model for low-carbon and climate resilient development.

In this chapter of the Third National Communication (TNC), Guyana explores its national context to best place into perspective the challenges, needs, priorities, progress, and achievements as it pertains to climate change mitigation and adaptation.

2. Administrative structure

The Government of the Cooperative Republic of Guyana (GoG) operates as a parliamentary democracy with a representative system of government divided into national, regional, and local levels.

Municipalities have their own local government structures, with the capital of the country being Georgetown. The country is divided into ten administrative regions as shown in Figure 1.1, each with its own Regional Democratic Council responsible for regional governance within its territorial span.

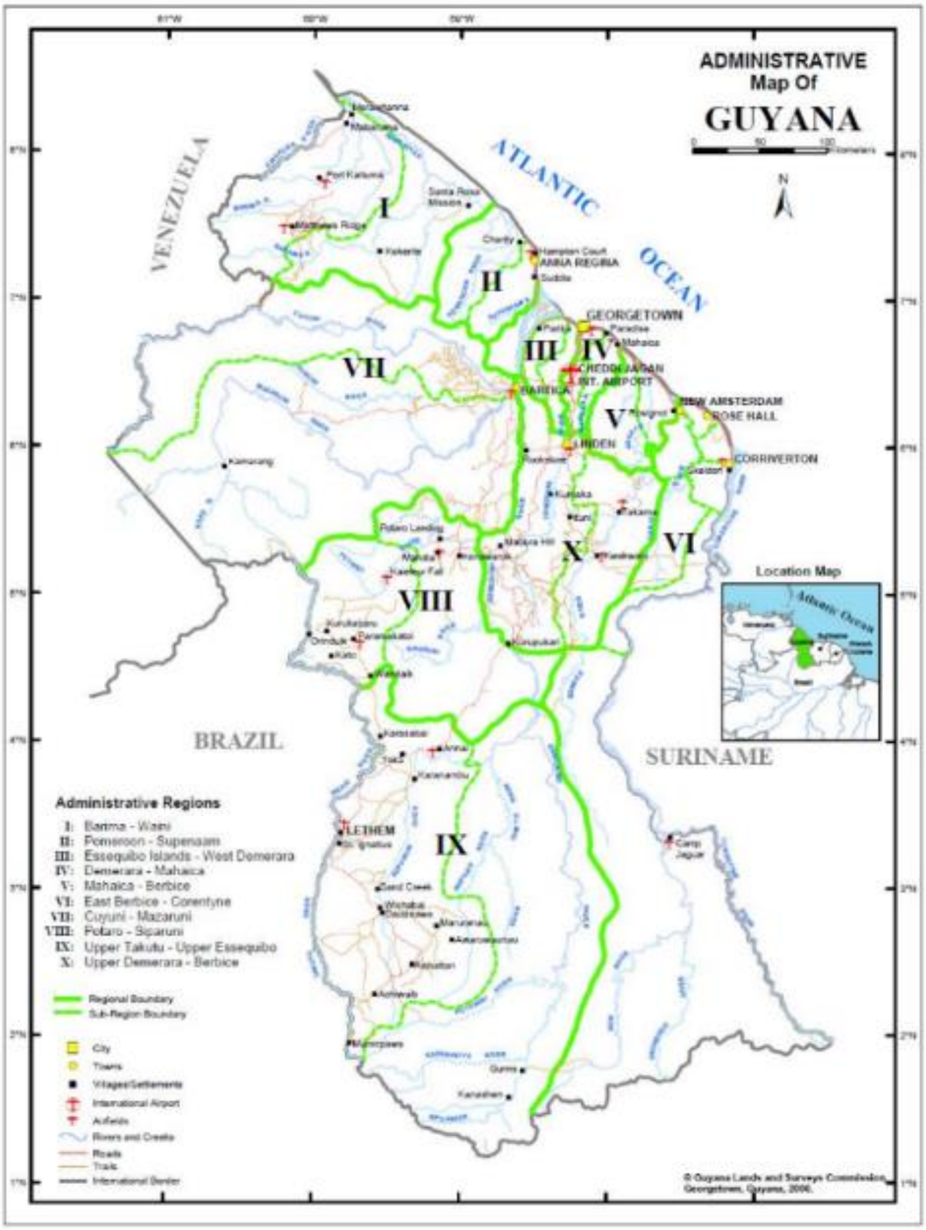


Figure 1.1. Guyana's administrative regions.
Source: (Guyana Lands and Surveys Commission, n.d.)

At the national level, the GoG is divided into the executive, legislative, and judicial branches as follows:

- **Executive Branch:**
    - President: The elected President is the head of state and government, responsible for the overall administration of the country.
    - Cabinet: Ministers appointed by the President are responsible for various government departments and functions.
- **Legislative Branch:**
    - National Assembly: Guyana´s unicameral legislature is comprised of elected Members of Parliament responsible for making laws.
- **Judicial Branch:**
    - Judiciary: Independent systems of justices and judges responsible for interpreting and upholding the law, headed by the Supreme Court and the Chief Justice.

3. Geography and topography

Geographically situated in South America, Guyana is an integral part of the expansive Guianas Shield and the Amazon Biome. It is bordered by Venezuela to the West, Brazil to South, Suriname to the East, and Atlantic Ocean stretching along the North.

Guyana´s territory encompasses a total surface area of 214,970km^2, with 196,850km^2 of land over 724km of continental extent and 18,120km^2 of water over 430km of coastline. Despite its modest size, Guyana's diverse topography and ecological richness are remarkable. As illustrated in Figure 1.2, the country's landscape is marked by four natural biophysical regions as follows:

- **Low Coastal Plain:** A narrow belt bordering the Atlantic Ocean comprising 5% of Guyana´s total land mass. This zone lies at an average 0.5-1m below mean sea level and up to 3m below high tide, necessitating an extensive system of sea and river defences as drainage networks for protection against coastal flooding. This region is also prone to seasonal fluvial flooding as it lies on the delta of various watersheds and downstream of key water conservancies. Due to its silty clay, pegasse, and sandy soil, the region is an agricultural hub for fruits, vegetables, rice, sugar, and coconut. Furthermore, 90% of the Guyanese population lives in this zone, centred around the urban hubs of Georgetown.
- **Hilly Sand and Clay Region:** Extending approximately 160km southward from the coastal plain, this region encompasses 15% of Guyana´s land territory. Composed of crystalline basement rock outcrops, the region is known for its bauxite mines, red and

white clay and hills ranging 30-122m in height covered in scrub (low) to medium height vegetation. Its main resources and economic activities are bauxite mining, logging and stone quarrying. Clay, sand, and alluvial soils extend through this region and saturated soils are common in water-logged areas around rivers and estuaries.

- **Forested Highland:** A densely forested area comprised of table-top mountain ranges, steep escarpments, waterfalls, and rapids extending 73% of the country's land mass (approximately 156,450km^2). The area is rich in forest, gold and diamond deposits, and is home to the majority of Guyana´s Amerindian populations. Soils vary from deep peat in poorly drained low-lying areas, lithosols across steep slopes, to deep reddish-brown soils with visible horizons (latosols), especially on old erosion surfaces.
- **Interior (Rupununi) Savannahs:** Contained within the forested highlands, the North and South Savannahs are divided by Kanuku Mountains. The vegetation consists of mostly grassland, scrub and low trees with hills, supporting cattle ranching, balata bleeding and farming, whereby savannah fires are common and play a vital role in maintaining the local ecosystem.

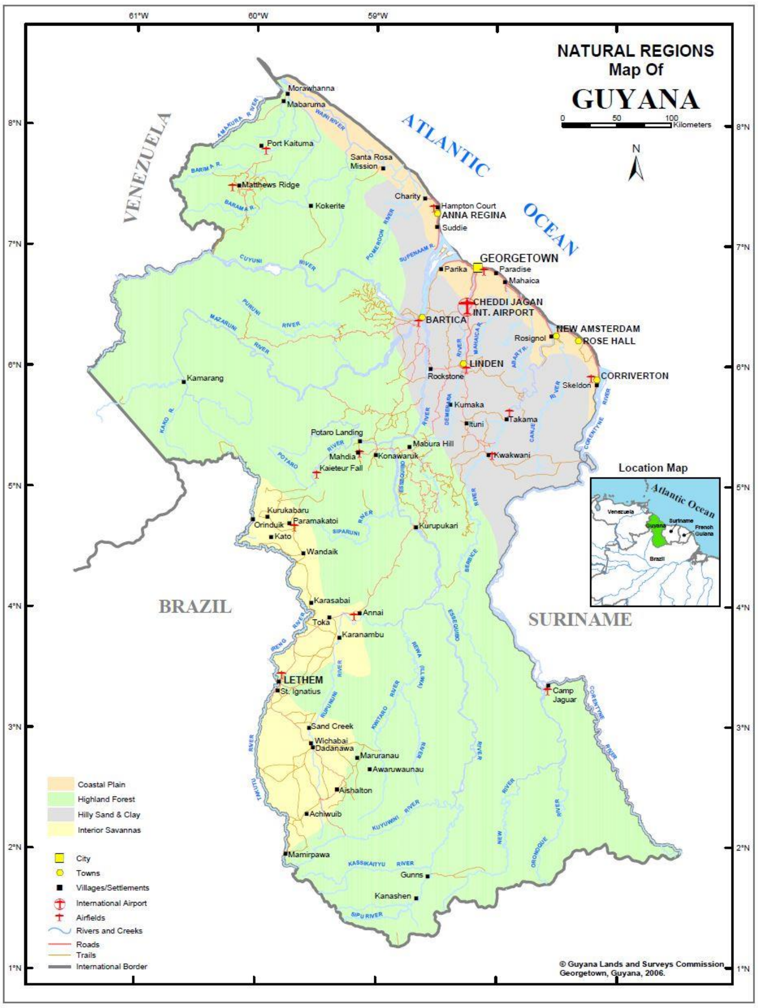


Figure 1.2. Guyana's natural biophysical regions.
Source: (Guyana Lands and Surveys Commission, n.d.)

4. Natural resources

Guyana boasts plentiful natural resources including water, minerals, forests, biodiversity, and oil and gas, all of which sustain local and traditional livelihoods and support socioeconomic development.

4.1. Hydrological resources

Guyana is derived from the Amerindian word "Guiana" which translates to "land of many waters".

Guyana has six major national **watersheds** that drain into the Atlantic Ocean, namely the Essequibo, Mazaruni, Berbice, Demerara, Barama, and Barima watersheds. Guyana also has two major transboundary watersheds: the Cuyuni watershed, which originates in Venezuela and ends in the Essequibo River, and the New River Watershed, which originates in the far Southeast of Guyana and ends in Suriname. Guyana is party to the Amazon Cooperation Treaty Organisation (ACTO), formed by eight countries of the Amazon Basin to promote, among other things, sustainable cross-border water management (Ministry of Finance, 2023).

Abundant in **freshwater resources**, Guyana has an estimated renewable annual per capita water availability of 344,541m^3 obtained from of rivers, lakes, wetlands, conservancies, and groundwater aquifers, ranking Guyana the third country with the highest quantity of freshwater per capita globally (Ministry of Finance, 2023). A total annual 1,836m^3 per capita water withdrawal is estimated, with agricultural, domestic, and industrial consumption remaining stable over the 2015-2022 period and agriculture accounting for 94% of the total withdrawal rate (Food and Agriculture Organisation, 2014).

The overall availability of freshwater is currently not an issue for Guyana. Rather, the country is actively addressing challenges to control seasonal flooding and droughts by regulating the equitable water distribution between the dry and rainy seasons and across its various regions.

As shown in Figure 1.3, surface freshwater is perennially plentiful in most of the country spanning Regions 7, 8, 10, and most of 6. Surface freshwater is seasonally plentiful across Regions 5 and North of 9, with the South of Regions 6 and 9 showing drought-like conditions between October and March. On the other hand, surface freshwater is very scarce along the coastal zone due to tidal influence inflicting brackish and saline water up to 80km upstream of major rivers and over 200km upstream of smaller rivers, which would be exacerbated by sea level rise (Netzer et al, 2014).

Guyana has an **extensive system of rivers and creeks** that not only provide most of Guyana´s inland freshwater resources, but also serve as a comprehensive riverine transport network, and could potentially provide 8.5GW of hydropower if developed. The riverine network is crucial to reach remote Hinterland communities and to sustain exports of agricultural and mining products. The Essequibo, Berbice, and Demerara Rivers are the country´s three primary waterways, supplying 40.4%, 10.4% and 5.0% of Guyana´s freshwater with a total annual flow of 1,247km^3/yr, 322km^3/yr, and 153km^3/yr, respectively. Other secondary coastal rivers include the Barima, Waini, Kaituma, Pomeroon, Supenaam, Moruca, Mahaica, Mahaicony, Abary, and Canje Rivers.

This nature makes Guyana extremely prone to seasonal flooding, which, due to the flat topography of the coastal zone and extensive river deltas, tend to recede very slowly, leaving stagnated river water for several weeks.

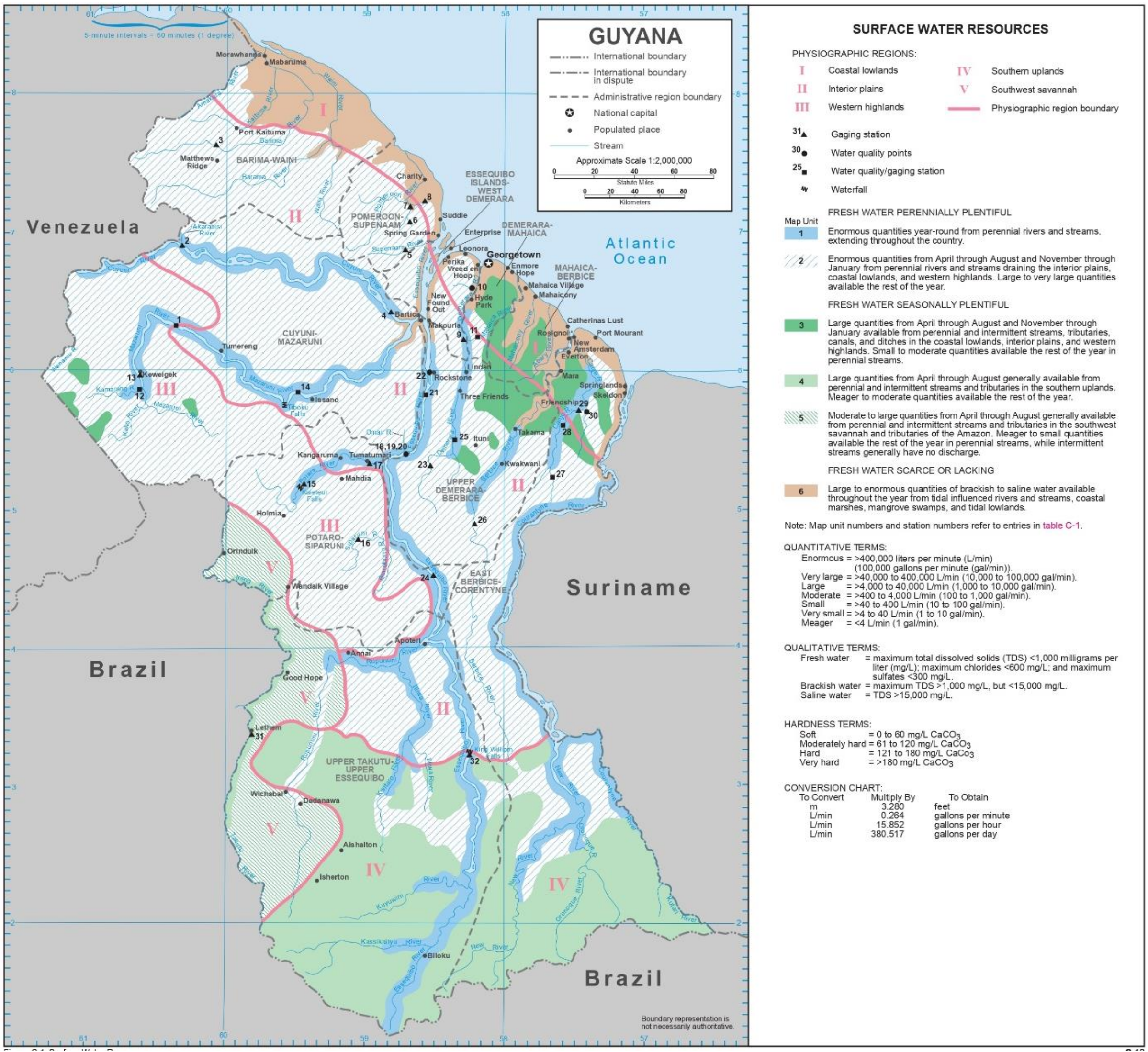


Figure 1.3. Surface water resources.
Source: (United States Army Corps of Engineers, 1998)

There are 37 **natural lakes** scattered throughout the country and eight **artificial water conservancies**, across Regions 2, 3, 4, and 5. The conservancies are shallow reservoirs of varying sizes seeking to collect sufficient water for irrigation during periods of low rainfall and help control flooding during the rainy seasons. The conservancies are supported by a complex system of drainage and irrigation networks, with water from the conservancies taken into the agricultural lands by a network of irrigation canals and mobile pumps, and then leaving these lands to be discharged into the ocean by another network of drainage canals and stationary pumps and sluices.

Collectively, these structures provide irrigation water and flood control to populated coastal urban areas and surrounding agricultural lands. However, the conservancies are also a flood threat, because they store water at levels above the natural ground level contained by earthen dams which are subject to high levels of erosion and structural failure, coupled with systematically low maintenance, risking breaches and overflows.

The four most important conservancies are:

- Mahaica Mahaicony Abary (MMA) Conservancy: With a 609 million m^3 capacity, it irrigates 175 km^2 of agricultural land contributing between 35 to 50% of the gross national rice production.
- East Demerara Water Conservancy (EDWC): With a capacity of 16 million m^3, it irrigates 345 km^2 of land and the entirety of the Guyana Sugar Corporation, as well as providing potable water for Georgetown.
- Boerasirie Conservancy: With a 166 million m^3 capacity, it irritates 360 km^2 of land and is one of Guyana's major flood control facilities.
- Tapakuma Conservancy: With a capacity of 18 million m^3, it irrigates 20km^2 of land.

There is an intricate system of **wetlands** in Guyana, with at least 22 recognised naturally occurring wetlands. These wetlands are a unique and highly diverse ecosystem that is extremely important for biodiversity and ecosystem services (World Wildlife Fund Guianas, 2016). The intricate characteristics of these environments, coupled with the delicate and ever-changing interactions among the organisms that dwell in these areas, render wetland ecosystems particularly susceptible to environmental disruptions, including climate change (Ruiz-Ramos, et al., 2020). The largest wetlands in the country are the North Rupununi wetlands which cover an area of 220km^2. These wetlands are vast areas of flooded savannahs that store enormous quantities of water in the rainy season and slowly release it into the Essequibo River, limiting the severity of flooding in coastal Essequibo communities.

Groundwater is invaluable for Guyana, particularly across the coastal zone, which houses the vast majority of Guyana's population and agricultural activity but has limited access to surface freshwater due to the brackish and saline conditions of the river deltas. Guyana has three coastal groundwater aquifers that cover an area of 20,000km^2 - Upper Sand (1831 to 1931), A

Sand (1931 to present) and B Sand (1962 to present). The Upper Sand is the shallowest among the three, with depths ranging from 30m to 60m and thickness from 15m to 120m. However, it is not utilized as a water source due to its elevated iron content. The latter two aquifers are the primary sources of potable water for the coastal urban centres. The A Sand aquifer is found at depths between 200m and 300m, with a thickness ranging from 15m to 60m, whose water needs treatment to eliminate iron. The B Sand aquifer is situated at approximately 300m to 400m depth and has a thickness ranging from 350m to 800m, whose water needs treatment to eliminate traces of hydrogen sulphide.

Inland aquifers are shallow, lying between 10m to 30m depth, and more recently used as potable water sources for Hinterland communities, including the Sands Plateau (Region 10), the Takutu Sandstone Formation (Region 9), and the Barima Mazaruni Supergroup (Region 9) aquifers.

While water availability is plentiful, **water quality** is an area that Guyana has been addressing. Saltwater intrusion poses a significant risk to both surface and groundwater sources up to hundreds of kilometres inland. Pollution from sewerage overtopping, mining tailings, and agricultural runoff is also an area that is being addressed and involves the work of agencies at national, regional and community levels. (Environmental Protection Agency, 2016).

4.2. Forests and protected areas

Guyana is a high forest cover low deforestation rate country. Approximately 85% of Guyana´s land territory is covered by forests, including a substantial portion of the Amazon Rainforest, spanning approximately 18.39 million ha across four tenure classifications illustrated in Figure 1.4. Of this total, 85% is classified as State Forest, State Lands, and Protected Areas. Amerindian Titled Lands account for 15%.

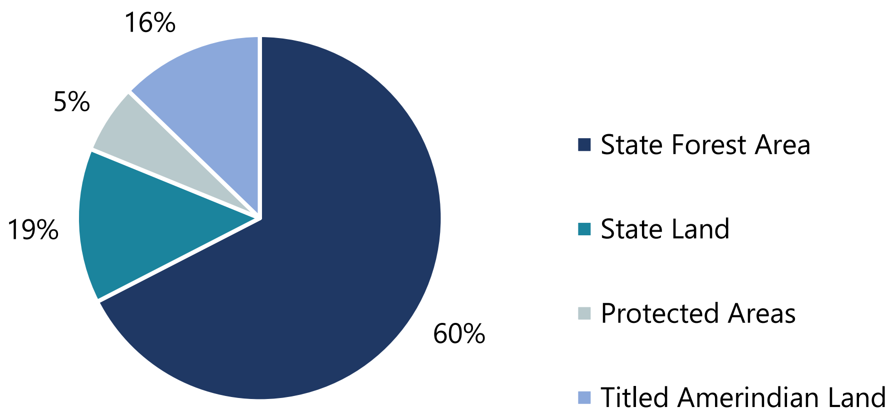


Figure 1.4. Forest tenure types in Guyana. Source: (Government of Guyana, 2022a)

Forests are one of Guyana´s most valuable natural assets as they contain an estimated 5.96 Gt of carbon in aboveground biomass which is equivalent to 21.8Gt of CO_2 with the inclusion of soil carbon. They are also critical habitat for diverse species and provide substantial ecosystem services such as flood regulation, water filtration, erosion control, timber products, and ecotourism opportunities.

Guyana is committed to safeguarding its forests, recognising their vital role in mitigating climate change by absorbing substantial amounts of CO_2, while providing key ecosystem services sustaining socioeconomic and environmental well-being and resilience in the country and globally.

1.1 million ha are designated as Protected Areas (Guyana Forestry Commission, 2018), including the Kaieteur National Park, Iwokrama International Centre for Rainforest Conservation and Development, Shell Beach and Kanuku Mountains Protected Areas, and Kanashen Community Owned Conservation Area, as well as the urban parks such as the National Park, Botanical Gardens, Zoological Park, and Joe Viera Park.

Historical deforestation in Guyana has been one of the lowest rates in the world ranging between 0.02% and 0.079% over the last two decades. Nevertheless, mining, agriculture, road infrastructure projects, forestry, and wildfires are the main drivers of deforestation and forest degradation in Guyana. Mining is the primary deforestation driver, accounting for 85% of all deforestation between 2001 and 2012, and 74% of deforestation between 2013 and 2020.

Since 2011, the forestry sector has accounted for less than 3% of national GDP. However, forestry is an important sector in Guyana as it directly employs over 22,000 individuals, with almost half involved in logging activity, and timber constitutes an important export, valued at US $26.5 million in 2021.

Guyana is spearheading sustainable logging operations through a robust policy and regulation framework compliable with international standards including the Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement (FLEGT VPA) signed with the European Union in December 2022. As such, associated deforestation is nearly zero among the 120 species currently logged, under which 15 are exported at a commercial scale.

Further, Guyana actively engages in the REDD+ (Reducing emissions from deforestation and forest degradation) framework and has built a world-class Monitoring Reporting and Verification System (MRVS), enabling it to benefit from forest results-based payments contribution to climate change mitigation.

4.3. Biodiversity

Guyana, as one of the eight nations in the Amazonian Cooperation Treaty (ACTO), actively plays a role in preserving the extensive biodiversity of the Amazon Rainforest. There are 47,677 unique species classified as part of Guyana, of which 17,291 (36.27%) are already classified as an endangered species (Convention on Biological Diversity, 2014), including:

- 8,000 plant species, 50% of which are endemic.
- More than 400 species of fish with at least 10 new species found annually.
- Over 130 species of amphibians with several endemic species.
- 814 species of birds.
- Over 200 species of mammals.
- More than 1,600 species of arthropods.
- Approximately 1,200 fungal species.
- 33 bacterial species.
- 44 algae species.
- 17 mollusc species.
- 30 viruses.

In terms of agricultural biodiversity more than 200 species of fruits and vegetables are cultivated in the agro-ecosystem. It is also estimated that more than 1,000 species are grown as ornamentals in the horticultural industry of Guyana. Various types of livestock are reared including poultry, goats, sheep, cattle, swine, horses, and mules, exhibiting a wide variety of exotic breeds interbred with local breeds to improve production (Food and Agriculture Organisation, 2016).

4.4. Minerals

Guyana is rich in mineral deposits of bauxite, gold, and diamonds, as well as notable deposits of semiprecious stones, laterite, manganese, kaolin, sand resources, radioactive minerals, copper, molybdenum, tungsten, iron, and nickel among others. The mining and quarrying sector represents a critical component of Guyana’s economy, contributing to 12.15% to Guyana’s GDP, 39.96% of Guyana’s total exports, and 14% of the total national labour force as of 2021 (Extractive Industries Transparency Initiative, 2023).

Mineral mining is generally allowed in six designated districts across Guyana’s Hinterland, as illustrated in Figure 1.5. Mining sites are remote and rely on riverine transportation and non-paved land networks, with operations therefore being highly vulnerable to the impacts of climate change.

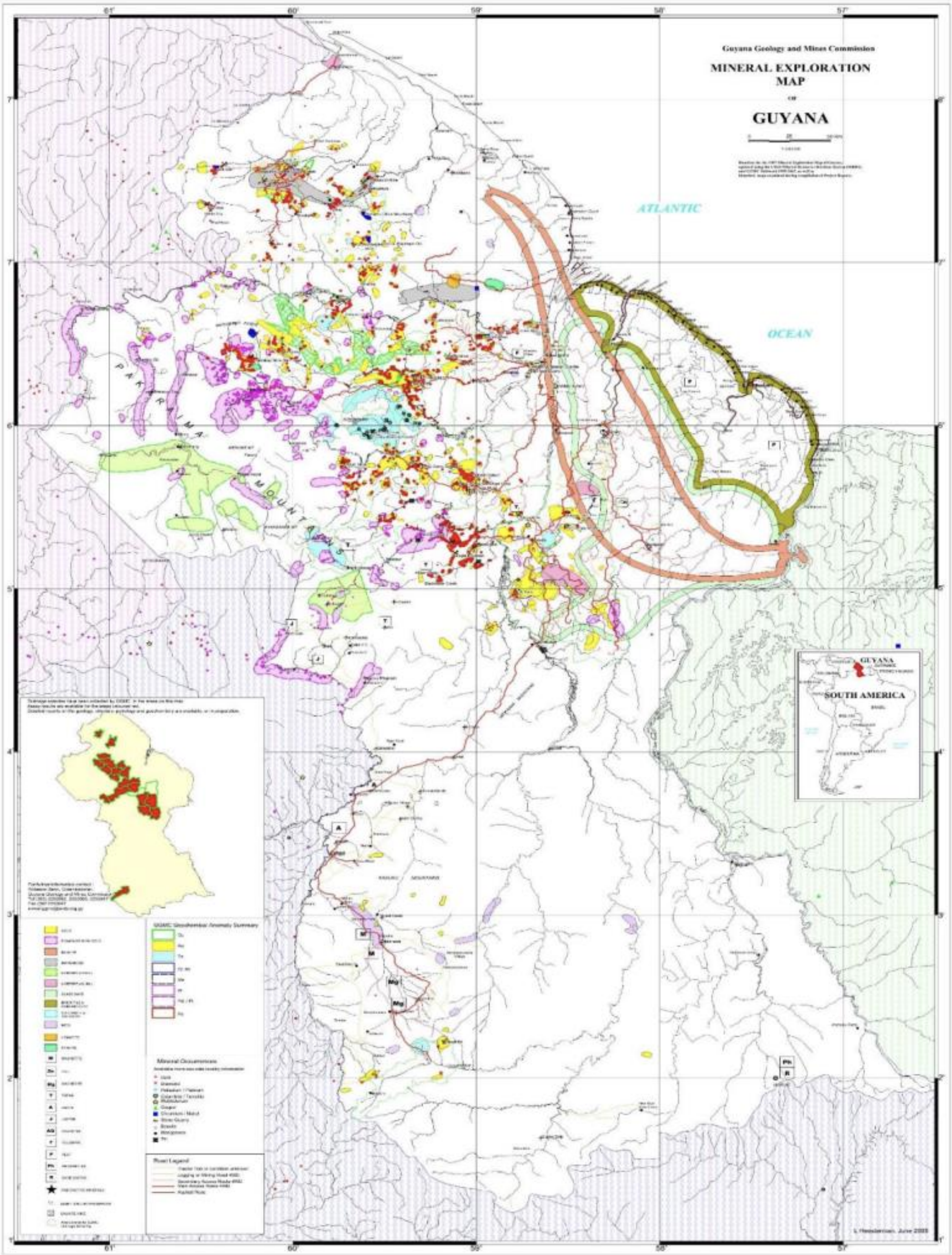


Figure 1.5. Land tenure map for mining licenses and permits.
Source: (Extractive Industries Transparency Initiative Guyana, 2023).

Approximately 90% of the current mining leases are issued by the Guyana Geology and Mines Commission and are located within the state forest boundary. Approximately 61% of issued prospecting licenses for potential future mining operations overlap with the state forest (Inter-American Development Bank, 2017).

Guyana is actively working on improving sustainable mining practices to maintain their critical role in national socioeconomic development, while protecting vulnerable forests in which they partake, including the key mitigation and adaptation ecosystem services they provide.

4.5. Oil and gas

In 2015, offshore petroleum was discovered in commercial quantities. With over 11 billion barrels discovered to date, additional exploration is being carried out as shown in Figure 1.6.

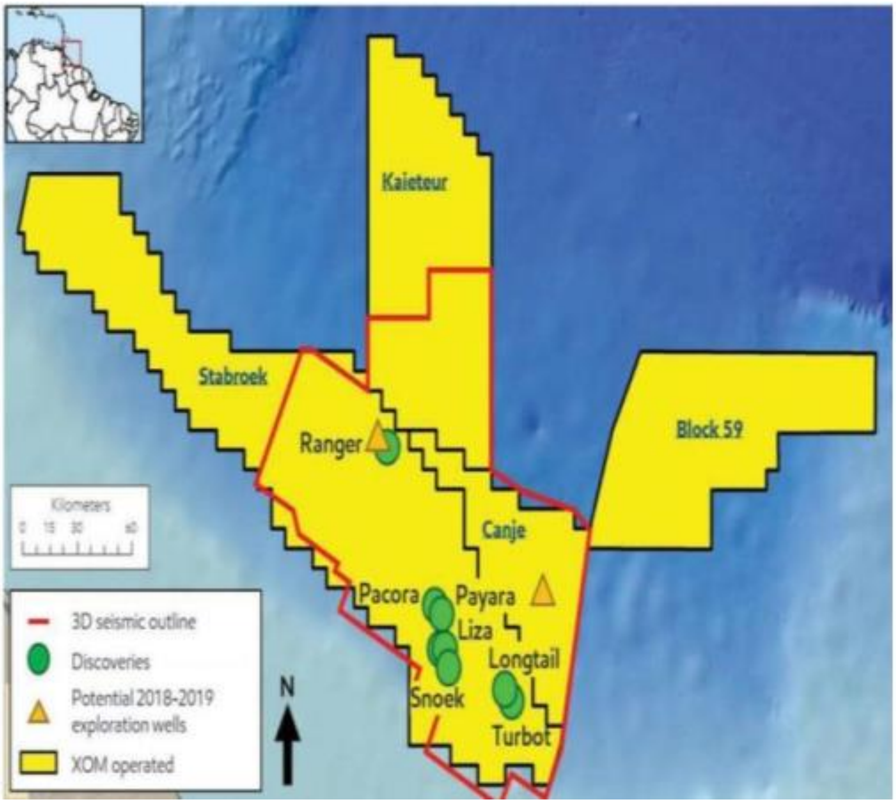


Figure 1.6. Guyana's coastal offshore petroleum exploration area.
Source: (Exxonmobil, 2016)

Oil production started in December 2019 with one Floating Production Storage and Offloading (FPSO) site, increased with a second FPSO commissioned in 2022 and a third in 2023. It is expected that at least three more FPSO will be commissioned in the coming years, with a total production capacity of over 1 million barrels of oil per day beyond 2028.

Guyana is committed to aligning its emerging oil and gas sector with global climate action. As set out in the Low Carbon Development Strategy (LCDS 2030), the environmental permit for the FPSO are issued with a carbon tax on flaring in amounts exceeding the non-routine flaring, including a carbon tax of US \$50/tonCO_2 emitted. All FPSOs have been designed as non-routine flaring to minimize associated emissions, whereby extracted gas is compressed and reinjected in the well, increasing production of oil and reducing the amount of flaring.

5. Climate profile

Guyana´s climate is defined as having wet tropical conditions with persistent humidity and abundant rainfall observing clear differences between rainy and dry seasons influenced by the annual migration of the Inter-Tropical Convergence Zone. The country observes generally warm temperatures without the extremes of hot or cold, whereby the national mean temperature is 24.17°C, while the national maximum temperature is 29.69°C on average.

Internal variations in climate arise from the influence of Northeast trade winds, convection currents, and orographic lifting, resulting in two main climate patterns in Guyana as follows:

- **Hot climate with two rainy seasons spanning most of the country through Regions 1, 2, 3, 4, 5, North of 6, 7, 8, and 10:** Central and Coastal Guyana observes temperatures between 25°C and 27.5°C with two distinct rainy seasons spanning from mid-April to mid-August/ mid-November.
- **Warm climate with a single rainy season spanning the South of the country through Regions 9 and South of 6:** Highland regions in the South of the country have temperatures ranging from 20°C to 23°C with a single rainy season spanning May to July. Upper Mazaruni Mountains, receiving over 4,000mm of rainfall, contribute to the country's intricate humid climate.

Average daily precipitation across the country is 4.6mm/day, oscillating between years of higher and lower cumulative precipitation under the cyclical nature of El Niño Southern Oscillation (ENSO). Lower amounts of rainfall are observed during El Niño (warmer) phases and greater amounts during the La Niña (cooler) phases. Regional distribution of precipitation is varied, with the North of the country observing an abundance of water year-round, with the capital of Georgetown witnessing an average annual rainfall of approximately 2,300mm. The South of the country, however, observes drought-like conditions during the dry season.

5.1. Climate change trends

Guyana is already observing the following climate trends compared to the 1950-2000 historical average:

- **Mean temperatures** have increased by up to 0.34°C.
- **Average maximum temperatures** have increased by up to 0.14°C.
- **Mean daily precipitation** has increased by 0.91mm/day.
- **Sea level** has risen at a rate of 10 mm/year, which is 2 to 5 times faster than the global average. Despite being outside of the mid-Atlantic hurricane belt, Guyana has suffered from high winds and storm surges triggered by hurricane activities in the past.

- **Change in seasonality** has been observed, whereby rainy seasons have become shorter and more intense, leading to severe seasonal flooding as well as periods of drought and saltwater intrusion.

By 2050, mean daily temperatures are projected to increase by an average of 1.60°C compared to the historical average, whereas average daily maximum temperatures could increase by an average of 1.46°C, resulting up to 10 heat waves per months scattered throughout various regions of Guyana. While average precipitation is expected to remain relatively constant compared to current amounts, disparities in water distribution between dry and rainy seasons are projected to intensify, manifesting in extensive flooding year-round throughout Central and Coastal Guyana and severe droughts in the Southern portion of the country during the dry season. By 2050, average sea level may rise by up to 0.34m above current values and up to 6m when accounting for the effect of storm surge.

5.2. Climate impact

The ongoing and projected changes in climate are already inflicting a series of slow onset extreme acute impacts for Guyana including extreme heat, fires, drought, storm, strong winds, fluvial flooding, coastal flooding, water pollution, and pests and diseases, all of which will increase in frequency, intensity, and extent in the future.

The impact of these climate hazards is resulting in major economic losses, infrastructural damage, food insecurity, energy insecurity, community isolation, loss of trade connectivity, shifting traditional livelihoods, biodiversity loss, ecosystem degradation, inland migration, physical and psychological stress, educational disruptions, and spread of water and vector-borne diseases.

According to Germanwatch (2021), Guyana Ranks 119th in terms of climate risk index for the 2000-2019 period, being 49th in average losses per unit GDP related to climate-induced extreme weather events. Guyana has already suffered from flooding events in 2005, 2006, 2008, 2010, 2011, 2013, 2014, 2015 and 2021, with the catastrophic floods of 2005 and 2021 causing losses equivalent to 60% and 12% of the national GDP respectively, particularly impacting coastal urban centres and over 60,000 farmers.

The coastal zone's particular vulnerability to flooding is due to its low-lying flat nature below current mean sea level and dependence on an aging sea wall defence and drainage network, coupled by its location on major river deltas downstream of water conservancies, exacerbated by its socioeconomic importance for housing over 90% of the Guyanese population and the majority of active agricultural lands.

6. Socioeconomic profile

6.1. Population and demographics

Guyana´s population structure has evolved irregularly due to various migrations and immigration periods, resulting in periods of societal expansion and decline, as well as certain age groups predominating national demographics.

Once significantly expansive until 1980, population growth stagnated until 2012 with two episodes of decline followed by rapid expansion, as illustrated in Figure 1.7. Since 2012, population growth has been steadily increasing at an average annual rate of 0.3%, manifesting in Guyana's current population estimated at over 780,800. This steady growing trend is expected to continue through 2035 due to attributed to significant economic development underway in the country.

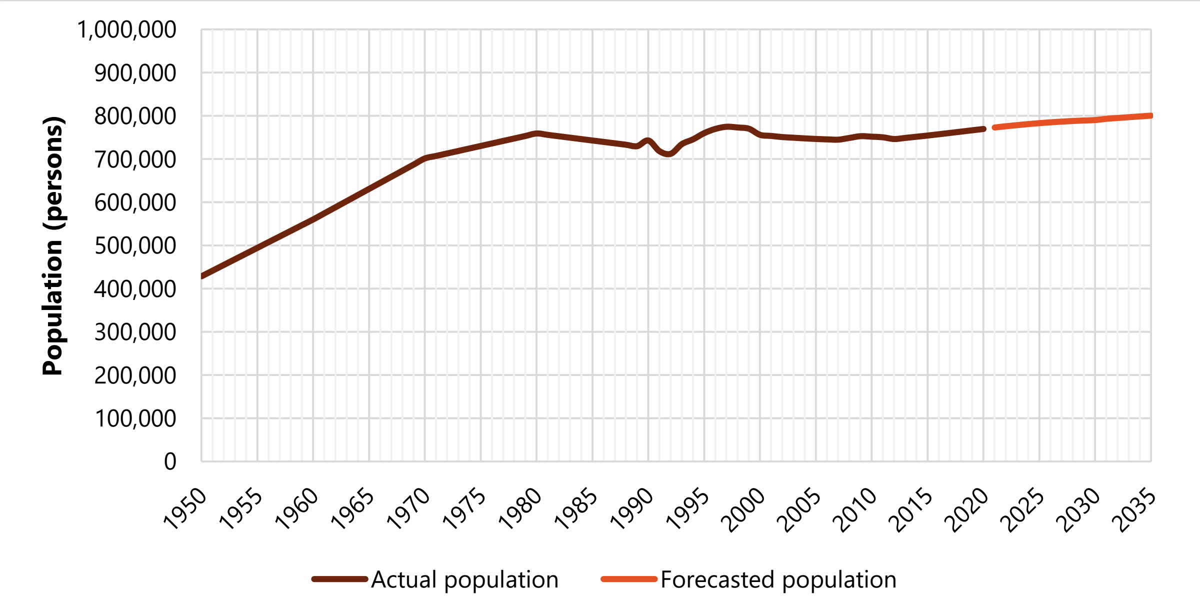


Figure 1.7. Estimated population by year.
Source: (Bureau of Statistics, 2024a).

As illustrated in Figure 1.8, the above-mentioned population evolution has resulted in an irregular demographic structure observed from elevated fertility rates and relatively low life expectancy, coupled with bi-directional migratory patterns. There is a significant expansive group below 20 years of age as well as mid-size population above 40 years of age. On the other hand, Guyana witnesses a shrinking prime working age group (20-39 years of age) due to continuous outward migration counter-balanced by influx of foreign-born individuals mostly 20-49 years' age. However, Guyana maintains a balanced gender distribution.

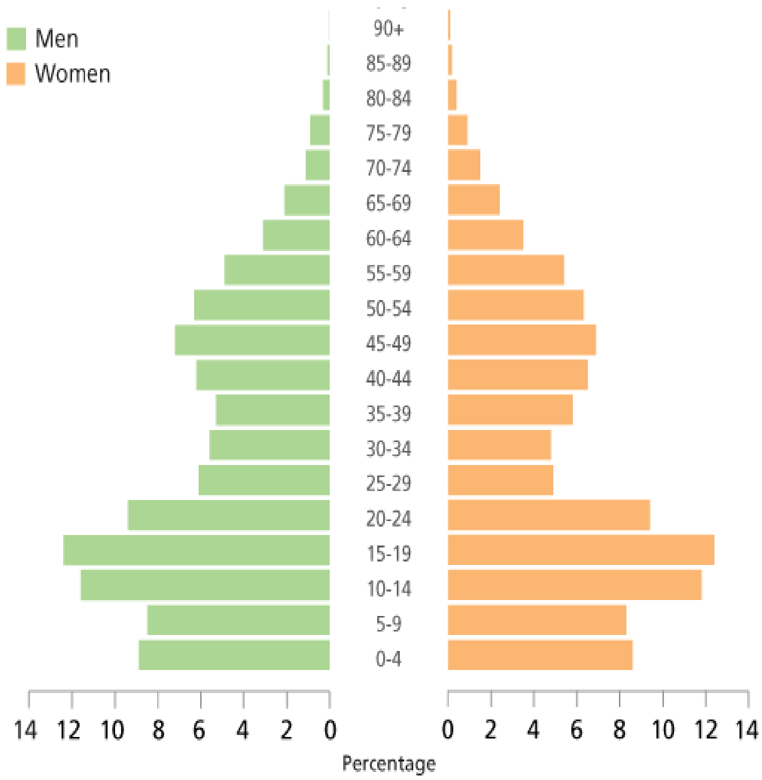


Figure 1.8. Population age-sex distribution 2015.
Source: (Bureau of Statistics, 2019).

Approximately 90% of the national population resides on the narrow coastal strip, constituting only 5% of the country's total land area. As shown in Figure 1.9, the highest population density occurs in Region 4 accounting for over 42% of the total national population, mostly concentrated around the greater Georgetown Metropolitan Area. The Hinterland (Regions 1, 2, 8, and 9) have the lowest population densities, often residing in small and remote communities. Continued urbanization migration patterns are observed.

Guyana's population is a tapestry of multi-ethnicity, consisting of six main ethnic groups with ancestry from India, Africa, Europe, Madeira, and China, as well as Amerindian peoples, the original inhabitants. These include Indo-Guyanese (40%), Afro-Guyanese (26%), Amerindian (11%), and ethnically mixed individuals (20%).

Ethnic groups also exhibit distinct territorial distribution, with Amerindian populations more prevalent in rural areas. The country has many migrants from Suriname, Brazil, Venezuela, and Caribbean countries. With English being the official language, other languages predominantly spoken include Amerindian dialects, Creole, Hindi, and Urdu.

Education plays a pivotal role in societal advancement. As of 2020, Guyana has a national average illiteracy rate of 10%, with the Coastal regions observing lower rates at 6% and the Hinterland regions observing higher illiteracy up to 16% (Bureau of Statistics, 2020).

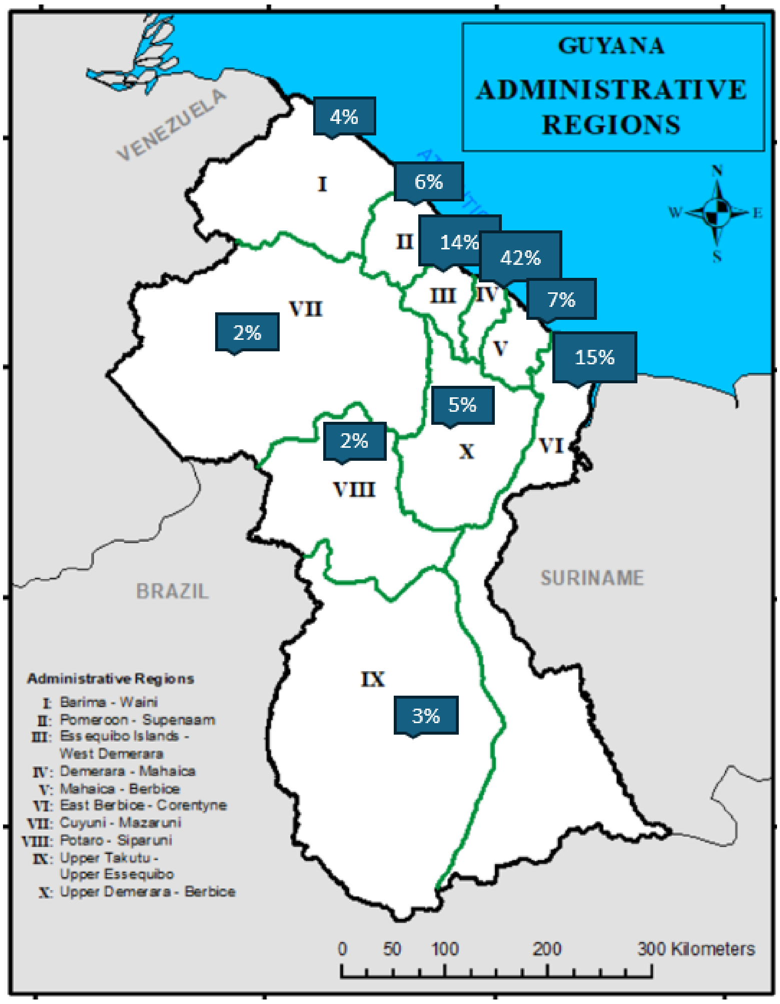


Figure 1.9. Regional population distribution.
Source: (Bureau of Statistics, 2019).

As per the latest available figures shown in Table 1.1, the overall unemployment rate is 13.4%, showing significant gender, regional, and age disparities. Guyana's Human Development Index (HDI) for 2022 is 0.742, which puts the country in the high human development category, positioned at 95 out of 193 countries and territories (United Nations Development Programme, 2024a). This is part of an ongoing socioeconomic development trend, significantly advancing the country from a HDI 0.538 value in 1990. Correspondingly, Guyana's Gender Inequality Index (GII) for 2022 is 0.416 ranking 104. (United Nations Development Programme, 2024b).

Table 1.1. Unemployment rate in 2019.

Group	Overall workforce (Ages 15-64)	Youth workforce (Ages 15-25)
Men	12.5%	25.3%
Female	14.7%	35.8%
Urban	13.9%	35.2%
Rural	12.3%	27.6%
Total	13.4%	29.7%

Source: (Bureau of Statistics, 2020)

6.2. Economy

Historically rooted in natural resources and agriculture, Guyana is advancing structural reforms to diversify and expand its domestic economy. Guyana currently stands as one of the fastest-growing economies in the world attributed to the expansion of offshore oil production since 2019, coupled with substantial sustained growth in the non-oil economy including a significant scale-up of infrastructure investment to support growth in other industries.

The official currency is the Guyanese dollar, and the exchange rate is regularly adjusted, currently standing at G $208.74 to US $1 as of July 2024 (Forbes, 2024).

The evolution of Guyana´s gross-domestic product (GDP) is illustrated in Figure 1.10 in constant 2012 Guyanese dollars. As of 2022, Guyana´s GDP summed to G $5,214,868 million in constant 2012 prices, accompanied by an impressive 63.3% real GDP growth rate to constant 2012 prices, indicating a tripling of Guyana's economy in recent years. Public sector gross debt is approximately 26% of GDP and are expected to continue in the same levels over next years.

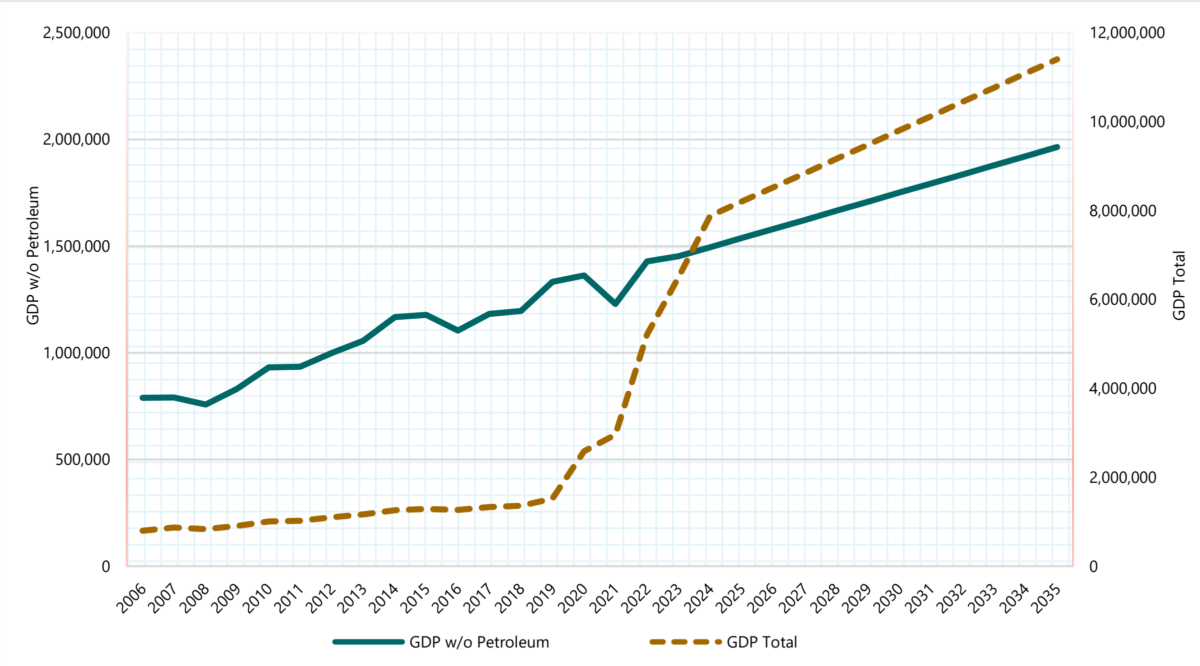


Figure 1.10. GDP evolution in constant 2012 G$ million prices.
Source: (Bureau of Statistics, 2024b).

As illustrated in Figure 1.11, Guyana's historical economy was based in agriculture (both subsistence-based and export of sugarcane, rice, shrimp, rum, and molasses) and mining (primarily of gold and bauxite extraction and exports), as well as timber production and exports, in addition to services and ecotourism concentrated primarily in the Hinterland due to Guyana's rich flora and fauna.

A significant shift occurred in 2019 with the discovery of substantial offshore oil deposits, leading to a pivotal role for the oil sector since 2020, driving economic growth and development. Revenues from the oil activities are deposited in a Sovereign Natural Resource Fund (NRF), the NRF Act allows for transfers from the NRF to the national budget to allow for public expenditure in key development projects and sectors.

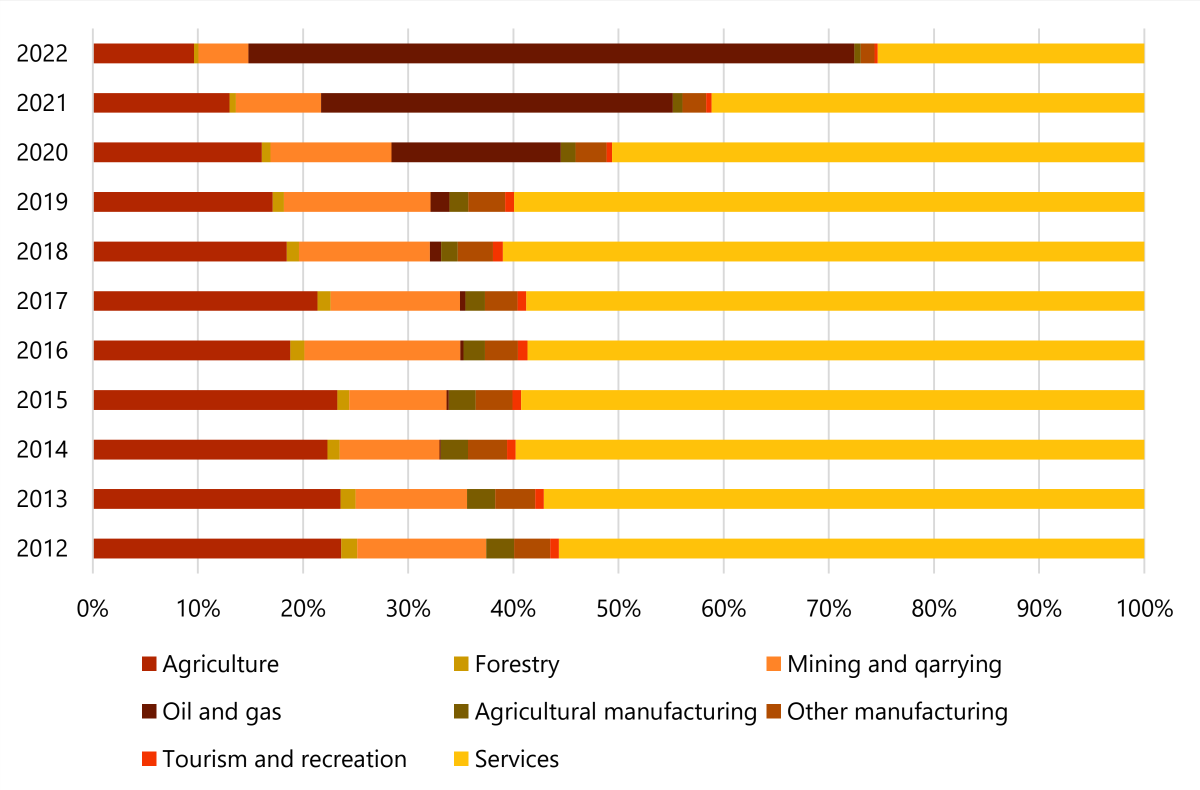


Figure 1.11. GDP evolution in constant 2012 G$ million prices.
Source: (Bureau of Statistics, 2024c).

Provisional data by the Bureau of Statistics for the year 2023 reveals a robust economic performance, with exports reaching US $13.2 billion and imports at US $6.6 billion. Oil exports accounted for about 88% of total exports in Guyana in 2023. Excluding oil, the major contributors to non-oil exports are sugar, gold, bauxite, shrimp, timber, and rice, representing nearly 90% of the country's non-oil exports.

Inflation average hovers at a low 0.7% (April 2024 - May 2024).

7. Energy sector overview

7.1. Current energy profile

Guyana's energy sector is currently reliant on petroleum-based fuel imports including products such as diesel, fuel oil, motor gasoline, avjet (jet fuel), avgas (aviation gasoline), kerosene, liquefied petroleum gas (LPG), and liquefied natural gas (LNG). Table 1.2 and Figure 1.12 illustrate the total annual fuel imports by product for the years 2017-2022 and tracks the changes in fuel imports over this period.

Table 1.2. Total annual imports of petroleum-based products for 2017-2022 (barrels).

Product	2017	2018	2019	2020	2021	2022
Mogas	1,323,717	1,317,450	1,375,211	1,505,954	1,676,056	1,635,026
Gasoil	2,388,315	2,572,503	3,013,280	3,140,147	3,597,281	3,849,991
Kero	78,893	76,488	77,976	80,409	85,962	74,278
Avjet	187,576	149,660	160,106	130,861	208,371	200,513
Fuel oil	1,378,196	1,458,369	1,450,255	1,504,966	1,563,278	1,694,130
LPG	193,916	209,844	225,570	247,151	264,682	266,514
LNG	3,082	333	2,538	9,685	8,263	11,068
Avgas	10,037	8,209	8,805	6,903	6,736	5,829
Total	5,563,733	5,792,857	6,313,740	6,626,075	7,410,630	7,737,349

Source: (Guyana Energy Agency, 2024)

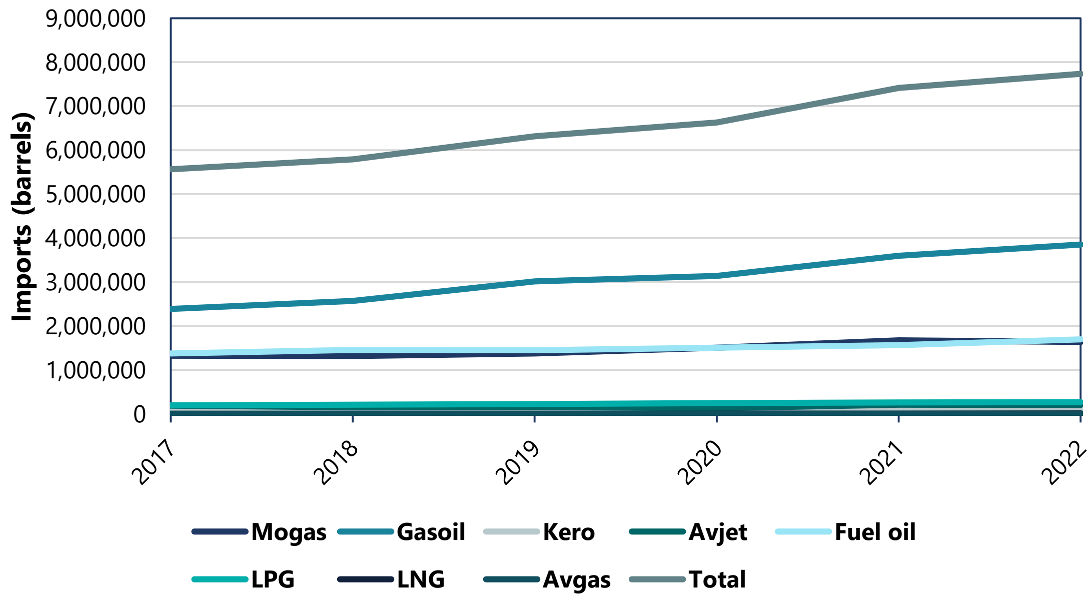


Figure 1.12. Total annual imports of petroleum-based products for 2017-2022 (barrels).
Source: (Guyana Energy Agency, 2024)

Between 2017 and 2022, Guyana imported a total of 39.4 million barrels of petroleum-based products, averaging about 6.57 million barrels per year. The data indicates that a significant volume of 7.74 million barrels of petroleum-based products was imported in 2022, averaging approximately 21,198 barrels per day. The highest increase occurred from 2020 to 2021, showing an 11.8% jump. In 2023, 49% of the imports originated from Trinidad and Tobago, with the remaining imports coming from various countries, including the United States, Sweden, Spain, Italy, Netherlands, United Kingdom, Argentina, St. Lucia, Latvia, Saudi Arabia, Kuwait, and Martinique (Guyana Energy Agency, 2024).

In the 2017-2022 period, the most imported products were gasoil, accounting for 46.8% of the total fuel products imported, followed by fuel oil at 23.1% and mogas at 22.5% (Figure 1.13). While gasoil exhibits an increasing trajectory over the years, the other two main imports are decreasing. The remaining products maintain a relatively consistent average over the five years, except for avjet, which experienced a substantial decline from 2017 to 2018 followed by a steady decrease.

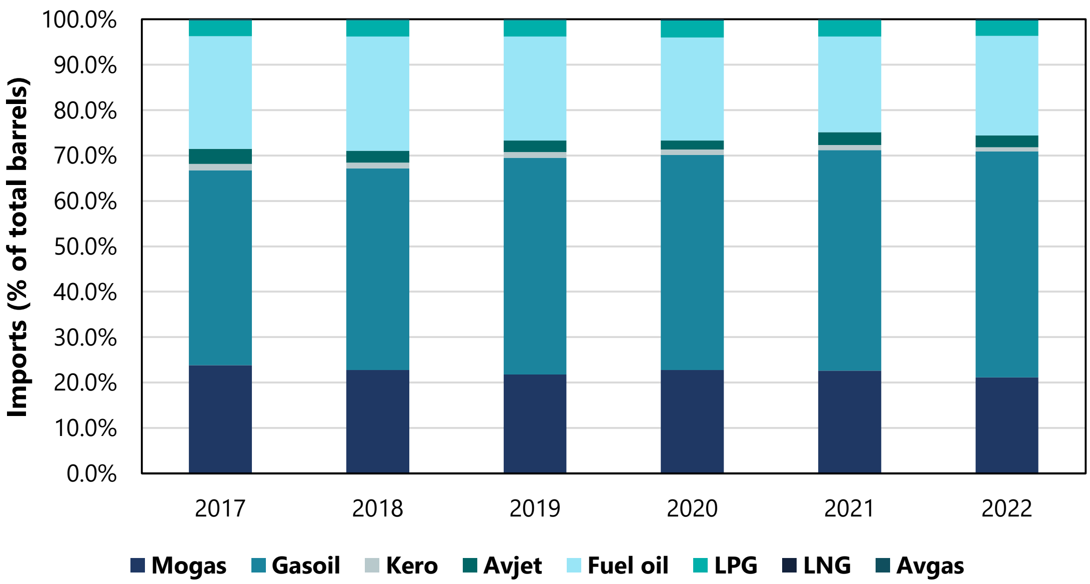


Figure 1.13. Average annual imports of petroleum-based products for 2017-2022 (barrels). Source: (Guyana Energy Agency, 2024)

A comparable upward trend of total annual consumption of petroleum-based products, as observed in imports, is evident from 2017 to 2022 (Table 1.3 and Figure 1.14). Between 2017-2022, the total annual consumption of petroleum-based products amounted to 39.9 million barrels, averaging 6.48 million barrels per year. The highest consumption occurred in 2022, reaching 7.7 million barrels, equivalent to 21,270.8 barrels per day. This indicates a consistent upward trajectory, aligning with the import trends, exhibiting an average growth rate of 18.7% with 2017 as the reference year. There was a decline in annual consumption in 2020 compared to 2019 by 3.4% (222,541 barrels less), followed by the most substantial increase from 2020 to 2021 at 12% (748,256 barrels more).

Table 1.3. Total annual consumption of petroleum-based products for 2017-2022 (barrels).

Product	2017	2018	2019	2020	2021	2022
Mogas	1,340,712	1,349,687	1,503,160	1,509,019	1,383,728	1,666,448
Gasoil	2,428,990	2,578,600	3,010,868	3,022,700	3,558,522	3,838,161
Kero	91,009	83,581	86,221	89,230	66,637	67,880
Avjet	164,564	154,992	168,921	128,935	183,209	210,913
Fuel oil	1,373,781	1,453,668	1,435,560	1,213,098	1,510,343	1,685,367
LPG	218,665	230,612	242,878	257,799	267,295	278,027
LNG	9,499	8,250	8,747	6,801	6,611	5,980
Avgas	3,082	333	2,538	8,769	8,263	11,068
Total	5,612,475	5,859,724	6,458,893	6,236,352	6,984,608	7,763,843

Source: (Guyana Energy Agency, 2024)

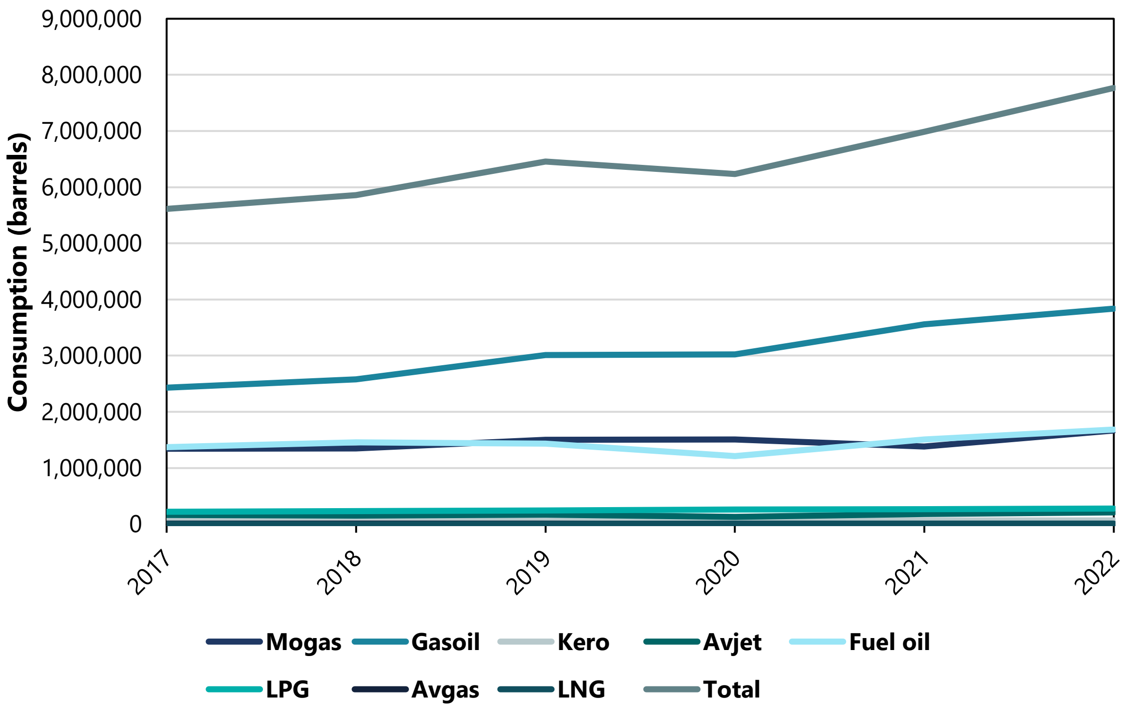


Figure 1.14. Total annual consumption of petroleum-based products for 2017-2022 (barrels). Source: (Guyana Energy Agency, 2024)

In the 2017-2022 period, gasoil has been the most consumed petroleum-based product, averaging 47.1%, followed by fuel oil at 22.4%, and mogas at 22.6% (Figure 1.15). Gasoil exhibits an increasing trajectory until 2022, where it slightly drops, while the others show a modest decreasing trend. Other petroleum-based products, such as kerosene, are decreasing, while others maintain a relatively consistent average over the five years.

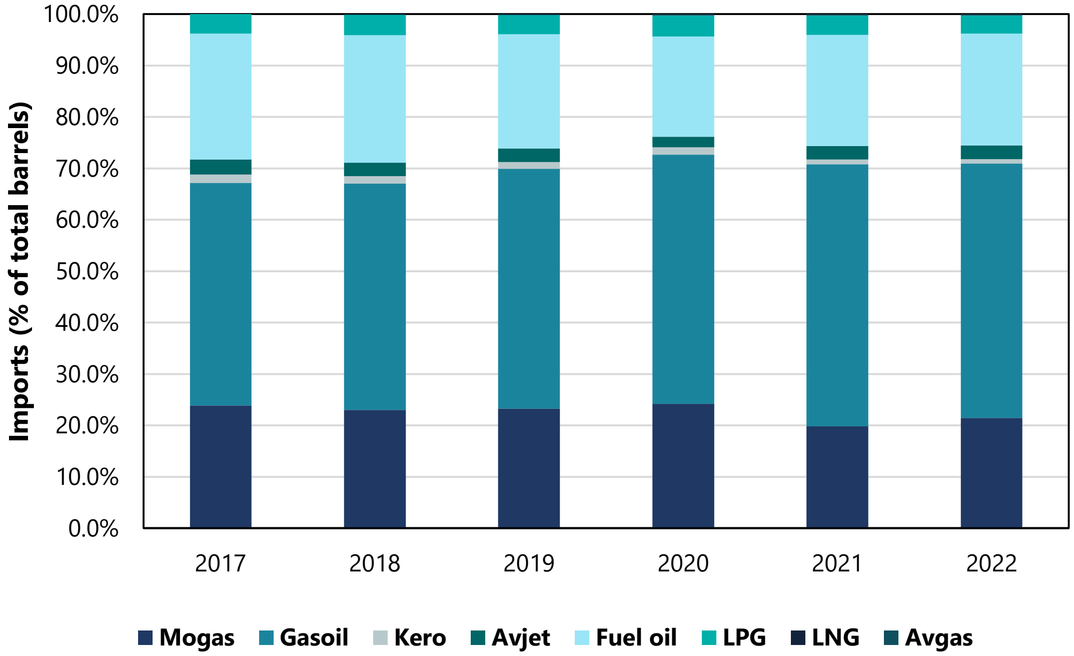


Figure 1.15. Mean annual consumption (barrels) of petroleum-based products for 2017-2022. Source: (Guyana Energy Agency, 2024)

Guyana's energy dependency rate on imports (Table 1.4) is shown below. This rate is defined as imports divided by consumption. It represents the proportion of petroleum-based products consumed at the national level that relies on imports of such products for the same year. In the years 2017-2022, approximately 100% depended on imports of petroleum-based products.

Table 1.4. Imports and consumption of petroleum-based products for 2017-2022 (barrels).

Product	2017	2018	2019	2020	2021	2022
Imports	5,563,733	5,792,857	6,313,740	6,626,075	7,410,630	7,737,349
Consumption	5,612,475	5,859,724	6,458,893	6,236,352	6,984,608	7,763,843
Dependency rate (%)	99.1%	98.9%	97.8%	106.2%	106.1%	99.7%

Source: (Guyana Energy Agency, 2024)

The breakdown of energy consumption by sector reveals that transport and electric power generation are the predominant consumers of imported fuel products in Guyana. Other sectors, including agriculture, fishing, mining, and households, follow in consumption. Figure 1.16 illustrates the final consumption by sector for Guyana from 1990 to 2020.

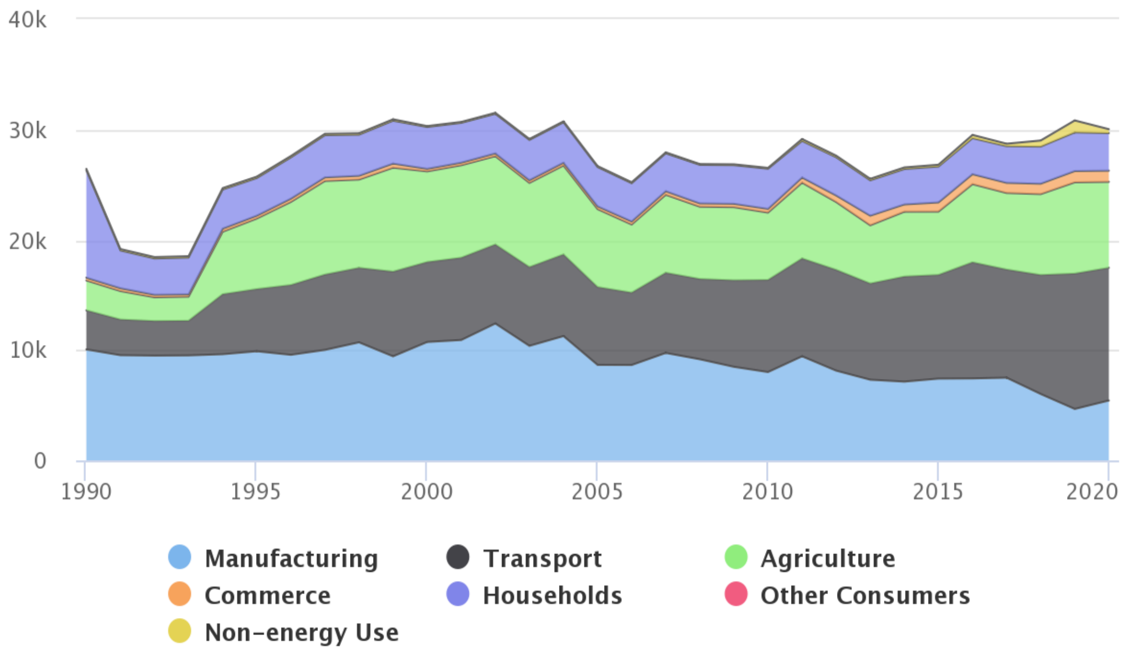


Figure 1.16. Final consumption by sector in terajoules (TJ) for the period 1990-2020. Source: (United Nations Statistics Division, n.d.)

7.2. Energy transition plan

As set out above, Guyana's historic energy supply has been carbon-intensive and expensive. However, as set out in the Low Carbon Development Strategy (LCDS) 2030, the country is on the threshold of an ambitious energy situation to change this reality, actively investing in clean energy and stimulating low carbon growth (Government of Guyana, 2022b).

The LCDS 2030 encompasses a comprehensive transition plan to decouple economic growth from fossil fuel dependency for electricity generation. This plan aims to reduce reliance on imported fossil fuels and decrease greenhouse gas (GHG) emissions by developing low-carbon energy resources. Key elements of the strategy include the incorporation of natural gas as a transitional fuel, with a gradual integration of solar, wind, and hydro sources. This transition is supported by several initiatives, including: (i) investment in transformational energy infrastructure across the generation and transmission systems; (ii) fiscal incentives and government policies to support the use of renewable energy at the level of households and businesses; (iii) investments to improve energy efficiency.

As part of this strategy, Guyana is actively pursuing an increased share of renewable energy sources and energy efficiency initiatives. This includes the development of wind and solar farms, small hydropower projects, and the promotion of energy efficiency across various sectors. Specific measures involve replacing inefficient lighting technology with energy-efficient light-emitting diodes (LEDs) in households, businesses, and public buildings.

Natural gas will facilitate the early stages of Guyana's energy transition. Over the medium and long term, the country aims to develop a sustainable and resilient energy mix that includes solar, wind, hydro, and biomass power plants. Among Guyana's renewable energy resources, hydropower is crucial for providing firm capacity and short-term energy storage to offset daily and weekly fluctuations from solar and wind. In the long run, hydropower offers a cost-effective solution due to its longevity.

In Guyana, solar, wind, and hydropower are complementary resources. Solar energy is available during daylight hours, peaking at noon, while wind energy is stronger during the evening and night. Wind energy decreases during the wet seasons, whereas hydropower is fully available. By leveraging this combined approach of complementary lower-carbon and renewable energy systems, Guyana will benefit from lower electricity prices and substantial GHG emissions savings.

8. Climate change policy and institutional framework

8.1. International environmental agreements

Guyana actively participates in international and regional efforts to safeguard the Earth's natural resources, being a signatory to key agreements such as the United Nations Framework for Climate Change Convention (UNFCCC), the Kyoto Protocol, and the Paris Agreement, among others (Table 1.5).

At the regional level, Guyana is committed to CARICOM's 2009 objectives for enhancing climate change resilience. Notably, between 2012 and 2016, Guyana ratified three significant international agreements: the Paris Agreement, the Nagoya Protocol, and the Minamata Protocol.

The Department of Environment and Climate Change (DECC) initiated a project funded by the GoG, United Nations Development Programme (UNDP), and the Global Environmental Facility (GEF). This project aimed to enhance technical capacities across agencies for mainstreaming and monitoring the Rio Conventions – UNFCCC (United Nations Framework for Climate Change Convention), UNCBD (United Nations Convention on Biological Diversity), and UNCCD (United Nations Convention to Combat Desertification). The key components involved establishing the Environmental Information Management and Monitoring System (EIMMS), strengthening the capabilities of stakeholders, enhancing awareness of global environmental values, and updating the national capacity self-assessment to align with the Sustainable Development Goals (SDGs).

Table 1.5. International environmental agreements to which Guyana is a signatory.

Name of international agreement	Dates of adoption / Entry into force	Guyana´s ratification
UNFCCC	Adopted on 09 May 1992; entered into force on 21 March 1994	Ratified on 29 August 1994
Kyoto Protocol	Adopted on 11 December 1997; entered into force on 16 February 2005	Acceded on 05 August 2003
Paris Agreement	Adopted 12 December 2015; Entered into force 04 November 2016	Ratified on 20 May 2016
Vienna Convention for the Protection of the Ozone Layer	Adopted on 22 March 1985; entered into force on 22 September 1988	Acceded on 12 August 1993
Montreal Protocol on Substances that Deplete the Ozone Layer	Adopted on 16 September 1987; entered into force on 1 January 1989	Acceded on 12 August 1993
UNCBD	Signed on 5 June 1992, entered into force on 29 December 1993.	Ratified on 29 August 1994
Cartagena Protocol on Biosafety to the Convention on Biological Diversity	Adopted on 29 January 2000; entered into force on 11 September 2003	Acceded on 18 March 2008
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	Adopted on 29 October 2010; entered into force on 12 October 2014	Acceded on 22 April 2014
UNCCD	Adopted on 17 June 1994; entered into force on 26 December 1996	Acceded on 26 June 1997
United Nations Convention on the Law of the Sea	Opened for signature on 10 December 1982; entered into force 16 November 1994	Ratified on 16 November 1993
Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982	Adopted on 28 July 1994; entered into force on 28 July 1996	Ratified/acceded on 25 September 2008

Name of international agreement	Dates of adoption / Entry into force	Guyana´s ratification
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	Adopted on 2 November 1973; the Convention and the Protocol of 1978 were combined and entered into force on 2 October 1983	Acceded on 10 December 1997
Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region and its Oil Spill Protocol	Adopted on 24 March 1983; Entered into force on 11 October 1986	Ratified on 14 July 2010
Special Protected Areas and Wildlife Protocol under the Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	Entered into force on 18 June 2000	Acceded on 14 July 2010
Protocol Concerning Pollution from Land Based Sources and Activities	Entered into force on 13 August 2010	Acceded on 14 July 2010
Basel Convention for the Control of Transboundary Movements of Hazardous Wastes and their Disposal	Adopted on 22 March 1989; entered into force on 5 May 1992	Acceded on 04 April 2001
Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Adopted on 10 September 1998; entered into force 24 February 2004	Acceded on 25 June 2007
Stockholm Convention on Persistent Organic Pollutants	Adopted on 22 May 2001; entered into force on 17 May 2004.	Acceded on 12 September 2007
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Opened for signature on 3 March 1973; entered into force on 1 July 1975	Acceded on 27 May 1977

Name of international agreement	Dates of adoption / Entry into force	Guyana´s ratification
Minamata Convention on Mercury	Adopted on 10 October 2013; entered into force on 16 August 2017	Ratified on 24 September 2014
Amazon Cooperation Treaty Organization (ACTO)	Signed on 3 July 1978; entered into force on 2 August 1980	Adopted
The 2030 Agenda for Sustainable Development	Approved in September 2015 by the United Nations General Assembly	Adopted
Sendai Framework for Disaster Risk Reduction 2015-2030	March 18, 2015	Adopted

8.2. Legal framework

The **Constitution of the Co-operative Republic of Guyana**, enacted in 1980 and amended in 2001, is the supreme law of Guyana, rendering any conflicting legislation void to the extent of inconsistency.

The Constitution recognises the right of every person to an environment that is not harmful to his or her health or well-being and the duty of every citizen to participate in activities designed to improve the environment and protect the health of the nation. Furthermore, it expresses Guyana's commitment to protect its natural environment and resources while taking advantage of global finances, industry, communication, education, business, and technology. Article 36 reads: *"In the interests of the present and future generations, the State will protect and make rational use of its land, mineral and water resources, as well as its fauna and flora, and will take all appropriate measures to conserve and improve the environment."* Additionally, Article 25 states that "*Every citizen has a duty to participate in activities designed to improve the environment and protect the health of the nation*."

The **Environmental Protection Act of 1996**, along with its 2005 Amendment, serves as the legislative framework for implementing environmental provisions outlined in the Constitution. The Act and its amendment cover aspects such as management, conservation, protection, and improvement of the environment; prevention or control of pollution; assessment of the impact of economic development on the environment; and the sustainable use of natural resources.

While not explicitly addressing climate change, the Constitution empowers the Environmental Protection Agency (EPA), which was established under the Environmental Protection Act in 1996, to implement measures for the effective management of the natural environment and its various components and to ensure the right to healthy environmental conditions, laying the groundwork for potential climate-related legislation. A critical role of the EPA is the establishment, monitoring, and enforcement of environmental regulations. To this end, among others, the EPA has established the following regulations:

- Hazardous Wastes Management Regulation 2000;
- Water Quality Regulations 2000;
- Air Quality Regulations 2000;
- Litter Enforcement Regulations 2013;
- Styrofoam Regulations (Expanded Polystyrene Ban) 2015.

In its efforts to prevent pollution and evaluate developmental initiatives, the EPA plays a crucial role in ensuring the safeguarding of the environment. These measures aim to curb pollution and support reduce GHG emissions, making a significant contribution to the fight against climate change.

Furthermore, **the Protected Areas Act (2011)** was enacted to safeguard and conserve Guyana's natural heritage and capital. It establishes the Protected Areas Commission (PAC), the National Protected Areas System (NPAS), and the Protected Areas Trust Fund (PATF). These Acts aim to maintain crucial ecosystem services with global importance, fulfil international environmental responsibilities, and encourage public participation in conservation efforts. The NPAS, a tool for addressing climate change, plays a key role in preserving and expanding Guyana’s terrestrial and aquatic environments, aligning with the country's international environmental commitments.

Under the PAC’s legislative framework, the Minister has the role of declaring national protected areas which applies to various maritime zones and empowers village councils to seek recognition for Amerindian protected areas. The legislation outlines the management of protected areas and focuses on conserving biological diversity, natural landscapes, seascapes, wetlands, and ecosystems. Emphasizing principles of ecologically sustainable development, the Act is integral to Guyana's commitment to environmental.

The **Wildlife Conservation and Management Act 2016** serves the purpose of establishing a supportive mechanism aligned with national goals for wildlife protection, conservation, management, and sustainable use. This legislation creates a framework governing local and international trade in all species of Guyana’s wildlife, ensuring compliance with the Convention. The Act aims to provide a transparent and fair framework of licensing and decisions. In addition to establishing the Guyana Wildlife Conservation and Management Commission (WCMC), the Act addresses the protection, conservation, management, and sustainable use of all wildlife within and beyond Guyana. The WCMC plays a pivotal role in effective wildlife management and conservation, preventing overexploitation through various measures. It also takes steps to protect endangered ecosystems, habitats, and species while advising on regional and international compliance. The Act empowers the WCMC to promote and facilitate the rescue, rehabilitation, and return of wildlife to their natural habitats. Furthermore, the WCMC, along with the EPA, enforces the Act, ensuring Guyana's fulfilment of international environmental commitments, particularly under the UNCBD and CITES, where the WCMC serves as the focal point. Additionally, through the promotion of reforestation programs, the Commission contributes to climate change mitigation efforts.

There are some other natural resources legislation and those that ensure the country’s environment is protected. Among these are the **Fisheries Act, 2002**[1], **Amerindian Act, 2006**[2], **Forest Act, 2009**[3], and **Mining Act, 1989**[4] and its regulations, particularly, Mining Regulations, 2005.

8.3. Institutional arrangements

In Guyana, the Office of Climate Change (OCC) within the Office of the President was established in 2009 and was the National Focal Point (NFP) to the UNFCCC. In this role, it had the responsibility to coordinate Guyana’s international reporting requirements.

In 2020, the OCC merged with the Department of Environment (DoE) forming the **Department of Environment and Climate Change (DECC)** under the Office of the President, which is currently the **NFP to the UNFCCC** and is tasked with coordinating Guyana’s international engagements with the UNFCCC and other climate change processes both nationally and internationally. As such, DECC is the governmental agency responsible for developing and implementing national policies and actions for ‘climate change mainstreaming’ and coordinating efforts to mitigate and adapt to climate change and coordinates all reporting to the UNFCCC.

In this context, DECC has been taking on aspects of a coordinating role, working with key agencies in this process. It supports Guyana's transition to a low carbon economy and works closely with agencies such as the Guyana Forestry Commission (GFC), Environmental Protection Agency (EPA), Protected Areas Commission (PAC), National Parks Commission (NPC), and the Wildlife Conservation and Management Commission (WCMC).

9. Development priorities and objectives

Key policies, strategies and development plans being implemented in Guyana are summarised by sector in Table 1.6 – 1.9. These tables provide a comprehensive overview of Guyana's

[1] https://faolex.fao.org/docs/pdf/guy142497.pdf
[2] https://parliament.gov.gy/documents/acts/4680-act_no_6_of_2006.pdf
[3] https://forestry.gov.gy/wp-content/uploads/2016/07/Forests-Act-2009.pdf
[4] https://faolex.fao.org/docs/pdf/guy81462.pdf

development priorities and objectives across three key areas: **Agriculture, Forestry, and Energy**, as well as **overarching climate change** objectives and priorities. Each sector is strategically aligned with national goals and global sustainability targets. The objectives and priorities outlined herein reflect Guyana's commitment to fostering economic prosperity, environmental sustainability, and climate resilience.

9.1. Agriculture sector

Table 1.6. Agriculture sector objectives and priorities.

Title	Year	Description
National Policy on Inland Fisheries and Aquaculture	2012	Objectives: • Promote sustainable development of inland fisheries and aquaculture. • Ensure food security and social and economic benefits. • Protect, maintain, and rehabilitate the ecosystem. Priorities: • Institutional strengthening. • Capacity building. • Research and development.
National Strategy for Agriculture in Guyana (updated in 2021)	2013-2020	Objectives: • Achieve sustained economic and social prosperity through agriculture. • Ensure food security and social and economic benefits. • Protect, maintain, and rehabilitate the ecosystem. Priorities (F-5 Strategic Approach): • Food security consolidate end hunger. • Fiber and nutritious food accessibility. • Fuel production via alternative fuel sources. • Fashion and health products based on agro-process industry. • Furniture and crafts industry expansion.
Disaster Risk Management Plan for the Agriculture Sector	2013-2018	Objectives: • Strengthen technical capacities and institutional frameworks. • Improve decision-making and coordination. • Articulate sustainable mechanisms for integrated financial resource mobilization. Priority:

Title	Year	Description
		• Strengthening institutional and technical capacities. • Risk identification, information system and early warning. • Building resilience for sustainable livelihoods. • Preparedness response and rehabilitation.
Marine Fisheries Management Plan	2013-2018	Objectives: • Manage key fisheries - artisanal, industrial seabob and prawn, semi-industrial red snapper, and shark. Priorities: • Data collection and management. • Monitoring, control, and surveillance. • Fisheries Department capacity building.
Hydrometeorological Service Strategic Development Plan	2014-2018	Objectives: • Study Guyana's weather and climate. • Provide meteorological, hydrological, and oceanographic services. Priorities: • Implement the 6 program areas: Administration, Warning and weather forecasting, Agrometeorology, Climate services, Water survey, and Informatics and technical services.
Agriculture Development Strategy 2021-2025	2021-2025	Objectives: • Growth of agriculture and agri-business while employing new developments and technologies. • Ensure diversity and inclusivity in the sector. • Improve synergies across sectors. Priorities (technologies for agriculture): • Diversify agriculture production. • Improve land access. • Create a robust marketing system. • Promote food and nutrition security. • Strengthen resilience and sustainability. • Modernize supporting infrastructure.

Title	Year	Description
		• Strengthen support services. • Develop human resources. • Improve multi-sectoral coordination. • Strengthen data systems.
Guyana's National Pathway for Food systems Transformation	2021	Objectives: • Transform the national food systems. Priorities: • Food Security. • Climate Resilience. • Funding and Financing.
National Adaptation Strategy and Action Plan to Address Climate Change in the Agriculture Sector	2009-2018	Objectives: • Effectively reduce the risks posed by climate change and position the agricultural sector to adapt. Priorities: • Mainstream adaptation. • Foster research and development. • Build awareness communication. • Enhance coordination. • Mobilize public-private partnership for adaptation.

9.2. Forestry sector

Table 1.7. Forestry sector objectives and priorities.

Title	Year	Description
National Forest Policy Statement and National Forest Plan	2018	Objectives: • Deriving development benefits from the forest (economics). • Conserving, protecting, and sustaining the forest (conservation). • Governing the forest to ensure current and future benefits (governance). • Building human and institutional capacity for forest management activities (capacity). Priorities: • Deriving development benefits from the forest (economics). • Conserving, protecting, and sustaining the forest (conservation). • Governing the forest to ensure current and future benefits (governance). • Building human and institutional capacity for forest management activities (capacity).
Action Plan for Implementing the Program of Work on Protected Areas of the Convention on Biological Diversity	2012-2020	Objectives: • Identify, manage, and improve effectiveness of the protected areas both at national and regional level. Priorities: • Establish and strengthen the institutional framework for protected areas. • Improve capacity building for planning, establishment, and management of protected areas. • Ensure financial sustainability of protected areas and national/regional systems. • Evaluate and improve the effectiveness of protected areas management.

Title	Year	Description
Protected Areas Commission Strategic Plan 2016-2020	2016-2020	Objectives: • Development of Guyana's National Protected Areas System (NPAS). • Encompasses hinterland and urban parks. Priorities: • Administration and Management. • Finances. • Stakeholder Involvement and Benefits. • Awareness, Education, and Outreach.
Protected Areas Trust Strategic Plan 2017-2021	2017-2021	Objectives: • Increase funds for NPAS management. • Raise global, regional, and national awareness of PAT and its functions. • Implement an agile and transparent grant-making process. • Strengthen capacity of board trustees in PAT administration. Priorities: • Mobilization of resources to co-finance the management of the NPAPS objectives.
National Mangrove Management Action Plan	2010-2012	Objectives: • Establish administrative capacity for mangrove management. • Promote sustainable mangrove forest management. • Develop legal framework encouraging community-based participation. • Support research and development of Guyana's mangrove forest. • Implement effective protection or rehabilitation of mangrove ecosystems. • Increase public awareness and education on mangrove benefits. Priorities: • Respond to climate change and mitigate its effects through mangrove ecosystem protection, rehabilitation, and wise use.

Title	Year	Description
National Mangrove Action Plan 2022-2032	2022-2032	Objectives: • Continue increasing the mangrove national area as it has been observed since 2011. Priorities: • Increase mangrove forest width by 2030. • Conserve 15-20% of coastal and marine ecosystems. • Update institutional arrangements for integrated mangrove management. • Protect ecosystem services, floral and faunal biodiversity. • Enhance economic benefits through sustainable resource management. • Maintain and enhance the biological productivity of mangroves. • Target public awareness and improve livelihood opportunities. • Focus on sustainable aquaculture, tourism, and mangrove utilization. • Provide economic benefits to communities, especially women and youth.

9.3. Energy sector

Table 1.8. Energy sector objectives and priorities.

Title	Year	Description
Draft National Energy Policy of Guyana – Report 2 – Green Paper	2016	Objectives: • Position the energy sector as an engine of national economic growth • Minimize the foreign exchange cost of energy to the national economy. • Increase the efficiency of energy use per unit of GDP. • Diversify away from imported fossil fuels with indigenous renewable energy resources. • Enhance environmental sustainability by minimizing negative environmental impact. • Attain universal access and equitable distribution of green energy services at the least cost. • Establish a regional export trade of green energy services and commodities. • Develop the oil and gas sector for export.

Title	Year	Description
		Priorities: • Target energy demand and end-use in residential, agriculture, transport, mining, industry and commerce, and tourism.
Arco Note study	2016	Objectives: • Build a sustainable connection across Brazil, the three Guianas and the Caribbean. Priorities: • Assess the implementation of a large transmission power system connecting northern Brazil, the three Guianas, and the Caribbean Sea. • Explore opportunities for Guyana to participate in cross-border electric grids. • Evaluate the potential for large-scale hydro power resources. • Consider infrastructure development, including roadways, high-speed communication systems, and a port or harbour in Guyana or neighbouring countries.
Guyana's Power Generation System Expansion Study	2018	Objectives: • Update the study on system expansion of the generation system, considering the availability of indigenous natural gas for power generation. • Assess the impact of increased electrical demand associated with the oil industry. • Compare the current situation with three other cases: two cases of gas availability and a "green case" where hydropower supplies a significant portion of the demand. Priorities: • Explore the feasibility and benefits of utilizing indigenous natural gas for power generation. • Plan for increased electrical demand resulting from the growing oil industry. • Evaluate and compare different scenarios, including gas availability and a green energy approach. • Consider options for the Demerara-Berbice Interconnected System, weighing the benefits and challenges of each

9.4. Climate change

Table 1.9. Overarching climate change objectives and priorities.

Title	Year	Description
Nationally Determined Contribution (NDC)	2016	Objectives: • Outline Guyana's conditional and unconditional contributions to the Paris Agreement. • Provide the basis for climate change mitigation actions in the energy and forestry sectors. Priorities: • Develop and implement strategies to meet the specified mitigation targets. • Enhance resilience and adaptive capacity to address the impacts of climate change.
Climate Change Adaptation Programme (CCAP)	2016	Objectives: • Reduce risks to human and natural assets resulting from climate change vulnerability. Priorities: • Promote the use of climate data and information for decision-making. • Support innovative adaptation approaches to secure additional financing. • Foster climate financing for the scale-up and replication of sustainable adaptation initiatives.
Low Carbon Development Strategy (LCDS) 2030	2022	Objectives: • Value ecosystem services. • Invest in clean energy and stimulate low carbon growth. • Protect against climate change and biodiversity loss. • Align with global climate and biodiversity goals. Priorities: • Implement measures to enhance the value of ecosystem services. • Invest in clean energy initiatives to promote low carbon growth. • Implement strategies to protect against climate change and biodiversity loss. • Align local strategies with global climate and biodiversity goals.

Title	Year	Description
Guyana-Norway Agreement	2009	Objectives: • Maintain low deforestation rates. • Promote sustainable land use practices. • Secure financial support. Priorities: • Effective monitoring and reporting. • Community engagement and participation. • Prioritize capacity building initiatives to enhance the technical and institutional capabilities. • Biodiversity protection within the forests. • Promote research and innovation to identify and implement best practices.

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2 National Greenhouse Gas Inventory

1. Introduction

As a Party to the United Nations Framework for Climate Change Convention (UNFCCC) Guyana has committed to develop, periodically update, publish, and make available national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol. These inventories are to be compiled using comparable methodologies to be agreed upon by the Conference of the Parties (COP).

Anthropogenic emissions and removals mean that GHG emissions and removals included in national inventories are a result of human activities. In this context, national GHG inventories can be defined as a comprehensive account of the annual anthropogenic GHG emissions by sources and GHG removals by sink within a national territory over a specified time period whereby the national territory covers the mainland territory and the offshore areas over which the country has jurisdiction and the time series refers to the specified period of time over which the national GHG inventory accounts emissions and removals annually, starting from the base year.

In compliance with its commitments under the UNFCCC, Guyana has thus far completed three national GHG inventories as follows:

- The national GHG emissions inventory for the period 1990-1998 reported in the first National Communication (NC) according to the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (IPCC, 1996).
- The national GHG emissions inventory for the period 1990-2004 reported in the second NC according to the Revised 1996 IPCC Guidelines for National GHG Inventories (IPCC, 2006).
- The national GHG emissions inventory for the period 1990-2016 reported in the draft of the third national communication (TNC) (not published, which this document replaces) according to the Revised 1996 IPCC Guidelines for National GHG Inventories (IPCC, 2019).

In this Third National Communication (TNC), Guyana presents an updated GHG inventory for the period 1990-2022 using the 2006 IPCC Guidelines for National GHG Inventories (hereinafter referred to as the 2006 IPCC Guidelines) and the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories (hereinafter referred to as the 2019 Refinement). This updated GHG inventory has also been reported in Guyana´s first Biennial Update Report (BUR) and first Biennial Transparency Report (BTR), both of which were submitted to the UNFCCC in 2024. The entire time series 1990-2016 has been recalculated and the time series 2017-2022 has been calculated considering the transition to more recent guidelines, incorporating additional available information, and implementing methodological improvements. This inventory spans 32 years, commencing from the base year 1990 and extending to the inventory year 2022. It encompasses the four sectors outlined in the 2006 IPCC Guidelines, namely Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and Waste.

2. Overview of the national GHG inventory

2.1. Institutional arrangements for inventory preparation

Guyana is actively working on establishing a GHG inventory MRV system that encompasses all relevant sectors. More information on the institutional arrangements for the GHG inventory are provided in Chapter 6 to the BUR.

In the context of the preparation of the GHG emissions inventory prepared as part of this TNC of Guyana, it has been conducted under the centralised leadership and coordination of the Department of Environment and Climate Change (DECC) under the Office of the President.

The inventory preparation adheres to a sector-based approach for gathering emissions and removal data while ensuring that sectoral synergies are taken into account to avoid double counting or omission. To compile the necessary data, sectoral data collection forms are employed. These forms are distributed to the pertinent data providers within each sector. Guyana enlisted the expertise of Gauss International Consulting, an international technical consultancy, to handle data processing, emission estimation, and the implementation of quality assurance and quality control procedures.

To ensure the enduring enhancement of the GHG inventory system and the timely delivery of transparent, accurate, consistent, complete, and coherent information, Guyana aims to institutionalise the procedures, roles, and responsibilities for future national GHG inventories.

2.2. Definitions and scope

The definitions of the GHG inventory principles as provided in Section 1.4, Chapter 1 of Volume 1 of the 2006 IPCC Guideline shall be adhered to throughout the national GHG inventory of Guyana.

The scope of the national GHG inventory of Guyana can be defined by (i) the coverage of the GHGs, (ii) the sectoral coverage, and (iii) the area that makes up the national territory of the country.

The national GHG inventory covers a total of seven GHGs that are either emitted to or removed from the atmosphere within the national territory of Guyana, namely:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)
- Nitrogen trifluoride (NF_3)

As previously stated, the four sectors covered by the national GHG inventory of Guyana are the Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and Waste Sectors. These sectors, identified by a numerical designation, are subsequently broken down into categories (indicated by capital letters), sub-categories (identified by numbers), and emissions sources (denoted by small letters), as shown in Figure 2.1.

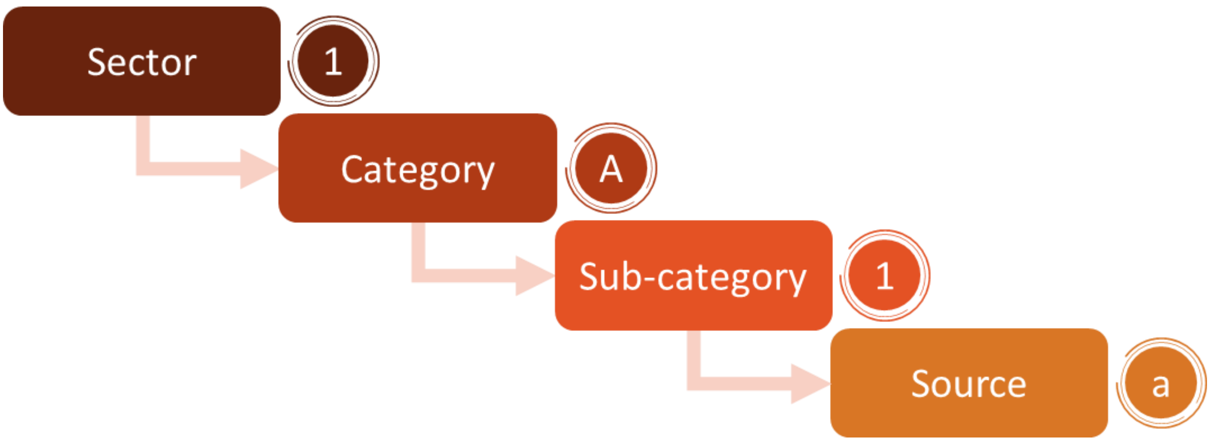

Figure 2.1. Nomenclature of the 2006 IPCC Guidelines.

Considering the coverage of the seven GHGs and the four categories, the following table presents the specific GHGs covered under each of these categories within the national GHG inventory of Guyana (Table 2.1).

Table 2.1. GHGs and sectors covered by the national GHG inventory of Guyana.

Sector		GHG						
		CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3
1	Energy	X	X	X				
2	IPPU	X	X	X	X	X	X	X
3	AFOLU	X	X	X				
4	Waste	X	X	X				

Guyana's national GHG inventory encompasses emissions and removals occurring throughout the entirety of the national territory, spanning a total geographic area of 214,970 km^2. This area includes four biophysical regions: the Coastal Plain, Hilly Sand and Clay, Forested Highland, and Interior Savannahs. The distribution comprises 196,850 km^2 of land and 18,120 km^2 of water. Notably, Guyana features a 430-kilometre Atlantic coastline to the northeast and extends continentally for about 724 km.

2.3. Description of methodologies

The national GHG inventory of Guyana is prepared in accordance with the recommended methods (tier level) for individual source and sink categories outlined in the 2006 IPCC Guidelines and 2019 Refinement.

The IPCC inventory methodology is divided into various levels of tiers, with generally higher tiers being more detailed methodology and more accurate while the tier 1 level represents the minimum, or default methodology.

In its most basic form, the estimates of emissions and removals involve a direct relationship between an emission factor (EF) (which denotes the emission rate per unit of activity) and the activity data (AD) representing the associated level of activity. The AD outlines the annual magnitude of a specific activity, while the EF quantifies the amount of gas emitted per unit of that activity. Default emission factors are provided by the 2006 IPCC Guidelines for the direct GHGs emissions.

The national GHG inventory of Guyana for the period 1990-2022 is generally estimated using the tier 1 methodology.

The basic equation for estimating the emission of one category is the following:

$$Emissions_{c,g,t} = AD_{c,t} \cdot EF_{c,g,t}$$

Where:

$Emissions_{c,g,t} = E\ missions\ of\ category\ c, gas\ g\ and\ year\ t$

$AD_{c,t} = Activity\ data\ of\ category\ c, year\ t$

$EF_{c,g,t} = Emission\ factor\ of\ emissions\ of\ category\ c, gas\ g\ and\ year\ t$

Frequently, the available activity data do not align with the available or utilised emission factor. In such instances, conversion factors are employed to adjust the data. In these cases, the equation is as follows:

$$\{2\}\ Emissions_{c,g,t} = AD_{c,t} \cdot EF_{c,g,t} \cdot Conversion\ factor$$

Furthermore, to ensure completeness, the national GHG inventory of Guyana uses notation keys where numerical data are not available. These notation keys include:

- **"NO" (not occurring):** Used for categories or processes, including recovery, under a particular source or sink category that do not occur within a Party.
- **"NE" (not estimated):** Used for activity data and/or emissions by sources and removals by sinks of GHGs that have not been estimated but for which a corresponding activity may occur within a Party.
- **"NA" (not applicable):** Used for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas.
- **"IE" (included elsewhere):** Used for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of under the expected source/sink category.
- **"C" (confidential):** Used for emissions by sources and removals by sinks of GHGs where the reporting would involve the disclosure of confidential information.

Table 2.2 provides an overview of the IPCC inventory methodology used and corresponding EF of Guyana's national GHG inventory in the inventory year 2022.

Table 2.2. Methodological tiers used the national GHG inventory of Guyana in the inventory year 2022.

Categories by sources and sinks	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NF_3	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
1. Energy	T1	D	T1	D	T1	D								
A. Fuel combustion activities (sectoral approach)	T1	D	T1	D	T1	D								
1. Energy industries	T1	D	T1	D	T1	D								
a. Public electricity and heat production	IE	IE	IE	IE	IE	IE								
i. Electricity Generation	IE	IE	IE	IE	IE	IE								
ii. Combined Heat and Power Generation (CHP)	IE	IE	IE	IE	IE	IE								
b. Petroleum refining	NO	NO	NO	NO	NO	NO								
c. Manufacture of solid fuels and other energy industries	IE	IE	IE	IE	IE	IE								
2. Manufacturing industries and construction	T1	D	T1	D	T1	D								
3. Transport	T1	D	T1	D	T1	D								
a. Domestic aviation	T1	D	T1	D	T1	D								
b. Road transportation	T1	D	T1	D	T1	D								
c. Railways	NO	NO	NO	NO	NO	NO								
d. Domestic navigation	IE	IE	IE	IE	IE	IE								
e. Other transportation	NO	NO	NO	NO	NO	NO								
4. Other sectors	T1	D	T1	D	T1	D								
a. Commercial/institutional	T1	D	T1	D	T1	D								
b. Residential	T1	D	T1	D	T1	D								
c. Agriculture/forestry/fishing	T1	D	T1	D	T1	D								
5. Other	NO	NO	NO	NO	NO	NO								
B. Fugitive emissions from fuels	T1	D	T1	D	T1	D								
1. Solid fuels	T1	D	T1	D	T1	D								
2. Oil and natural gas	T1	D	T1	D	T1	D								
a. Oil	T1	D	T1	D	T1	D								
b. Natural Gas	T1	D	T1	D	T1	D								
3. Other emissions from energy production	NO	NO	NO	NO	NO	NO								
C. CO_2 Transport and storage	NO	NO												

Categories by sources and sinks	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NF_3	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
2. Industrial Processes and Product Use	NE, NA, NO	NE, NA, NO	NA, NO	NA, NO	NE, NA, NO	NE, NA, NO	NE, NA, NO	NE, NA, NO	NE, NO	NE, NO	NE, NO	NE, NO	NA, NO	NA, NO
A. Mineral Industry	NO	NO	NO	NO	NO	NO								
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-Energy Products from Fuels and Solvent Use	NE	NE	NE	NE	NE	NE								
E. Electronics Industry	NO	NO	NA, NO	NA, NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Product Uses as Substitutes for Ozone Depleting Substances	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NE	NE	NE	NE			NA	NA
G. Other Product Manufacture and Use	NA, NO	NA, NO	NA, NO	NA, NO	NE	NE	NA	NA	NE	NE	NE	NE	NA	NA
H. Other	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO								

Categories by sources and sinks	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NF_3	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
3. Agriculture, Forestry, and Other Land Use	T3/T2	CS	T3/T2	CS	T3/T2	CS								
A. Livestock			T1	D	T1	D								
1. Enteric Fermentation			T1	D										
2. Manure Management			T1	D	T1	D								
B. Land	T3/T2	CS			NE	NE								
1. Forest Land	T3/T2	CS												
a. Forest Land Remaining Forest Land	T3/T2	CS												
b. Land Converted to Forest Land	NE	NE												
2. Cropland	T3/T2	CS												
a. Cropland Remaining Cropland	NE	NE												
b. Land Converted to Cropland	T3/T2	CS												
3. Grassland	NE	NE												
a. Grassland Remaining Grassland	NE	NE												
b. Land Converted to Grassland	NE	NE												
4. Wetland	NE	NE			NE	NE								
a. Wetland Remaining Wetland	NE	NE			NE	NE								
b. Land Converted to Wetland	NE	NE			NE	NE								
5. Settlements	T3/T2	CS												
a. Settlements Remaining Settlements	NE	NE												
b. Land Converted to Settlements	T3/T2	CS												
6. Other Land	T3/T2	CS												
a. Other Land Remaining Other Land	NE	NE												
b. Land Converted to Other Land	T3/T2	CS												
C. Aggregate sources and non-CO_2 emissions sources on Land	T1	D	T1	D	T1	D								
1. Emissions from biomass burning	IE	IE	T1	D	T1	D								
2. Liming	T1	D												
3. Urea Application	T1	D												
4. Direct N_2O Emissions from managed soils					T1	D								
5. Indirect N_2O emissions from managed soils					T1	D								
6. Indirect N_2O Emissions from manure management					T1	D								
7. Rice cultivations			T1	D	NA	NA								
8. Other	NO	NO	NO	NO	NO	NO								
D. Other	IE, NO	IE, NO												
1. Harvested Wood Products	IE	IE												
2. Other	NO	NO												

Categories by sources and sinks	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		NF_3	
	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF	Method	EF
4. Waste	T2a	D	T1	D	T1	D								
A. Solid Waste Disposal			T1	D	NE	NE								
1. Managed Waste Disposal Sites			T1	D	NE	NE								
2. Unmanaged Waste Disposal Sites			IE	IE	NE	NE								
3. Uncategorized Waste Disposal Sites			T1	D	NE	NE								
B. Biological Treatment of Solid Waste			NE	NE	NE	NE								
C. Incineration and Open Burning of Waste	T2a	D	T1	D	T1	D								
1. Waste Incineration	NE	NE	NE	NE	NE	NE								
2. Open Burning of Waste	T2a	D	T1	D	T1	D								
D. Wastewater Treatment and Discharge			T1	D	T1	D								
1. Domestic Wastewater Treatment and Discharge			T1	D	T1	D								
2. Industrial Wastewater Treatment and Discharge			NE	NE	NE	NE								
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items: [1]	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO								
International bunkers	NE	NE	NE	NE	NE	NE								
Aviation	NE	NE	NE	NE	NE	NE								
Navigation	NE	NE	NE	NE	NE	NE								
Multilateral operations	NE	NE	NE	NE	NE	NE								
CO_2 emissions from biomass	T1	D												
CO_2 captured	NO	NO												
For domestic storage	NO	NO												
For storage in other countries	NO	NO												

Abbreviations: T1 - Tier 1 method; T2 - Tier 2 method; T3 – Tie 3 method; D - Default; CS – Country Specific; IE - Included Elsewhere; NA - Not Applicable; NE - Not Estimates; NO - Not Occurring

Explanation for the use of Notation Key NE:

- Emissions from Category 2D – Non-Energy Products from Fuels and Solvent Use were not estimated due to a lack of data for this category.
- HFC and PFC Emissions from Category 2F – Product Uses as Substitutes for Ozone Depleting Substances were not estimated due to a lack of data for this category.
- N_2O, PFC, and SF_6 Emissions from Category 2G – Other Product Manufacture and Use were not estimated due to a lack of data for this category.
- CO_2 Emissions from Category 3B3 – Grassland were not estimated due to a lack of data for this category.
- CO_2 Emissions from Category 3B4 – Wetland were not estimated due to a lack of data for this category.
- N_2O Emissions from Category 4A – Solid Waste Disposal were not estimated given that no methodologies are provided in the IPCC Guidelines for estimating these emissions and the IPCC FOD model does not calculate these emissions.
- CH_4, and N_2O Emissions from Category 4B – Biological Treatment of Solid Waste were not calculated due to the lack of data for this category.
- CO_2, CH_4, and N_2O emissions from Category 4C1 – Waste Incineration were not estimated due to a lack of data for this category.
- CH_4, and N_2O Emissions from Category 4D2 – Industrial Wastewater Treatment and Discharge were not calculated due to the lack of data on on-site industrial wastewater treatment practices in Guyana.
- CO_2, CH_4, and N_2O Emissions from International bunkers were not estimated due to a lack of data.
- CO_2, CH_4, and N_2O Emissions from Multilateral operations were not estimated due to a lack of data.

Explanation for the use of Notation Key IE:

- CO_2, CH_4, and N_2O Emissions from Category 1A1 – Energy Industries were not further disaggregated by sub-category and all was included in 1A1.
- CO_2, CH_4, and N_2O Emissions from Category 1A1cii – Other Energy Industries are included in 1A1.
- CO_2, CH_4, and N_2O Emissions from Category 1A3d – Domestic Navigation are included in the other sectoral fuel consumption.
- N_2O emissions from Category 3A2 – Manure management are included in Category 3C6 – Indirect N_2O emissions from manure management.
- CO_2 Emissions from Category 3C1 – Biomass Burning are included in the Category 3B1.
- CO_2 Emissions from Category 3D1 – Harvested Wood Products are included in Category 3B1.
- CH_4 Emissions from Category 4A2 – Unmanaged Waste Disposal Sites are included in category 4A3 – Uncategorized Waste Disposal Sites due to the lack of data on particular practices and conditions at solid waste disposal sites in Guyana other than the Haags Bosch Landfill, which inhibits their classification as per the IPCC definition of types of solid waste disposal sites. As such, all solid waste disposal sites in the country, except for the Haags Bosch Landfill are considered uncategorized.

2.4. Description of metrics

GHGs vary in their capacity to absorb energy (referred to as 'radiative efficiency') and the time they stay in the atmosphere (known as their 'lifetime'). In light of these differences, the Global Warming Potential (GWP) was developed, which compares the radiative forcing of one metric tonne of a GHG over a specified time period, typically 100 years, to that of one tonne of CO_2. This allows for the assessment of the global warming impacts of different gases. A higher GWP indicates that a particular gas has a more significant warming effect on Earth compared to CO_2 over the given time period.

As such, GWP is the ratio of the time-integrated radiative forcing resulting from the instantaneous release of 1 kg of a trace substance relative to that of 1 kg of a reference gas. The reference gas used is CO_2, and therefore, GWP-weighted emissions are expressed in units of CO_2 equivalent.

In Guyana's national GHG inventory, the most recent GWPs for a 100-year period, as outlined in the IPCC Fifth Assessment Report (AR5), are applied (Table 2.3).

Table 2.3. GWPs as outlined in AR.

GHG	GWP
CO_2	1
CH_4	28
N_2O	265
HFC134a	1300
HFC125	3170
HFC143a	4800
HFC32	677

Source: (IPCC, 2014)

2.5. Quality control and quality assurance

The national GHG inventory of Guyana is prepared ensuring the quality throughout all steps of the inventory compilation, from data collection to reporting, according to the good practice principles defined by the 2006 IPCC Guidelines and 2019 Refinement.

These emphasise the importance of building inventories that are consistent, comparable, complete, accurate, and transparent, also known as the TACCC principles, and maintaining the inventory in a manner that improves its quality over time.

As such, the following five quality principles have been adhered to throughout Guyana's inventory compilation process:

- **Transparency:** There is sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the good practice requirements for national greenhouse gas emissions inventories.
- **Accuracy:** The national greenhouse gas inventory contains neither over- nor under-estimates so far as can be judged.
- **Completeness:** Estimates are reported for all relevant categories of sources and sinks, and gases.
- **Consistency:** Estimates for different inventory years, gases, and categories are made in such a way that differences in the results between years and categories reflect real differences in emissions. Inventory annual trends, as far as possible, should be calculated using the same method and data sources in all years and should aim to reflect the real annual fluctuations in emissions or removals and not be subject to changes resulting from methodological differences.
- **Comparability:** The national greenhouse gas inventory is reported in a way that allows it to be compared with national greenhouse gas inventories for other countries.

Quality assurance/quality control (QA/QC) and verification procedures are essential to ensure the development of national GHG inventories that can be readily assessed in terms of quality. The outcomes of QA/QC and verification will support Guyana in the reassessment of inventory or category uncertainty estimates and to subsequently implement improvements in the estimates of emissions or removals on a continuous basis.

In accordance with the 2006 IPCC Guidelines, quality control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. Quality assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Verification refers to the collection of activities and procedures conducted during the planning and development, or after completion of an inventory that can help to establish its reliability for the intended applications of the inventory.

For the compilation of the GHG inventory included in the TNC, the Department of Environment and Climate Change (DECC) under the Office of the President was responsible for overseeing all QA/QC activities in collaboration with international consultants and with the support of the Global Green Growth Institute (GGGI) in Guyana. DECC was responsible for coordinating among all stakeholders involved in the QA/QC plan, and for archiving the relevant data and reports.

The international consultants were responsible for the implementation of QA/QC procedures on a sectoral basis and for the whole GHG inventory related to data collection, handling, processing, quality control, documentation, archiving, and necessary reporting procedures related to the inventory. Throughout this process, GGGI and senior consultants from Gauss conducted QA activities of the work conducted by the international consultants. Furthermore, each entity/organisation contributing data to the development of the national GHG inventory of Guyana is responsible for the quality of its own data.

The results of the QA/QC activities serve as the main input for the development of the inventory improvement plan for the next GHG inventory compilation cycles.

The individuals directly involved in the preparation of the inventory undertook QC procedures in two distinct steps as shown in Table 2.4. These steps involved conducting a data quality assessment and utilising general and sector-specific QC checklists.

Table 2.4. Quality control procedures.

Step	Description
Data quality assessment	After the completion of data collection, the information supplied undergoes an evaluation concerning data availability and quality. This assessment precedes the preliminary estimation of GHG emissions and removals. The primary goal of this evaluation is to pinpoint any existing data gaps and outline immediate, short-term, and long-term corrective actions or areas for improvement within each sector. This process provides an opportunity to take the necessary actions to address immediate and short-term data gaps before finalising the GHG emissions and removals estimates.
General and sector-specific QC checklists	General QC procedures include generic quality checks related to calculations, data processing, completeness. The QC checklist that was followed for all sectors is in line with the recommended QC procedures in Table 6.1, Chapter 6 of Volume 1 of the 2006 IPCC Guidelines. This checklist comprises 12 QC activities, further broken down into QC procedures. These general QC checks are conducted routinely throughout the preparation of the inventory, applying a QC checklist irrespective of the type of data used to develop the inventory estimates. Category-specific QC complements general inventory QC procedures and is directed at specific types of data used in the methods for individual source or sink categories. These category-specific procedures are applied selectively, focusing on key categories and those undergoing significant methodological and data revisions. The objective is to minimise errors during the final selection of data, emission factors, and other parameters. This includes unit conversion, selection of methodological tiers, preparation of computation files,

Step	Description
	evaluation of trends, and documentation of inventory processes. In every instance, the individual responsible for each QC check, the date of its performance, and any corrective actions taken are meticulously documented.

Furthermore, QA procedures were conducted aimed at reviewing and validating the quality of the inventory, determining the conformity of the procedures taken and identifying areas where improvements can be made. The validation has been undertaken at two levels as shown in Table 2.5. These levels include international expert peer review and quality assessment at the national level.

Table 2.5. Quality assurance procedures.

Level	Description
International expert peer review	Within the team of international consultants, an expert peer reviewer was assigned by sector to undertake checks, propose improvements, and ensure the quality of the inventory. The international peer reviewers checked the five quality principles at various levels in the data compilation and reporting processes. This included, among others, checking if the chapters and sections provide the activity data and emission factors with the sources used, explain the methods used and summarise the data set, whether the same methods and the same data sources are used for the whole time series, if the same IPCC guidelines for the methodologies and reporting templates have been used for the whole inventory and for the same group of gases, if estimates are provided for all gases, all source categories existing within the national territory of Guyana, and if uncertainty analysis is undertaken and improvement plans proposed.
Quality assessment at national level	Validation was conducted at the national level through a series of meetings and exchanges held throughout the inventory preparation process. These engagements facilitated discussions and collaborative assessments, ensuring a thorough examination of the inventory's accuracy, methodologies, and overall quality.

3. Cross-cutting elements

3.1. Sources of activity data

Tables 2.6, 2.7, 2.8, and 2.9 summarize the principal sources of activity data used for each sector, including assumptions and treatment methods. To the extent possible, official country-specific activity data was used for inventory elaboration, first from official published statistics and secondly from published peer-reviewed or official publications. When such data was not available, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.6. Activity data sources for the energy sector.

Category	Type of data	Data source and treatment method
1A1 Energy Industries	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request (OLADE, 2023).
1A2 Manufacturing Industries and Construction	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request (OLADE, 2023).
1A3 Transport	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request (OLADE, 2023).
1A4 Other Sectors	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request (OLADE, 2023).
1A5 Other	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request (OLADE, 2023).
1B1 Solid Fuels	Charcoal production (kt)	OLADE Guyana supply and demand data obtained upon request (2023).
1B2 Oil and Natural Gas	Offshore oil produced	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) (2023).
	Offshore oil loaded onto tanker ship	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) (2023).
	Offshore gas produced	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) (EPA, 2023).

Table 2.7. Activity data sources for the IPPU sector.

Category	Type of data	Data source and treatment method
Domestic Solvent Use Including Fungicides (2D3a)	Total population of Guyana	The total population for Guyana over the period 1990-2022 obtained from World Bank Population Statistics (World Bank, 2022).

Table 2.8. Activity data sources for the AFOLU sector.

Category	Type of data	Data source and treatment method
3A1 Enteric Fermentation	Livestock population (number of heads) from 1990 to 2022.	Guyana Livestock Development Authority (GLDA) (Ministry of Agriculture). Complete time series of daily and other cattle from 2018 to 2022 extrapolating from the total cattle data (GLDA, n.d.).
3A2 & 3C6 Manure Management & Indirect N_2O emissions from Manure Management	Livestock population (number of heads) from 1990 to 2022.	Guyana Livestock Development Authority (GLDA) (Ministry of Agriculture). Complete time series of daily and other cattle from 2018 to 2022 extrapolating from the total cattle data (GLDA, n.d.).
3B1a Forest Land Remaining Forest Land	Total forest area (ha)	Guyana ART Workbook for REDD+ for period 2011-2022 (Government of Guyana, 2023). Guyana Forestry Commission (GFC) for period 1990-2010 (GFC, 2023b).
	Buffer area (ha)	Guyana ART Workbook for REDD+, held constant for 1990-2015 (Government of Guyana, 2023).
	Logging-Skid trail length (km)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
	Logging volume harvested (m^3)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
	Total area deforested due to fire and biomass burning (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
3B2b Land Converted to Cropland	Total area deforested due to agriculture (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).

Category	Type of data	Data source and treatment method
	Total area deforested due to shifting cultivation (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2016 (Government of Guyana, 2023).
3B5b Land Converted to Settlements	Total area deforested due to settlement (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
	Total area deforested due to infrastructure (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
	Total area deforested due to forestry infrastructure (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
3B6b Land Converted to Other Land	Total area deforested due to mining (medium and large scale) (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
3C1 Emissions from Biomass Burning	Area burnt of sugarcane from 1990 to 2017	Guyana Sugar Corporation (GUYSUCO) (Ministry of Agriculture). Complete time series forecasting to 2022 (GUYSUCO, n.d.).
	Area harvested of rice from 1990 to 2022	Guyana Rice Development Board (GRDB) (Ministry of Agriculture). It is assumed based on information from the data providers that all rice residues are burnt (GRDB, n.d.).
	Area burnt of forest from 1990 to 2010	Guyana ART Workbook for REDD+, held constant for period 1990-2010 (Government of Guyana, 2023).
3C2 Liming	Limestone applied to sugarcane from 1990 to 2016	GUYSUCO (Ministry of Agriculture). Complete time series forecasting to 2022. Data related to the dolomite applied was not available. (GUYSUCO, n.d.).
3C3 Urea application	Urea imports data from 2020 to 2023	Guyana Revenue Authority (GRA). The urea imports data is used for estimating the GHG emissions from urea application from 2020 to 2023. The time series of urea imports data obtained from GRA was completed surrogating data from the total urea imported data from 1990 to 2019, obtained from Food and Agriculture Organisation (FAO) (GRA, n.d.).

Category	Type of data	Data source and treatment method
	Total urea imported from 1990 to 2021	FAO (FAO, 2023).
3C4 & 3C5 Direct and Indirect N_2O Emissions from Managed Soils	Synthetic fertilizers usage for sugarcane from 1990 to 2016	GUYSUCO (Ministry of Agriculture). Complete time series forecasting to 2022. (GUYSUCO, n.d.)
	Harvested rice area from 1990 to 2022	Guyana Rice Development Board (Ministry of Agriculture) (GRDB, n.d.).
	Paddy production from 2011 to 2022	Guyana Rice Development Board (Ministry of Agriculture) (GRDB, n.d.).
	Harvested sugarcane area from 1990 to 2022	GUYSUCO (Ministry of Agriculture). (GUYSUCO, n.d.)
	Sugarcane production from 2000 to 2022	GUYSUCO (Ministry of Agriculture). (GUYSUCO, n.d.)
	Harvested area and production of several crops from 2016 to 2022	National Agricultural Research and Extension Institute (NAREI), Ministry of Agriculture. The major crop types considered to calculate the N from crop residues and forage/pasture renewal (FCR) were grain (corn) beans and pulses (soya, pigeon peas, other beans), tubers (potato, sweet potato, bitter cassava, cassava, dasheen, eddoes, tannia and yam), root crop (ginger, carrot and peanut) and perennial grasses (sugarcane data from GUYSUCO). The individual crop rice was also considered (data from GRDB). The time series before 2016 until 1990 was maintained as a constant of the value in 2016 due to lack of data for most of the crop types. For calculating the FCR the fraction of annual harvested area burnt (Frac burnt) is considered to be 0 as its N20 emissions associated are calculated at the category 3C1 - Emissions from Biomass Burning (NAREI, n.d.).
	Livestock population (number of	Guyana Livestock Development Authority (Ministry of Agriculture). Complete time series of daily and other cattle from 2018 to 2022 extrapolating from the total cattle data (GLDA, n.d.).

Category	Type of data	Data source and treatment method
	heads) from 1990 to 2022	
3C7 Rice Cultivations	Annual harvested area of rice cultivations in Guyana from 1990 to 2022	Guyana Rice Development Board (Ministry of Agriculture) (GRDB, n.d.).
	Water cultivation period	Guyana Rice Development Board (Ministry of Agriculture). (GRDB, 2016).

Table 2.9. Activity data sources for the waste sector.

Category	Type of data	Data source and treatment method
Cross-cutting issues in the waste sector	Total population of Guyana.	Total national population was obtained from the Guyana Bureau of Statistics Census (2012) containing data points for the years 1946, 1960, 1970, 1980, 1991, 2002, 2012, whereby linear interpolation was used to estimate population in years in between 1950-2012. The total population for Guyana over the period 2013-2022 was obtained from World Bank Population Statistics (World Bank, 2022).
	Percentage population distribution by region.	Percentage population distribution by region in Guyana was obtained from the Guyana Bureau of Statistics Census (2002) containing data points for the years 1980, 1991, and 2002. The regional distribution for the year 2012 was obtained from the Guyana Bureau of Statistics 2012 Census (Guyana Bureau of Statistics, 2012). Projected regional population change rates over 2010-2024 were obtained from the Guyana National Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013). Linear interpolation and extrapolation were used to complete the time series 1950-2022.
	Municipal Solid Waste (MSW) per capita generation rates by region.	Regional waste generation rates for the years 2010 and 2024 were obtained from Guyana's Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013). Rates were held constant prior to 2010 and linear interpolation was used between 2020 and 2024.
	MSW composition.	Waste composition was obtained from the most recent comprehensive study conducted by Hydroplan for Georgetown (Hydroplan CEMCO, Inc., 2010) and grouped as per IPCC categorization. Due to lack of further reliable data, waste composition was assumed constant for all of Guyana and throughout all the time series.

Category	Type of data	Data source and treatment method
4A Solid Waste Disposal	Climate Zone of Guyana.	Default climate zone extracted from in Figure 3A.5.1 of Volume 4 from the 2019 IPCC Refinement (IPCC, 2019).
	Percentage of waste sent to solid waste disposal sites (SWDS).	Percentage distribution of waste to SWDS obtained from Guyana´s Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013) and cross-checked with the Analysis of Waste at the Local Level research paper (Oyedotun et al., 2021), assumed constant throughout the time series.
	Description of Guyana´s SWDS.	SWDS description obtained from Guyana's Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013), differentiated as sanitary landfill, controlled dump, and open dump, and categorized as per IPCC classification: The Haags Bosch Landfill is the only "anaerobic managed SWDS" operating in the country since 2011 as per the IPCC definition. Due to insufficient information on operating conditions at both controlled and open dumps, these were assumed "uncategorized SWDS" as per the IPCC definition on table 3.1 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006).
	Quantity of waste treated at managed landfills, controlled dumps, and open dumps.	Actual tonnage of MSW disposed of at Haags Bosch Landfill (anaerobic managed SWDS) were used, as provided by the landfill operators for 2011-2022. Percentage distribution of controlled dumps and open dumps was assumed constant throughout the time series, extracted from Guyana's Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013) and cross-checked with the Analysis of Waste at the Local Level research paper (Oyedotun et al., 2021).
	Annual quantity of CH_4recovered at SWDS (R).	No CH_4 recovery takes place in Guyana, consistent with IPCC default expressed in Section 3.2.3 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006).
4B Biological Treatment of Solid Waste	Although it is known that some small-scale composting activities take place in Guyana, associated emissions from this category were not estimated due to a lack of data.	
4C1 Waste Incineration	Although it is known that incineration of clinical waste takes place in Guyana's healthcare facilities associated emissions from this category were not estimated due to a lack of data.	
4C2 Open Burning of Waste	Percentage of waste opened burned.	The percentage distribution of waste directly opened burned was obtained from the Analysis of Waste at the Local Level research paper (Oyedotun et al., 2021), assumed constant throughout the time series. It was also assumed open burning took place in open dumps as per Guyana's Solid Waste Management Strategy 2013-2024 (Ministry of Local Government and Regional Development, 2013).

Category	Type of data	Data source and treatment method
	Fraction of the waste amount that is burned relative to the total amount of waste treated (Bfrac).	As per Box 5.1 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006), a default values of Bfrac=0.6 is assumed when open burning takes place in shallow conditions such as direct open burning. Consistent with this logic, expert judgement by inventory compilers assumed a Bfrac=0.4 value for open burning in open dumps whereby MCF=0.6.
	Dry matter content (dm), carbon fraction in dry matter (CF), and fossil carbon fraction in total carbon (FCF) of waste.	Default values obtained from Table 2.4 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006) and held constant throughout the time series.
4D1 Domestic Wastewater Treatment and Discharge	Description of Guyana´s wastewater treatment systems.	Description of historic evolution obtained from the WHO Country Estimate on SDG6 Monitoring Report (WHO, 2020).
	Degree of utilization of wastewater treatment system (U).	Data for the year 1991 were obtained from the Guyana Bureau of Statistics Census (2002). Data for 2002 and 2012 obtained from the following Guyana Bureau of Statistics Census (2012). Data for 2020 was obtained from the WHO Country Estimate on SDG6 Monitoring Report (WHO, 2020). Linear interpolation was conducted between 1991 and 2020. The 1991 value held constant for 1990, while the 2020 value held constant for 2021 and 2022.
	Biochemical oxygen demand (BOD).	The default value for the Latin America region was used, extracted from Table 6.4 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019).
	Correction factor for additional industrial BOD discharged into sewers (I).	Default values from Equation 6.3 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006).
	Sludge removal.	Very limited sludge removal information is available for Guyana. It is assumed no sludge removal takes place as per de default value in Page 6.9 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006).
	Annual quantity of CH_4 recovered.	No CH_4 recovery and flaring from wastewater treatment and discharge occurs in Guyana, consistent with default value from Page 6.13 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019).

Category	Type of data	Data source and treatment method
	Protein Supply.	Per capita protein supply was obtained from FAO Stat Data over the time period 1990-2013 (FAO Stat, 2023a) and 2010-2021 (FAO Stat, 2023b). The overlap method (as per Section 5.3.3.1 of Volume 1 from the 2006 IPCC Guidelines) was used to back-cast the 2010-2021 data. The 2021 value was held constant for 2022.
	Protein Consumed as a Fraction of Protein Supply (FPC).	The default value for the Latin America Region was obtained from Table 6.10A of Volume 5 from the 1019 IPCC Refinement (IPCC, 2019).
4D2 Industrial Wastewater Treatment and Discharge	There is a lack of data on on-site industrial wastewater treatment practices in Guyana. Associated emissions are included in Category 4D1 by accounting for industrial wastewater that is discharged into the domestic sewer system through the default correction factor from the 2006 IPCC Guidelines for additional industrial BOD discharged into sewers (I).	

3.2. Sources of emission factors

The principal sources of emission factors used for each sector are described in Tables 2.10, 2.11, 2.12, and 2.13. Country-specific emission factors were used when available to develop the national GHG inventory of Guyana. Otherwise, default values were adopted primarily from the 2019 IPCC Refinement and secondly from the 2006 IPCC Guidelines.

Table 2.10. Emissions factor sources for the energy sector.

Category	Type of data	Data source and treatment method
1A1 Energy Industries	kg/TJ	Default values from Table 2.2 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).
1A2 Manufacturing Industries and Construction	kg/TJ	Default values from Table 2.3 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).
1A3a Domestic Aviation	kg/TJ	Default values from Table 3.6.4 and Table 3.6.5 from Chapter 3, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).
1A3b Road Transport	kg/TJ	Default values from Table 3.2.1 and Table 3.2.2 from Chapter 3, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).
1A4 Other Sectors	kg/TJ	Default values from Table 2.4 and Table 2.5 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).

Category	Type of data	Data source and treatment method
1A5 Other	kg/TJ	Default values from Table 2.4 and Table 2.5 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines (IPCC, 2006).
1B1 Solid Fuels	kg/kt	Default values from Table 4.3.3 from Chapter 4, Volume 2 of the 2019 Refinement (IPCC, 2019).
1B2 Oil and Natural Gas	tonnes/1,000 m3 offshore oil produced	Default values from Table 4.2.4A from Chapter 4, Volume 2 of the 2019 Refinement (IPCC, 2019).
	tonnes/1,000 m3 offshore oil loaded onto tanker ship	Default values from Table 4.2.4B from Chapter 4, Volume 2 of the 2019 Refinement (IPCC, 2019).
	tonnes/1,000,000 m3 offshore gas produced	Default values from Table 4.2.4G from Chapter 4, Volume 2 of the 2019 Refinement (IPCC, 2019).

Table 2.11. Emissions factor sources for the IPPU sector.

Category	Type of data	Data source and treatment method
Domestic Solvent Use Including Fungicides (2D3a)	Kg/capita	Default emission factor for NMVOC emissions from the domestic use of solvents obtained from Table 3.1. of chapter '2.D.3.a Domestic solvent use including fungicides' of the EMEP/CORINAR Emission Inventory Guidebook 2023 (EEA, 2023).

Table 2.12. Emissions factor sources for the AFOLU sector.

Category	Type of data	Data source and treatment method
3A1 Enteric Fermentation	Enteric fermentation emission factors for Tier 1 method	Default values for low productivity systems in Table 10.10 and for Latin America in Table 10.11, Chapter 10, Volume 4 of the 2019 Refinement (IPCC, 2019).
3A2 & 3C6 Manure Management & Indirect N_2O emissions from	Live weights for animal categories	Default values from the 2019 Refinement, Table 10A.5, Chapter 10, Volume 4 (IPCC, 2019).
	CH_4 emission factors by animal category, manure management	Default values from the 2019 Refinement (IPCC, 2019), Table 10.14, Chapter 10, Volume 4. Using default data for Latin America, tropical wet climate (>18 C mean annual temp and >2000 mm annual precipitation) and low productivity systems.

Category	Type of data	Data source and treatment method
Manure Management	system and climate zone	
	Volatile solid excretion rate	Default values from the 2019 Refinement, Table 10.13A, Chapter 10, Volume 4 (IPCC, 2019). Using default data for Latin America and low productivity systems.
	Nitrogen excretion rate	Default values from the 2019 Refinement, Table 10.19, Chapter 10, Volume 4 (IPCC, 2019). Using default data for Latin America and low productivity systems.
	Emission factors for direct N_2O emissions from manure management	Default emission factors of the 2019 Refinement (IPCC, 2019), Table 10.21, Chapter 10, Volume 4.
	Nitrogen loss fractions due to volatilisation of NH_3 and NO_X and leaching of nitrogen from manure management	Default values from the 2019 Refinement (IPCC, 2019), Table 10.22, Chapter 10, Volume 4.
	Volatilisation and leaching factors for indirect soil N_2O emissions	Default emission factors of the 2019 Refinement (IPCC, 2019), Table 11.3, Chapter 10, Volume 4.
3B1a Forest Land Remaining Forest Land	Average annual above-ground biomass growth (tonnes C/ha)	Country-specific emission factor, published in Wiley's Global Change Biology: Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity, 2017 Journal Article. Provided by the country (Government of Guyana, 2021).
	Annual biomass decrease by degradation from mining and infrastructure (buffer area) (tC/ha)	Country-specific emission factor for degradation in buffer zones caused by mining and infrastructure activities (Government of Guyana, 2023).

Category	Type of data	Data source and treatment method
	Annual biomass decrease by degradation from skid trails of logging activities (tC/km)	Country-specific emission factor for forest degradation caused by skid trails, Logging Infrastructure Factor (LIF) (Government of Guyana, 2023).
	Annual biomass decrease by degradation from logging (tC/m^3)	Country-specific emission factor for volume harvested, Logging Damage Factor (LDF) (Government of Guyana, 2023).
	Emission factor for deforestation due to fires and biomass burning ($t\ CO_2/ha$)	Country-specific emission factor for deforestation due to fire and biomass burning. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, and CO_2 emissions from fire (Government of Guyana, 2023).
3B2b Land Converted to Cropland	Emission factor for deforestation due to agriculture (t C/ha)	Country-specific emission factor for forest land converted to agriculture. The emission factor includes carbon pools: Above-ground biomass (AG tree), Below-ground biomass (BG tree), saplings, standing dead wood, lying dead wood, litter, and the change in soil carbon for conversion to permanent agriculture (Government of Guyana, 2023).
	Emission factor for deforestation due to shifting cultivation ($t\ CO_2/ha$)	Country-specific emission factor for forest land deforested due to shifting cultivation. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, the change in soil carbon for shifting cultivation (short cycle) (Government of Guyana, 2023).
3B5b Land Converted to Settlements	Emission factor for deforestation due to settlements (t C/ha)	Country-specific emission factor for deforestation due to settlements. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, and the change in soil carbon due to conversion to unpaved roads (Government of Guyana, 2023).
	Emission factor for deforestation due to forestry infrastructure (t C/ha)	Country-specific emission factor for deforestation due to forestry infrastructure. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, and the change in soil carbon due to conversion to unpaved roads (Government of Guyana, 2023).

Category	Type of data	Data source and treatment method
	Emission factor for deforestation due to infrastructure (t C/ha)	Country-specific emission factor for deforestation due to forestry infrastructure. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, and the change in soil carbon due to conversion to unpaved roads (Government of Guyana, 2023).
3B6b Land Converted to Other Land	Emission factor for deforestation due to mining (tC/ha)	Country-specific emission factor for deforestation due to medium- and large-scale mining including mining infrastructure. The emission factor includes changes in carbon pools: AG, BG, saplings, standing dead wood, lying dead wood, litter, and the change in soil carbon due to conversion to mining and to unpaved roads (Government of Guyana, 2023).
3C1 Emissions from Biomass Burning	Fuel biomass consumption values for fires in a range of vegetation types	Default values of the 2006 IPCC Guidelines, Table 2.4, Chapter 2, Volume 4 (IPCC, 2006).
	Emission factors for various types of burning	Default emission factors from the 2006 IPCC Guidelines, Table 2.5, Chapter 2, Volume 4 (IPCC, 2006).
3C2 Liming	Emission factor for limestone	Default emission factor for limestone is 0.12 according to the 2006 IPCC, page 11.29, Chapter 11, Volume 4 (IPCC, 2006).
3C3 Urea application	Emission factor for carbon emissions from urea applications	The default emission factor is 0.20 for carbon emissions from urea applications, according to the 2006 IPCC Guidelines, page 11.34, Chapter 11, Volume 4 (IPCC, 2006).
3C4 & 3C5 Direct and Indirect N_2O Emissions from Managed Soils	Emission factors to estimate direct N_2O emissions from managed soils	Default emission factors from the 2019 Refinement, Table 11.1, Chapter 11, Volume 4 (IPCC, 2006).
	Values for NAG, NBG, RAG, RS, DRY	For calculating the annual amount of N in crop residues (above and below ground) it was used the default values of N content of below-ground residues for crop (NBG), N content of above-ground residues for crop (NAG), the ratio of above-ground residue dry matter to harvested yield for crop (RAG), the ratio of below-ground root biomass to above-ground shoot biomass for crop (RS) and the dry matter fraction of harvested crop (DRY) from the 2019 Refinement, Table 11.1A, Chapter 11, Volume 4. (IPCC, 2019).

Category	Type of data	Data source and treatment method
	Volatilisation and leaching factors for indirect soil N2O emissions	Default emission factors of the 2019 Refinement, Table 11.3, Chapter 11, Volume 4 (IPCC, 2019).
3C7 Rice Cultivations	CH4 baseline emission factor for continuously flooded fields without organic amendments	Default emission factors of the 2019 Refinement, Table 5.11, Chapter 5, Volume 4 (IPCC, 2019).
	CH4 emission scaling factors to account for the differences in water regime during cultivation period (SFw)	Default emission factors of the 2019 Refinement, Table 5.12, Chapter 5, Volume 4 (IPCC, 2019).
	Scaling factor to account for the differences in water regime before the cultivation period (SFp)	Default emission factors of the 2019 Refinement, Table 5.13, Chapter 5, Volume 4 (IPCC, 2019).
	Conversion factors for different types of organic amendments (CFOA)	Default emission factors of the 2019 Refinement, Table 5.14, Chapter 5, Volume 4 (IPCC, 2019).

Table 2.13. Emissions factor sources for the waste sector.

Category	Type of data	Data source and treatment method
4A Solid Waste Disposal	Methane Correction Factors (MCF)	Default values obtained from Table 3.1 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019) and held constant throughout the time series for each SWDS type.

Category	Type of data	Data source and treatment method
	Degradable organic carbon (DOC)	Default values obtained from Table 2.4 of Volume 5 from the 2006 IPCC Guidelines (IPCC, 2006), held constant throughout the time series.
	Fraction of DOC disseminated (DOCf)	Default values obtained from Table 3.0 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	CH_4 generation rate constant (k)	Default values obtained from Table 3.4 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Delay time	Default value from Section 3.2.3 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Fraction of CH_4 in developed gas (F)	Default value from Section 3.2.3 of Volume 5 of the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Oxidation factor (OX)	As per default assumption in Table 3.2 of Volume 5 the 2019 IPCC Refinement (IPCC, 2019), it is assumed no oxidation takes place due to lack of further information.
4B Biological Treatment of Solid Waste	Although it is known that some small-scale composting activities take place in Guyana, associated emissions from this category were not estimated due to a lack of data.	
4C1 Waste Incineration	Although it is known that incineration of clinical waste takes place in Guyana´s healthcare facilities associated emissions from this category were not estimated due to a lack of data.	
4C2 Open Burning of Waste	Oxidation factor (OF) for MSW open burning	Default value from Table 5.2 of Volume 5 from the 2019 Refinement (IPCC, 2019), held constant throughout the time series.
	CH_4 emission factor (EF_{CH4}) for MSW open burning	Default value from Page 5.13 of Volume 5 from the 2019 Refinement (IPCC, 2019), held constant throughout the time series.
	N_2O emission factor (EF_{N2O}) for MSW open burning	Default value from Table 5.6 of Volume 5 from the 2019 Refinement (IPCC, 2019), held constant throughout the time series.
	Methane Correction Factors (MCF)	Default values obtained from Table 6.3 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.

Category	Type of data	Data source and treatment method
4D1 Domestic Wastewater Treatment and Discharge	Maximum CH_4 producing capacity (Bo)	Default values obtained from Table 6.2 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Fraction of Nitrogen in protein (F_{NPR})	Default value from Equation 6.10 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Additional Nitrogen from household chemicals (N_{HH})	Default value from Equation 6.10 of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	Factor for non-consumed protein added to the wastewater ($F_{NON-CON}$)	Default value from Table 6.10A of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the time series.
	N_2O emission factor from effluent	Default value from Table 6.8A of Volume 5 from the 2019 IPCC Refinement (IPCC, 2019), held constant throughout the timeseries.
4D2 Industrial Wastewater Treatment and Discharge	There is a lack of data on on-site industrial wastewater treatment practices in Guyana. Associated emissions are included in Category 4D1 by accounting for industrial wastewater that is discharged into the domestic sewer system through the default correction factor from the 2006 IPCC Guidelines for additional industrial BOD discharged into sewers (I).	

3.3. Uncertainty assessment

Uncertainty is inversely tied to accuracy, denoting a cognitive state of incomplete knowledge that results from a lack of information and/or from disagreement about the extent of knowledge which may impact the level of accuracy of data or results evaluated.

Uncertainty assessments are an essential element for improving the accuracy of the national GHG inventory by identifying the most significant sources of uncertainties in order to prioritise improved data collection efforts and guide methodological selection.

While the National Inventory of Guyana has been prepared with the highest possible accuracy considering the current availability of country-specific data, uncertainties are associated to a varying degree due to the following reasons:

- In a few cases, the lack of high-quality, complete, country-specific, and recent data leading to the use of assumptions, default data, and splicing techniques.
- Model approximations which simplify real systems.
- Random errors from used measurements, studies, and statistics.

Further analysis of the causes of uncertainties for each Sector is provided in section 6 of this chapter, as well as the identification of improvement methods to reduce these uncertainties, which have been incorporated into the Inventory Improvement Plan in section 7 of this chapter.

The 2006 IPCC Propagation of Error Approach 1 has been used to conduct the uncertainty assessment, based on uncertainties in activity data, emission factors, and other estimation parameters. As such, uncertainty was determined for individual categories and for the inventory as a whole, as well as the trends between the latest inventory year (2022) and the base year (1990). A description of the main equations used is as follows:

Uncertainty in the Total Level of the Emissions of the Inventory

Combined Uncertainty:

The combined uncertainty is utilized to provide uncertainty estimates of a source or sink based on the combination of the uncertainties of the activity data and emissions factors.

$$U_x = \sqrt{U_{AD,x}^2 + U_{EF,x}^2}$$

Where:

U_x = *Combined uncertainty for source or sink x*
$U_{AD,x}$ = *Uncertainty of the activity data for source or sink x*
$U_{EF,X}$ = *Uncertainty of the emission factor for source or sink x*

Total Level Uncertainty in the Inventory:

Type B sensitivity arises from uncertainties that affect emissions or removals in the current year only.

$U = \sqrt{\sum_x V_x}$, where $V_x = \frac{(U_x \cdot E_{x,t})^2}{(\sum_y E_{y,t})^2}$

Where:

V_x = *Contribution to variance by category x in year t*
U_x = *Combined uncertainty for source or sink x*
$E_{x,t}$ = *Emission or removal estimate of source or sink x in year t*

$\sum_y E_{y,t}$ = *Total inventory estimates in year t*
U = *Uncertainty in the total level of the emissions of the inventory*

Uncertainty Introduced into the Trend in Total National Emissions

Type A Sensitivity:

The Type A Sensitivity arises from uncertainties that affect emissions or removals in the base year and the current year equally.

$$S_{A,x} = \left| \frac{0.01 \cdot E_{x,t} + \sum_y E_{y,t} - \left(0.01 E_{x,0} + \sum_y E_{y,0}\right)}{\left(0.01 E_{x,0} + \sum_y E_{y,0}\right)} \cdot 100 - \frac{\sum_y E_{y,t,} - \sum_y E_{y,0}}{\sum_y E_{y,0}} \cdot 100 \right|$$

Where:

$S_{A,x}$ = *Type A sensitivity for source or sink x*
$E_{x,t}$ and $E_{x,0}$ = *Emission or removal estimate of source or sink x in year t and year 0, respectively*
$\sum_y E_{y,t}$ and $\sum_y E_{y,0}$ = *Total inventory estimates in year t and 0, respectively*

Type B Sensitivity:

Type B sensitivity arises from uncertainties that affect emissions or removals in the current year only.

$$S_{B,x} = \left| \frac{E_{x,t}}{\sum_y E_{y,0}} \right|$$

Where:

$S_{B,x}$ = *Type B sensitivity for source or sink x*
$E_{x,t}$ = *Emission or removal estimate of source or sink x in year t*
$\sum_y E_{y,0}$ = *Total inventory estimates in year 0*

Total Trend Uncertainty in the Inventory:

$$U_{trend} = \sqrt{\sum_x U_{trend,x'}}$$

where: $U_{trend,EF,x} = S_{A,x} \cdot U_{EF,x}$, $U_{trend,AD,x} = S_{B,x} \cdot U_{AD,x} \cdot \sqrt{2}$, and $U_{trend,x} = U_{trend,AD,x}{}^2 + U_{trend,EF,x}{}^2$

Where:

$U_{trend,EF,x}$ = *Uncertainty in trend in national emissions introduced by emission factor uncertainty*
$S_{A,x}$ = *Type A sensitivity for source or sink x*
$S_{B,x}$ = *Type B sensitivity for source or sink x*
$U_{EF,x} = Emission\ factor\ uncertainty$
$U_{AD,x} = Activity\ data\ uncertainty$
$U_{trend,AD,x}$ = *Uncertainty in trend in national emissions introduced by activity data uncertainty*
$U_{trend,x}$ = *Uncertainty introduced into the trend in total national emissions by category x*
U_{trend} = *Trend uncertainty*

Uncertainty calculations performed for the inventory as a whole are presented in Table 2.14, whereby the uncertainty on the level has been estimated for the base year (1990) and the last inventory year (2022), and the trend between these two years. Results indicate an 81.27% uncertainty for 2022 and a trend uncertainty of 22.30% between 1990 and 2022. Except for emission factors for Category 3B, the source of all the uncertainty values are the default uncertainty values selected among the ranges provided by the IPCC 2006 Guidelines and 2019 Refinement, for which the selection criteria have been based on the conservative principle, using the upper values of the ranges by default. For Category 3B, country-specific uncertainty values were obtained from data available through Guyana's REDD+ MRVS.

Table 2.14. Uncertainty calculations for the GHG inventory of Guyana.

IPCC category	Gas	Base year emissions (1990)	2022 emissions	AD uncertainty	EF uncertainty	Combined uncertainty	Contribution to variance by category in year 2022	Type A sensitivity	Type B sensitivity	Uncertainty in trend by EF	Uncertainty in trend by AD	Uncertainty introduced into the trend in total national emissions
		Gg of CO2-eq		%	%	%		%	%	%	%	%
1A1 – Energy Industries	CO_2	332.98	838.97	10	7	12	0.006	-0.004	0.006	-0.026	0.060	0.004
1A1 – Energy Industries	CH_4	1.10	1.45	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A1 – Energy Industries	N_2O	1.61	2.41	10	100	100	0.000	0.000	0.000	-0.001	0.000	0.000
1A2 – Manufacturing Industries and Construction	CO_2	301.18	76.54	20	7	21	0.000	0.001	0.001	0.010	0.011	0.000
1A2 – Manufacturing Industries and Construction	CH_4	12.46	5.30	20	100	102	0.000	0.000	0.000	0.005	0.001	0.000
1A2 – Manufacturing Industries and Construction	N_2O	15.91	6.73	20	100	102	0.000	0.000	0.000	0.006	0.001	0.000
1A3a – Domestic Aviation	CO_2	34.56	37.39	10	7	12	0.000	0.000	0.000	0.000	0.003	0.000
1A3a – Domestic Aviation	CH_4	0.01	0.01	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A3a – Domestic Aviation	N_2O	0.26	0.28	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A3b – Road Transport	CO_2	231.33	1094.72	10	7	12	0.010	-0.006	0.008	-0.043	0.078	0.008
1A3b – Road Transport	CH_4	2.09	9.71	10	100	100	0.000	0.000	0.000	-0.005	0.001	0.000
1A3b – Road Transport	N_2O	2.97	14.10	10	100	100	0.000	0.000	0.000	-0.008	0.001	0.000
1A4 – Other Sectors	CO_2	242.31	878.97	25	7	26	0.029	-0.005	0.006	-0.032	0.156	0.025
1A4 – Other Sectors	CH_4	76.20	11.79	25	100	103	0.000	0.000	0.000	0.043	0.002	0.002
1A4 – Other Sectors	N_2O	9.99	2.83	25	100	103	0.000	0.000	0.000	0.005	0.001	0.000
1A5 – Other	CO_2	0.92	33.78	10	7	12	0.000	0.000	0.000	-0.002	0.002	0.000

1A5 – Other	CH_4	0.00	0.05	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A5 – Other	N_2O	0.00	0.06	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1B1 – Solid Fuels	CH_4	0.00	0.00	25	121	124	0.000	0.000	0.000	0.000	0.000	0.000
1B1 – Solid Fuels	N_2O	0.00	0.00	25	163	165	0.000	0.000	0.000	0.000	0.000	0.000
1B2a - Oil	CO_2	0.00	873.44	15	40	43	0.078	-0.006	0.006	-0.248	0.093	0.070
1B2a - Oil	CH_4	0.00	1540.15	15	40	43	0.241	-0.011	0.011	-0.437	0.164	0.218
1B2a - Oil	N_2O	0.00	0.93	15	100	101	0.000	0.000	0.000	-0.001	0.000	0.000
1B2b – Natural Gas	CO_2	0.00	37.81	15	20	25	0.000	0.000	0.000	-0.005	0.004	0.000
1B2b – Natural Gas	CH_4	0.00	648.52	15	20	25	0.015	-0.005	0.005	-0.092	0.069	0.013
1B2b – Natural Gas	N_2O	0.00	0.17	15	100	101	0.000	0.000	0.000	0.000	0.000	0.000
3A1 – Enteric fermentation	CH_4	381.22	535.68	20	40	45	0.032	-0.001	0.004	-0.049	0.076	0.008
3A2 – Manure management	CH_4	36.75	65.51	20	30	36	0.000	0.000	0.000	-0.007	0.009	0.000
3A2 – Manure management	N_2O	0.01	0.02	54	116	128	0.000	0.000	0.000	0.000	0.000	0.000
3B1a – Forest Land Remaining Forest Land	CO_2	-152319.30	-148875.77	21	70	73	6600.630	0.029	1.056	2.055	22.177	496.020
3B2b –Land Converted to Cropland	CO_2	564.80	476.21	21	35	41	0.021	0.000	0.003	0.015	0.071	0.005
3B5B –Land Converted to Settlements	CO_2	320.02	457.89	21	61	65	0.049	-0.001	0.003	-0.067	0.068	0.009
3B6B –Land Converted to Other Land	CO_2	7716.75	5534.47	21	35	41	2.845	0.013	0.039	0.446	0.824	0.879
3C1 – Emissions from biomass burning	CH_4	63.16	111.48	28	161	163	0.019	0.000	0.001	-0.059	0.022	0.004
3C1 – Emissions from biomass burning	N_2O	16.26	28.04	28	161	163	0.001	0.000	0.000	-0.014	0.006	0.000
3C2 – Liming	CO_2	11.35	15.11	60	50	78	0.000	0.000	0.000	-0.002	0.006	0.000
3C3 – Urea application	CO_2	6.98	11.56	100	50	112	0.000	0.000	0.000	-0.002	0.008	0.000
3C4 – Direct N2O emissions from managed soil	N_2O	269.75	299.92	101	447	458	1.053	0.000	0.002	-0.138	0.215	0.065

3C5 – Indirect N2O emissions from managed soil	N_2O	103.71	139.06	20	121	123	0.016	0.000	0.001	-0.035	0.020	0.002
3C6 – Indirect N2O emissions from manure management	N_2O	6.89	12.02	54	110	123	0.000	0.000	0.000	-0.004	0.005	0.000
3C7 – Rice cultivations	CH_4	227.31	708.62	10	52	53	0.079	-0.003	0.005	-0.182	0.050	0.036
4A1– Managed Waste Disposal Sites	CH_4	0.00	147.73	52	52	73	0.007	-0.001	0.001	-0.054	0.054	0.006
4A3 – Uncategorized Waste Disposal Sites	CH_4	215.51	159.25	52	75	91	0.012	0.000	0.001	0.024	0.059	0.004
4C2 – Open Burning of Waste	CO_2	8.05	6.62	52	40	66	0.000	0.000	0.000	0.000	0.002	0.000
4C2 – Open Burning of Waste	CH_4	12.00	9.86	52	100	113	0.000	0.000	0.000	0.001	0.004	0.000
4C2 – Open Burning of Waste	N_2O	1.67	1.37	52	100	113	0.000	0.000	0.000	0.000	0.001	0.000
4D1 – Domestic Wastewater Treatment and Discharge	CH_4	108.28	110.44	59	58	83	0.005	0.000	0.001	-0.003	0.046	0.002
4D1 – Domestic Wastewater Treatment and Discharge	N_2O	5.54	9.68	58	497	500	0.001	0.000	0.000	-0.016	0.004	0.000
		-140977	-133919				81.27					22.30
		Total 1990 emissions	**Total 2022 emissions**				**2022 inventory uncertainty (%)**					**1990-2022 trend uncertainty (%)**

3.4. Key category analysis

A key category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term key category is used, it includes both source and sink categories. Through the identification of these categories in the national inventory, Guyana utilises the results as a foundation for making methodological choices. This enables the prioritisation of efforts toward these specific key categories, leading to enhancements in the overall accuracy of estimates.

The key category analysis of the national GHG inventory of Guyana is conducted in a systematic and objective manner by performing a quantitative analysis of the relationships between the level and the trend of each category's emissions and removals and total national emissions and removals.

The 2006 IPCC Approach 1 has been used to conduct the key category analysis for both the level and the trend analysis, considering the base year 1990 and the latest inventory year 2022. Furthermore, key categories were identified both including and excluding emissions and removals from Forestry and Other Land Use (FOLU). In Approach 1, key categories are determined based on a pre-established cumulative emissions threshold. These categories, when summed in descending order of magnitude, constitute 95% of the total level. The undertaken analysis has adhered, to the extent possible, to the recommended aggregation level for Approach 1 outlined in the 2006 IPCC Guidelines.

A description of the main equations for the level and trend assessment used is as follows.

Level Assessment

The contribution of each source or sink category to the total national inventory level is calculated according to the following equation:

$$L_{x,t} = \frac{|E_{x,t}|}{\sum_y |E_{y,t}|}$$

Where:

$L_{x,t}$ = *level assessment for source or sink x in latest inventory year*

$|E_{x,t}|$ = *absolute value of emission or removal estimate of source or sink category x in year t*

$\sum_y |E_{y,t}|$ = *total contribution in year t (sum of the absolute values of emissions and removals)*

Under the level assessment, key categories are therefore those that, when aggregated in descending order of magnitude, collectively constitute 95% of the overall contribution from all source and sink categories to the national inventory level.

Trend Assessment

The contribution of the trends of each source or sink category to the total national inventory trends is calculated according to the following equation:

$$T_{x,t} = \frac{|E_{x,0}|}{\sum_y |E_{y,0}|} \cdot \left| \frac{|E_{x,t} - E_{x,0}|}{|E_{x,0}|} - \frac{(\sum_y E_{y,t} - \sum_y E_{y,0})}{|\sum_y E_{y,0}|} \right|$$

Where:

$T_{x,t}$ = *trend assessment for source or sink x in year t as compared to the base year (year 0)*
$|E_{x,0}|$ = *absolute value of emission or removal estimate of source or sink category x in base year*
$E_{x,t}$ and $E_{x,0}$ = *real values of estimate of source or sink category X in years t and base year, respectively.*
$\sum_y E_{y,t}$ and $\sum_y E_{y,0}$ = *total inventory estimates in years t and base year, respectively.*

It is important to note that both that both ascending and descending trends are considered. In the assessment of trends, key categories are those that, when aggregated in descending order of magnitude, account for 95% of the collective contribution from all source and sink categories to the national total inventory trend.

Table 2.15 provides a summary of the key categories identified in both level and trend assessments for the base year 1990 and the latest inventory year 2022, both including and excluding FOLU. For a more detailed examination of the results of the key category analysis in both level and trend assessments, with and without the contributions of FOLU, refer to Annex I of the TNC.

It is important to note the categories 1B2a – Oil and 1B2b – Natural Gas were not occurring in 1990. However, to be able to conduct the key category analysis, a value of 0 has been assigned to these two categories for the year 1990.

Table 2.15. Summary of identified key categories.

IPCC category	Gas	With FOLU			Without FOLU		
		L2022	L1990	Trend	L2022	L1990	Trend
1A1 – Energy Industries	CO_2				X	X	X
1A2 – Manufacturing Industries and Construction	CO_2					X	X
1A3a – Domestic Aviation	CO_2					X	X
1A3b – Road Transport	CO_2				X	X	X
1A4 – Other Sectors	CO_2				X	X	X
1A4 – Other Sectors	CH_4					X	X
1B2a – Oil	CO_2				X		X
1B2a – Oil	CH_4	X			X		X
1B2b – Natural Gas	CH_4				X		X
3A1 – Enteric Fermentation	CH_4				X	X	X
3A2 – Manure Management	CH_4					X	
3B1a – Forest Land Remaining Forest Land	CO_2	X	X	X			
3B6B – Land Converted to Other Land	CO_2	X	X	X			
3C1 – Biomass Burning	CH_4				X	X	X
3C4 – Direct N_2O Emissions from Managed soils	N_2O				X	X	X
3C5 – Indirect N_2O Emissions from Managed soils	N_2O				X	X	X
3C7 – Rice Cultivations	CH_4				X	X	
4A1 – Managed Waste Disposal Sites	CH_4				X		X
4A3 – Uncategorized Waste Disposal Sites	CH_4				X	X	X
4D1 – Domestic Wastewater Treatment and Discharge	CH_4				X	X	X

4. Summary of GHG emissions

4.1. National GHG emissions profile

Guyana is a net carbon sink, with its lush managed forest cover removing up to 13 times more GHGs than the emissions produced in the country up to the year 2012, and up to 10 times of those in 2022, as illustrated in Figure 2.2.

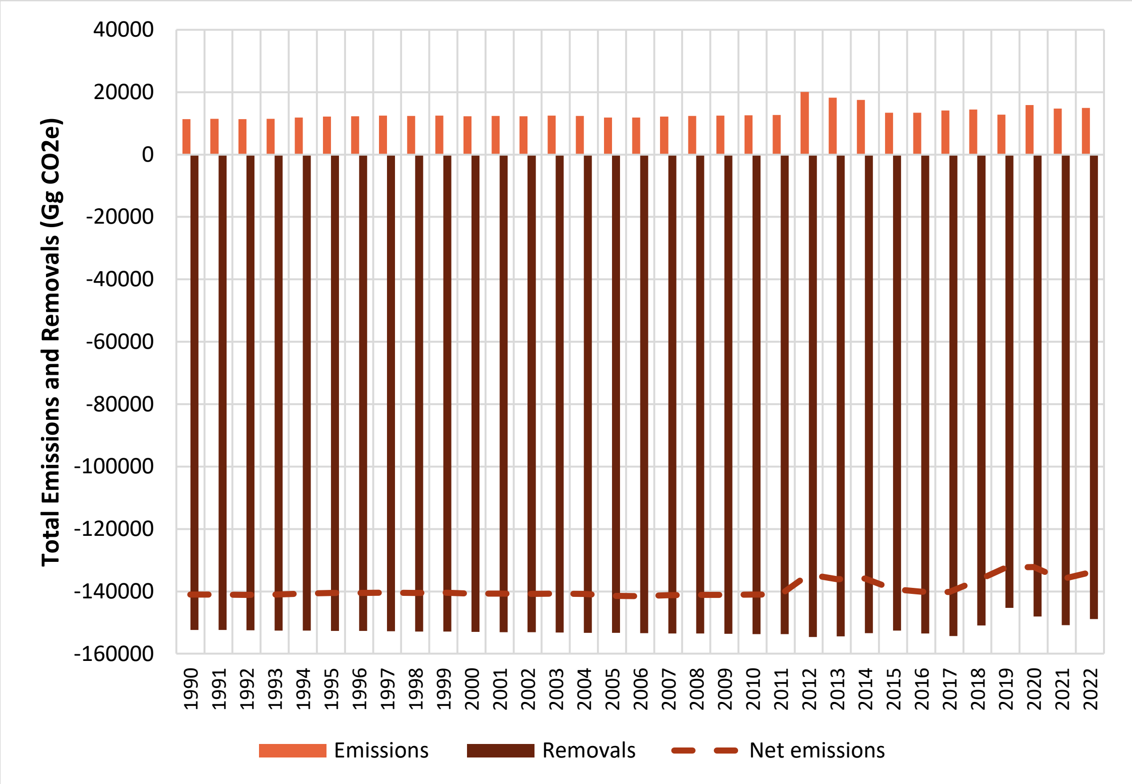

Figure 2.2. Total emissions and removals in Guyana.

Between 1990 and 2022, total GHG removals for managed forests remained stable, surmounting to 152,319 Gg CO_2e and 148,876 Gg CO_2e, respectively. A 31.87% increase in total national emissions is observed from 11,342 Gg CO_2e in 1990 to 14,957 Gg CO_2e in 2022. Such growth in emissions is attributed primarily to an expansion in the oil and gas industry, as well as population and economic growth contributing to more emissions from agriculture, waste management, and land conversion to settlements, cropland, and other lands.

When combined, Guyana contributed to a net 140,977 Gg CO_2e removal in 1990, slowly decreasing by 5% to a net 133,919 Gg CO_2e removal by 2022.

The following Figure 2.3 presents the sectoral contribution to total GHG emissions.

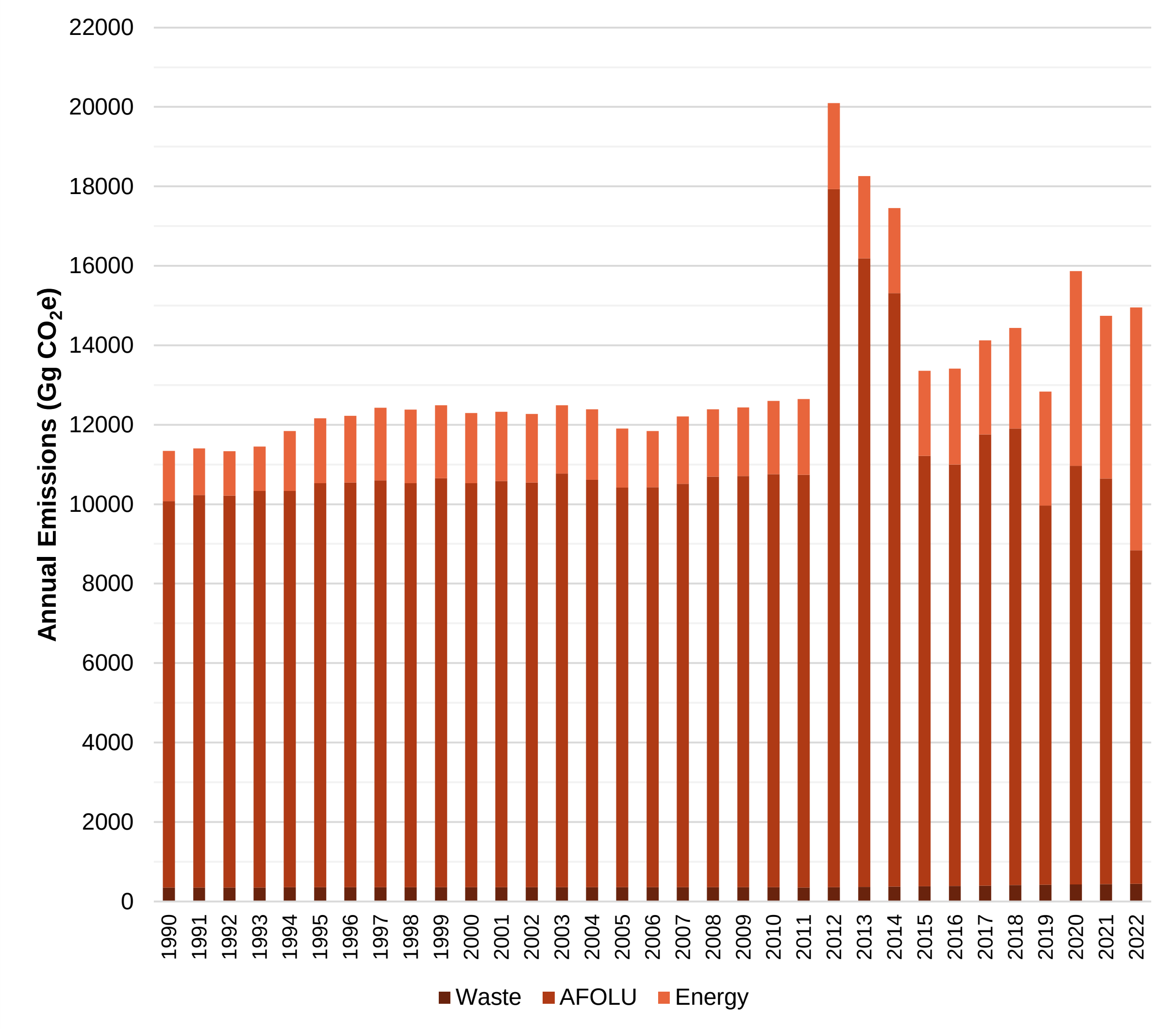

Figure 2.3. Sectoral contribution to total emissions in Guyana.

4.2. Reporting tables

The UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention (BUR Guidelines) specify that the inventory section of the BUR should incorporate Tables 1 and 2 from Decision 17/CP.8. However, these tables utilise nomenclature from the 1996 IPCC Guidelines. Since Guyana has conducted its inventory estimation in accordance with the 2006 IPCC Guidelines, the mentioned tables are not applicable. The 2006 IPCC Guidelines offer an equivalent summary reporting table in Chapter 8, Volume 1. These are presented in Tables 2.16 and 2.17 and provide a summary of the emissions in the inventory of Guyana in 2022.

Table 2.16. Reporting tables – summary table A of Guyana's 2022 GHG inventory.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
Total NET national emissions and removals	**-138,502.30**	**145.20**	**1.95**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**
1. Energy	**3,871.61**	**79.18**	**0.10**						**NE**	**NE**	**NE**	**NE**
1A. Fuel combustion (sectoral approach)	2,960.36	1.01	0.10						NE	NE	NE	NE
1A1. Energy industries	838.97	0.05	0.01						NE	NE	NE	NE
1A2. Manufacturing industries and construction	76.54	0.19	0.03						NE	NE	NE	NE
1A3. Transport	1,132.11	0.35	0.05						NE	NE	NE	NE
1A4. Other sectors	878.97	0.42	0.01						NE	NE	NE	NE
1A5. Non specified	33.78	0.002	0.000						NE	NE	NE	NE
1B. Fugitive emissions from fuels	911.25	78.17	0.004						NO	NO	22.59	NO
1B1. Solid fuels	IE	0.00006	0.0000001						NO	NO	NO	NO
1B2. Oil and natural gas	911.25	78.17	0.004						NO	NO	22.59	NO
1B3. Other emissions from energy production	NO	NO	NO						NO	NO	NO	NO
1C Carbon Dioxide Transport and Storage	NO								NO	NO	NO	NO
1C1. Transport of CO_2	NO								NO	NO	NO	NO
1C2. Injection and Storage	NO								NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
2. Industrial processes	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**
2A. Mineral products	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
2A1 Cement Production	NO	NO	NO						NO	NO	NO	NO
2A2 Lime Production	NO	NO	NO						NO	NO	NO	NO
2A3 Glass Production	NO	NO	NO						NO	NO	NO	NO
2A4 Other Process Uses of Carbonates	NO	NO	NO						NO	NO	NO	NO
2A5 Other (please specify)	NO	NO	NO						NO	NO	NO	NO
2B. Chemical industry	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
2B1. Ammonia production	NO	NO	NO						NO	NO	NO	NO
2B2. Nitric acid production	NO	NO	NO						NO	NO	NO	NO
2B3. Adipic acid production	NO	NO	NO						NO	NO	NO	NO
2B4. Caprolactam, glyoxal and glyoxylic acid production	NO	NO	NO						NO	NO	NO	NO
2B5. Carbide production	NO	NO	NO						NO	NO	NO	NO
2B6. Titanium dioxide production	NO	NO	NO						NO	NO	NO	NO
2B7. Soda ash production	NO	NO	NO						NO	NO	NO	NO
2B8. Petrochemical and carbon black production	NO	NO	NO						NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
2B9. Fluorochemical production				NO	NO	NO	NO	NO	NO	NO	NO	NO
2B10. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2C. Metal industry	**NO**	**NO**	**NO**						**NO**	**NO**	**NO**	**NO**
2C1. Iron and steel production	NO	NO	NO						NO	NO	NO	NO
2C2. Ferroalloys production	NO	NO	NO						NO	NO	NO	NO
2C3. Aluminium production	NO	NO	NO		NO				NO	NO	NO	NO
2C4. Magnesium production	NO			NO	NO	NO	NO	NO	NO	NO	NO	NO
2C5. Lead production	NO								NO	NO	NO	NO
2C6. Zinc production	NO								NO	NO	NO	NO
2C7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2D. Non-energy products from fuels and solvent use	**NE**	**NE**	**NE**						**NE, NA**	**NE, NA**	**0.97**	**NE, NA**
2D1. Lubricant use	NE								NE	NE	NE	NE
2D2. Paraffin wax use	NE	NE	NE						NE	NE	NE	NE
2D3. Other									NA	NA	0.97	NA
2E. Electronics industry	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2E1. Integrated circuit or semiconductor	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2E2. TFT flat panel display				NO	NO	NO	NO	NO	NO	NO	NO	NO
2E3. Photovoltaics				NO	NO	NO	NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
2E4. Heat transfer fluid							NO	NO	NO	NO	NO	NO
2E5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2F. Product uses as substitutes for ODS	**NO, NA**	**NO, NA**	**NO, NA**	**NE, NO**	**NE, NO**		**NE, NO**	**NE, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
2F1. Refrigeration and air conditioning	NA	NA	NA	NE	NE		NE	NE	NA	NA	NA	NA
2F2. Foam blowing agents	NA			NE	NE		NE	NE	NA	NA	NA	NA
2F3. Fire protection	NA			NE	NE		NE	NE	NA	NA	NA	NA
2F4. Aerosols				NE	NE		NE	NE	NA	NA	NA	NA
2F5. Solvents				NO	NO		NO	NO	NO	NO	NO	NO
2F6. Other applications	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
2G. Other product manufacture and use	**NO**	**NO**	**NE**	**NO**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
2G1. Electrical equipment					NE	NE	NE	NE	NA	NA	NA	NA
2G2. SF6 and PFCs from other product use					NO	NO	NO	NO	NO	NO	NO	NO
2G3. N_2O from product uses			NE						NA	NA	NA	NA
2G4. Other	NO	NO		NO			NO	NO	NO	NO	NO	NO
2H. Other	**NA, NO**	**NA, NO**	**NO**						**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
2H1. Pulp and Paper Industry	NA	NA							NE	NE	NE	NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
2H2. Food and Beverages Industry	NA	NA							NE	NE	NE	NE
2H3. Other (please specify)	NO	NO	NO						NO	NO	NO	NO
3. AGRICULTURE, FORESTRY AND OTHER LAND USE	**-142,380.53**	**50.76**	**1.81**						**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
3A. Livestock		21.47	0.0000796						**NA**	**NA**	**NA**	**NA**
3A1. Enteric Fermentation		19.13							NA	NA	NA	NA
3A2. Manure Management		2.34	8.0E-05						NA	NA	NA	NA
3B. Land	**-142,407.20**		**NE**						**NA**	**NA**	**NA**	**NA**
3B1. Forest Land	-148,875.77								NA	NA	NA	NA
3B2 Cropland	476,21								NA	NA	NA	NA
3B3. Grassland	NE								NA	NA	NA	NA
3B4. Wetlands	NE		NE						NA	NA	NA	NA
3B5. Settlements	457.89								NA	NA	NA	NA
3B6. Other Land	5534.47								NA	NA	NA	NA
3C. Aggregate Sources and Non-CO_2 Emissions Sources on Land	**26.67**	**29.29**	**1.81**						**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
3C1. Biomass Burning	IE	3.98	0.11						NA	NA	NA	NA
3C2. Liming	15.11								NA	NA	NA	NA
3C3. Urea Application	11.56								NA	NA	NA	NA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
3C4. Direct N_2O Emissions from Managed Soils			1.13						NA	NA	NA	NA
3C5. Indirect N_2O Emissions from Managed Soils			0.52						NA	NA	NA	NA
3C6. Indirect N_2O Emissions from Manure Management			0.05						NA	NA	NA	NA
3C7. Rice Cultivations		25.31	NA						NA	NA	NA	NA
3C8 Other (please specify)	NO	NO	NO						NO	NO	NO	NO
3D. Other	**IE, NO**			**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
3D1. Harvested Wood Products	IE								NA	NA	NA	NA
3D2. Other (please specify)	NO								NO	NO	NO	NO
4. WASTE	**6.62**	**15.26**	**0.04**						**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
4A. Solid Waste Disposal		10.96	NE						NE	NE	NE	NE
4B. Biological Treatment of Solid Waste		NE	NE						NE	NE	NE	NE
4C. Incineration and Open Burning of Waste	6.62	0.35	0.01						NE	NE	NE	NE
4D. Wastewater Treatment and Discharge		3.94	0.04						NE	NE	NE	NE
4E. Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO_2
	Gg			CO_2 equivalents (Gg)					Gg			
5. OTHER	**NO**	**NO**	**NE, NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
5A. Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3			NE						NE	NE	NE	NE
5B. Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items (5)	**NE**	**NE**	**NE**						**NE**	**NE**	**NE**	**NE**
International Bunkers	**NE**	**NE**	**NE**						**NE**	**NE**	**NE**	**NE**
International Aviation (International Bunkers)	NE	NE	NE						NE	NE	NE	NE
International Water-borne Transport (International Bunkers)	NE	NE	NE						NE	NE	NE	NE
Multilateral Operations	NE	NE	NE						NE	NE	NE	NE

Table 2.17. Reporting tables – summary table B of Guyana's 2022 GHG inventory.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO2
	Gg			CO_2 equivalents (Gg)					Gg			
Total national emissions and removals	**-138,502.30**	**145.20**	**1.95**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**
1. Energy	**3,871.61**	**79.18**	**0.10**						**NE**	**NE**	**NE**	**NE**
1A. Fuel combustion (sectoral approach)	2,960.36	1.01	0.10						NE	NE	NE	NE
1B. Fugitive emissions from fuels	911.25	78.17	0.004						NE	NE	NE	NE
1C Carbon Dioxide Transport and Storage	NO								NO	NO	NO	NO
2. Industrial processes	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**	**NO, NA, NE**
2A. Mineral products	NO	NO	NO						NO	NO	NO	NO
2B. Chemical industry	NO	NO	NO						NO	NO	NO	NO
2C. Metal industry	NO	NO	NO						NO	NO	NO	NO
2D. Non-energy products from fuels and solvent use	NE	NE	NE						NE, NA	NE, NA	0.97	NE, NA
2E. Electronics industry	NO		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2F. Product uses as substitutes for ODS	NA, NO	NA, NO	NA, NO	NE, NO	NE, NO		NE, NO	NE, NO	NA, NO	NA, NO	NA, NO	NA, NO
2G. Other product manufacture and use	NO	NO	NE	NO	NO, NE	NO, NE	NO, NE	NO, NE	NA, NO	NA, NO	NA, NO	NA, NO
2H. Other	NA, NO	NA, NO	NO						NE, NO	NE, NO	NE, NO	NE, NO

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO2
	Gg			CO_2 equivalents (Gg)					Gg			
3. AGRICULTURE, FORESTRY AND OTHER LAND USE	**-142,380.53**	**50.76**	**1.81**						**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**
3A. Livestock		21.47	0.0000796						NA	NA	NA	NA
3B. Land	-142,407.20	NA	NE						NA	NA	NA	NA
3C. Aggregate Sources and Non-CO_2 Emissions Sources on Land	26.67	29.29	1.81						NA, NO	NA, NO	NA, NO	NA, NO
3D. Other	IE, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
4. WASTE	**6.62**	**15.26**	**0.04**						**NE**	**NE**	**NE**	**NE**
4A. Solid Waste Disposal		10.96	NE						NE	NE	NE	NE
4B. Biological Treatment of Solid Waste		NE	NE						NE	NE	NE	NE
4C. Incineration and Open Burning of Waste	6.62	0.35	0.01						NE	NE	NE	NE
4D. Wastewater Treatment and Discharge		3.94	0.04						NE	NE	NE	NE
4E. Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. OTHER	**NO**	**NO**	**NE, NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
5A. Indirect N_2O Emissions from the Atmospheric			NE						NE	NE	NE	NE

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2	CH_4	N_2O	HFC	PFC	SF6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO2
	Gg			CO_2 equivalents (Gg)					Gg			
Deposition of Nitrogen in NOx and NH3												
5B. Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items (5)	**NE**	**NE**	**NE**						**NE**	**NE**	**NE**	**NE**
International Bunkers	NE	NE	NE						NE	NE	NE	NE
International Aviation (International Bunkers)	NE	NE	NE						NE	NE	NE	NE
International Water-borne Transport (International Bunkers)	NE	NE	NE						NE	NE	NE	NE
Multilateral Operations	NE	NE	NE						NE	NE	NE	NE

4.3. Comparison with previous national GHG inventories

In compliance with its commitments under the UNFCCC, Guyana has thus far completed three national GHG inventories according to the Revised 1996 IPCC Guidelines as follows:

- Period 1990-1998 reported in the first national communication.
- Period 1990-2004 reported in the second national communication.
- Period 1990-2016 reported in the third national communication (in draft – not published).

For the first time, the current edition of the national GHG emissions inventory of Guyana for the period 1990-2022 utilizes the 2006 IPCC Guidelines and the 2019 Refinement, edition of the GHG inventory which was also published in Guyana´s first BUR and BTR. Furthermore, the development of sectoral monitoring, reporting, and verification systems have permitted access to much more accurate and complete country-specific data since the previous inventory compilation. For these two principal reasons, the entire time series 1990-2016 has been recalculated and the time series 2017-2022 has been calculated using the most updated methodologies and data. It is for this reason that the current edition of the 1990-2022 GHG inventory of Guyana is not comparable to values reported previously.

Table 2.18 provides an overview of the methodological differences between the current and previous editions of the Guyana national GHG emission inventory.

Table 2.18. Changes in inventory compared to previous editions.

Sector	Description of changes and recalculations
Cross-cutting	• Methodologies, default parameters, and default emission factors from the 2006 IPCC Guidelines and 2019 Refinement were now adopted for the inventory as a whole, as opposed to the 1996 IPCC Guidelines from the previous inventory.
Energy Sector	• Category 1B1 Solid Fuels has been introduced for the first time in the current inventory to account for the fugitive emissions during the transformation of fuel for charcoal production. • Category 1B2 Oil and Natural Gas has been introduced for the first time in the current inventory to account for fugitive emissions originating from oil and natural gas systems.
IPPU Sector	• Improved information for all entries through the use of qualitative notation keys and supporting information to ensure the completeness of each individual emission estimate.
AFOLU Sector	• Country-specific parameters and emissions factors have been used for the estimation of emissions and removals from Category 3B based on the calculations from the workbook to determine the emissions reductions of Guyana's REDD+ program, for submission to the Architecture for REDD+ Transactions under TREES 2.0 standards.

Sector	Description of changes and recalculations
	• Emissions from urea application, Category 3C3, have been calculated using national urea imports data from 2020 to 2022 and surrogating data from FAO for the rest of the timeline. • Emissions from the Category 3C5: Indirect N2O Emissions from Managed Soils have been calculated using default values and emissions factors from the 2019 Refinements.
Waste Sector	• The waste sector now encompasses the entire geographical scope of Guyana, as opposed to only the geographical scope of Georgetown and its vicinity. • Category 4A now accounts for emissions from the Haags Bosch Sanitary Landfill under Category 4A1 (managed solid waste disposal sites) and the remaining emissions under Category 4A3 (uncategorized solid waste disposal sites), whereas the previous inventory grouped all solid waste disposal emissions under Category 4A3. • Category 4C2 (open burning of waste) has been introduced for the first time in the current inventory to account for emissions from open burning of waste. • CH_4 emissions under Category 4D1 (domestic wastewater treatment and discharge) were recalculated on the basis of updated country-specific information on the historical evolution of wastewater treatment methods including sewerage, latrines, and septic systems, available from the Guyana Bureau of Statistics Census. N_2O emissions were recalculated on the basis of updated information on the historical evolution on nitrogen consumption available from FAO statistics.

5. Emission trends by GHG

In Guyana, CO_2 is the predominant gas in national GHG emissions throughout the time series (Figure 2.4).

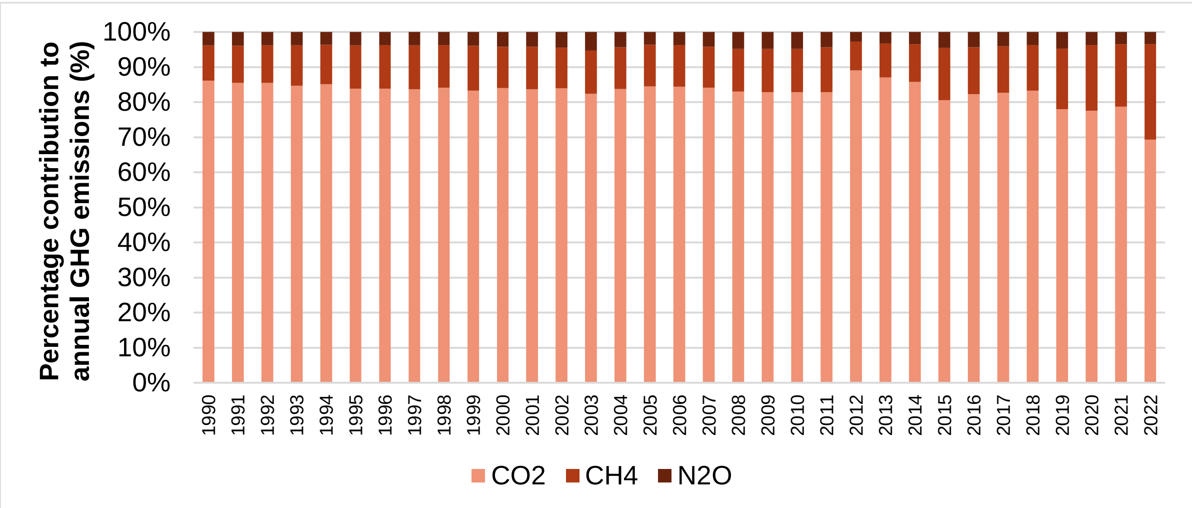

Figure 2.4. GHG contribution to total emissions in Guyana.

Whilst CO_2 is the most influential gas, its proportional contribution has evolved over time. CO_2 contributed to 86% of total GHG emissions in 1990, slowly increasing to a peak 89% by 2012, and subsequently decreasing to 69% by 2022. To a much lower extent, CH_4 is the second most important gas that is increasing in importance, growing from a 10% contribution to national total GHG emissions in 1990 to a 27% contribution in 2022. Lastly, N_2O is the third most important gas, with a fairly stable contribution to national GHG emission totals, ranging from 3-5% across the time series.

6. Emission trends by sector

6.1. Energy

The energy sector covers GHG emissions arising from the combustion of fossil fuels and as fugitive emissions or escape without combustion through several activities, including the exploration and exploitation of primary energy sources, the conversion of primary energy sources into more useable energy forms in refineries and power plants, and the use of fuels in stationary and mobile applications. This section presents the GHG emissions in Guyana associated with the energy sector.

6.1.1. Description of Sector

According to the 2006 IPCC Guidelines, GHG emissions in the energy sector are split into three main categories: 1A Fuel Combustion Activities, 1B Fugitive emissions from fuels and 1C CO_2 transport and storage. Fuel combustion activities concern emissions from the intentional oxidation of materials within an apparatus that is designed to raise heat and provide it either as heat or as mechanical work to a process or for use away from the apparatus. Fugitive emissions from fuels include all intentional and unintentional emissions from the extraction, processing, storage, and transport of fuel to the point of final use. CO_2 transport and storage involves the capture of CO_2, its transport to a storage location and its long-term isolation from the atmosphere.

In Guyana, energy sector GHG emissions are related to the emissions from fuel combustion activities and fugitive emissions from extraction, transformation, and transportation of primary energy carriers. As such, CO_2 transport and storage is currently not occurring in Guyana.

Fuel Combustion Activities

Emissions within the energy industry of Guyana primarily stem from the combustion of fuels utilised for electricity generation. This category holds significant importance in the country's overall GHG emissions profile within the energy sector. Notably, although petroleum refining does not occur in the country, emissions in the energy sector do encompass combustion emissions arising from electricity generation, specifically from projects like Liza Phase 1 and Liza Phase 2, as well as ExxonMobil's FPSO vessels.

In addition to energy industry emissions, Guyana experiences GHG emissions from the manufacturing industry and construction sector, albeit constituting a relatively small portion of the overall energy sector emissions. These emissions result from fuels combusted in industries, including fuel combustion for the generation of electricity and heat for own use in these industries. Emissions from the industry sector should be specified by sub-categories that correspond to the International Standard Industrial Classification of all Economic Activities (ISIC).

Transport emissions form another substantial component of Guyana's energy sector GHG emissions, originating from the combustion and evaporation of fuel across various transportation activities. The transport sector's emissions contribute significantly to the overall GHG emissions within the energy sector. Notably, road transport serves as the primary mode of transportation in Guyana, while rail transport is not occurring. The Cheddi Jagan International Airport in Georgetown, complemented by numerous smaller airports nationwide contributes to the emissions associated with aviation. Moreover, domestic navigation, primarily involving logistical vessels servicing FPSOs, further adds to the transport-related emissions.

Fuel combustion emissions in Guyana also occur in households and commercial and institutional buildings, and in the agriculture, forestry, fishing, and fishing industries, which are all accounted for in the national GHG emissions inventory.

Fugitive emissions from fuels

Fugitive emissions are the intentional or unintentional release of GHG occurring during extraction, processing, and delivery of fossil fuels to the point of final use. In the case of Guyana, there is a limited occurrence of charcoal production. However, in 2020, the country initiated offshore oil production in the Stabroek Block through the Liza Phase 1 Project, leading to the emergence of fugitive emissions from oil and natural gas systems.

Subsequently, Guyana has expanded its oil production activities within the Stabroek Block, initiating a second FPSO vessel under the Liza Phase 2 Project. Anticipated developments indicate the commencement of two additional oil production projects in the Stabroek Block in the upcoming years. This expansion in oil production not only signifies a significant stride in Guyana's energy sector but also underscore the importance of continuous monitoring of potential fugitive emissions associated with oil and natural gas systems.

6.1.2. Coverage of Sector

In line with the 2006 IPCC Guidelines, Figure 2.5 presents the categories that are covered in the energy sector of Guyana. It delineates the estimated categories and provides indications for those that have not been estimated or cannot be reported in the tables, using notation keys.

Figure 2.5. Coverage of the energy sector in Guyana.

Category 1A1 Energy Industries comprises emissions from fuels combusted by the fuel extraction or energy-producing industries. This category is not further disaggregated between the different sub-categories as part of Guyana's GHG emissions inventory. Although petroleum refining does not occur in the country, other emissions within the energy industries include the combustion emissions arising from the electricity generation on the Liza Phase 1 and Liza Phase 2 Projects, ExxonMobil's FPSO vessels.

Category 1A2 Manufacturing Industries and Construction relates to fuels combusted in industries, including fuel combustion for the generation of electricity and heat for own use in these industries. These GHG emissions occur in Guyana but are not further disaggregated by ISIC sub-categories as part of Guyana's GHG emissions inventory.

Category 1A3 Transport covers GHG emissions from the combustion and evaporation of fuel for all transport activities. Road transport is the main contributor to the transport sector while railways are not occurring. Furthermore, regarding domestic navigation, any fuel consumption and related emissions that is occurring under this sub-category are included in the other sector fuel consumption. Emissions from international aviation and navigation are not estimated due to information not being available. All fuel consumption is assumed to be domestic for aviation and navigation. Ascertaining the amount of fuel consumption linked to international aviation and navigation is incorporated into the improvement plan.

Category 1A4 Other Sectors refers to fuel combustion emissions in households and commercial and institutional buildings and in the agriculture, forestry, fishing, and fishing industries. The agriculture, forestry, fishing, and fishing industries sub-categories not further disaggregated.

Category 1B1 Solid Fuels includes all intentional and unintentional emissions from the extraction, processing, storage, and transport of solid fuel to the point of final use. In Guyana, this only relates to the production of charcoal, which is reflected in the national GHG emissions inventory.

Category 1B2 Oil and Natural Gas relates to fugitive emissions from oil and natural gas systems. As previously mentioned, Guyana recently commenced with oil and natural gas production, which is all being conducted offshore. Offshore exploration emissions data are unavailable, and these emissions are thought to be negligible. Furthermore, only sub-categories oil production and upgrading and oil transport, and gas production and gathering are assumed to be occurring in Guyana, while the other sub-categories are not occurring as the production is directly loaded onto tanker ships and not brought to shore.

Category 1C CO_2 Capture and Storage involves the capture of CO_2, its transport to a storage location and its long-term isolation from the atmosphere. This category is not occurring in Guyana.

6.1.3. Summary of Sector Emissions

In 2022, the energy sector represented 40.89% of total emissions in Guyana, being the second largest source of GHG emissions in the country following the AFOLU sector, as illustrated in

Figure 2.6. The energy sector accounts for 37.32% of the total national CO_2 emissions, 54.53% of the total national CH_4 emissions, and 5.31% of the total national N_2O emissions.

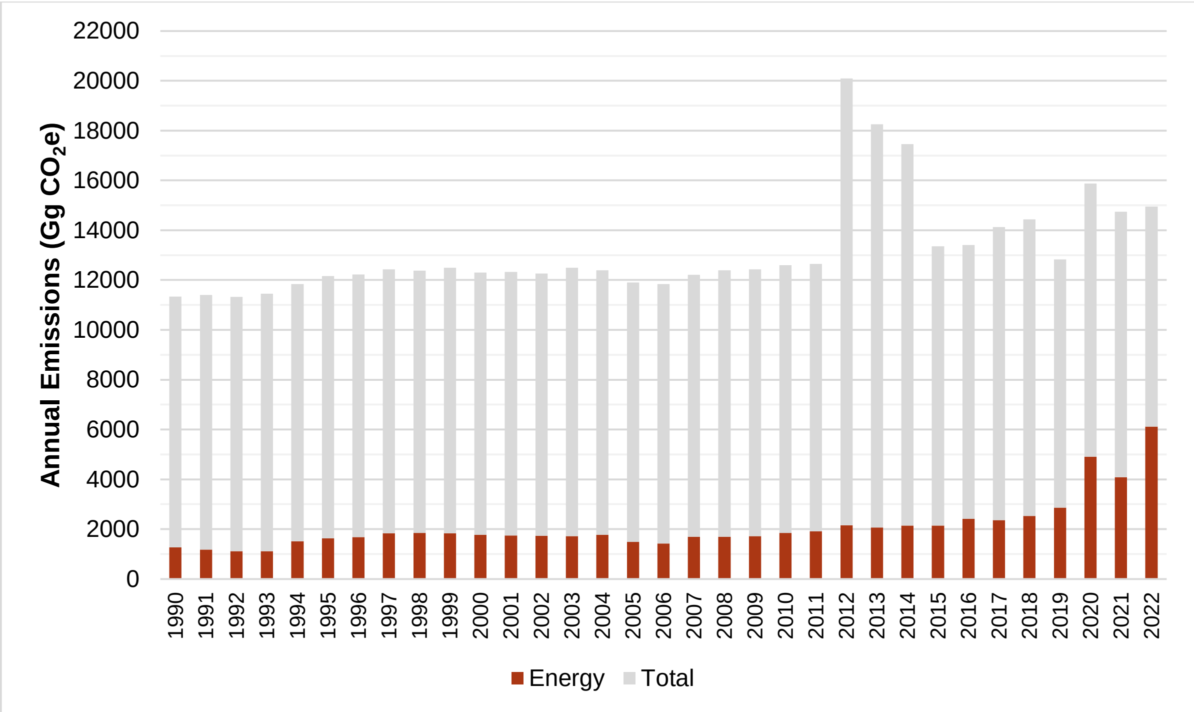

Figure 2.6. Contribution of energy sector emissions to national emission totals.

Figure 2.7 and 2.8 and Table 2.19 summarise sectoral emission trends by category and gas.

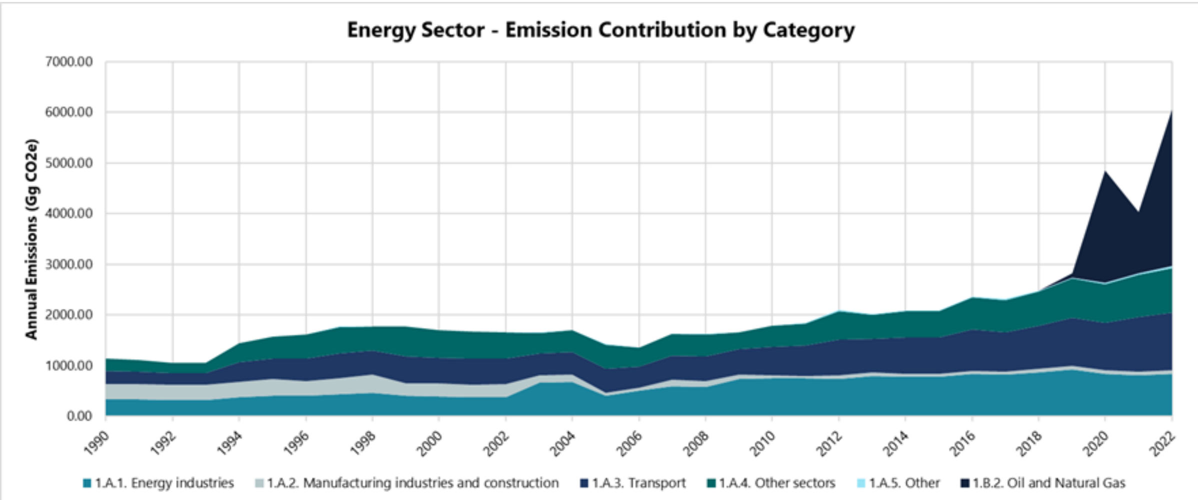

Figure 2.7. Total GHG emissions from the energy sector by category.

Table 2.19. Total GHG emissions from the energy sector by category and gas.

Category	Gas	Annual emissions in Gg CO_2e															
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1 Energy	CO_2	1143.27	1115.94	1052.45	1058.92	1447.48	1567.50	1616.56	1765.86	1779.84	1773.66	1703.27	1678.64	1658.80	1653.66	1708.19	1422.67
	CH_4	91.86	36.55	36.36	36.26	37.76	37.83	38.23	38.72	38.78	39.20	37.69	37.85	39.46	37.59	38.84	35.23
	N_2O	30.75	23.45	23.28	23.38	25.87	26.40	27.17	28.18	28.28	29.17	27.32	28.11	30.78	28.50	30.75	26.72
	Total	1265.88	1175.94	1112.09	1118.56	1511.11	1631.73	1681.96	1832.76	1846.90	1842.02	1768.28	1744.60	1729.04	1719.74	1777.78	1484.62
1A1 Energy industries	CO_2	332.98	335.96	321.59	320.72	378.42	410.46	399.61	436.71	467.28	398.77	388.69	377.11	380.40	671.83	682.79	407.32
	CH_4	1.10	0.92	0.90	0.90	0.97	1.01	1.00	1.05	1.09	1.02	0.97	0.97	1.05	1.35	1.41	1.01
	N_2O	1.61	1.39	1.36	1.36	1.49	1.55	1.54	1.63	1.70	1.57	1.50	1.48	1.60	2.18	2.26	1.56
	Total	335.69	338.27	323.86	322.99	380.88	413.02	402.15	439.40	470.07	401.36	391.16	379.56	383.05	675.36	686.46	409.89
1A2 Manufacturing industries and construction	CO_2	301.18	306.11	300.93	299.39	299.66	319.26	287.23	310.25	357.16	248.92	255.11	238.67	250.55	135.42	133.52	61.33
	CH_4	12.46	12.59	12.65	12.70	12.76	12.81	12.94	13.22	13.44	13.48	12.43	13.04	15.35	14.11	15.63	12.78
	N_2O	15.91	16.07	16.14	16.21	16.29	16.37	16.51	16.88	17.18	17.17	15.84	16.61	19.53	17.88	19.81	16.16
	Total	329.55	334.76	329.72	328.30	328.71	348.44	316.68	340.36	387.78	279.57	283.39	268.32	285.43	167.41	168.96	90.27
1A3 Transport	CO_2	265.89	243.55	234.32	237.98	385.59	410.87	450.81	486.53	473.64	538.09	515.19	519.95	501.89	438.88	455.71	473.94
	CH_4	2.10	1.87	1.97	1.99	2.87	2.86	3.13	3.27	3.44	3.66	3.59	3.71	3.59	3.58	3.62	3.57
	N_2O	3.23	2.97	2.85	2.89	4.82	5.12	5.69	6.14	6.00	6.84	6.50	6.61	6.37	5.48	5.72	5.99
	Total	271.22	248.39	239.14	242.85	393.27	418.85	459.63	495.94	483.07	548.59	525.28	530.27	511.84	447.94	465.05	483.50
1A4 Other Sectors	CO_2	242.31	229.43	194.88	200.09	382.12	424.99	476.69	529.89	479.50	585.10	541.76	540.33	523.51	398.10	425.71	468.08
	CH_4	76.20	21.18	20.84	20.67	21.16	21.15	21.16	21.19	20.81	21.02	20.69	20.13	19.46	18.53	18.16	17.86
	N_2O	9.99	3.02	2.93	2.92	3.27	3.35	3.43	3.52	3.40	3.58	3.48	3.40	3.28	2.94	2.95	2.98
	Total	328.50	253.63	218.65	223.68	406.56	449.50	501.28	554.59	503.71	609.71	565.93	563.86	546.25	419.58	446.82	488.92
1A5 Other	CO_2	0.92	0.89	0.73	0.74	1.68	1.90	2.21	2.47	2.26	2.78	2.52	2.58	2.46	9.42	10.46	12.00
	CH_4	0.001	0.001	0.001	0.001	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.011	0.012	0.014
	N_2O	0.002	0.002	0.002	0.002	0.004	0.004	0.005	0.005	0.005	0.006	0.005	0.006	0.005	0.020	0.022	0.026
	Total	0.92	0.89	0.73	0.74	1.69	1.91	2.22	2.48	2.27	2.79	2.53	2.59	2.47	9.45	10.49	12.04
1B1 Solid Fuels	CO_2	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
	CH_4	0.0011	0.0016	0.0016	0.0015	0.0015	0.0015	0.0015	0.0014	0.0014	0.0014	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011
	N_2O	0.00002	0.00004	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002
	Total	0.0011	0.0016	0.0016	0.0016	0.0015	0.0015	0.0015	0.0015	0.0014	0.0014	0.0014	0.0013	0.0013	0.0013	0.0012	0.0012
1B2 Oil and Natural Gas	CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1B3 Other Emissions from Energy Production	CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1C CO_2 Transport and storage	CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Category	Gas	Annual emissions in Gg CO_2e																
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1 Energy	**CO_2**	1359.85	1636.06	1630.88	1663.27	1790.57	1844.51	2097.33	2015.17	2089.10	2089.18	2361.84	2314.32	2479.50	2789.90	3980.70	3265.02	3871.61
	CH_4	34.57	34.89	33.86	33.24	32.98	35.34	32.92	29.78	29.29	29.67	28.60	27.83	26.53	53.66	899.92	800.67	2216.98
	N_2O	26.08	27.26	26.28	25.92	26.15	29.83	28.44	25.55	25.28	26.18	26.71	26.14	23.75	22.26	23.91	25.72	27.51
	Total	1420.51	1698.21	1691.02	1722.43	1849.70	1909.68	2158.68	2070.50	2143.67	2145.04	2417.15	2368.29	2529.78	2865.82	4904.53	4091.41	6116.10
1A1 Energy industries	**CO_2**	508.39	593.59	579.14	742.32	756.08	745.75	741.38	799.14	773.56	779.99	836.01	818.05	869.66	917.47	844.12	801.63	838.97
	CH_4	1.12	1.25	1.15	1.33	1.36	1.39	1.63	1.84	1.76	2.01	1.76	1.74	1.57	1.42	1.38	1.39	1.45
	N_2O	1.77	1.99	1.86	2.20	2.24	2.27	2.57	2.88	2.76	3.07	2.80	2.76	2.59	2.43	2.32	2.31	2.41
	Total	511.29	596.82	582.15	745.85	759.67	749.42	745.58	803.86	778.08	785.06	840.57	822.54	873.82	921.32	847.82	805.32	842.83
1A2 Manufacturing industries and construction	**CO_2**	50.68	129.55	120.79	74.75	59.20	55.10	65.41	62.70	61.59	58.53	63.53	63.06	67.08	73.88	71.22	73.14	76.54
	CH_4	12.90	13.03	12.24	11.86	11.39	13.90	11.32	9.53	8.79	9.33	8.93	8.87	6.28	3.90	4.44	5.06	5.30
	N_2O	16.31	16.52	15.51	15.00	14.39	17.56	14.32	12.07	11.12	11.80	11.29	11.22	7.96	4.96	5.64	6.43	6.73
	Total	79.89	159.09	148.54	101.62	84.98	86.57	91.05	84.30	81.49	79.66	83.75	83.15	81.32	82.75	81.30	84.63	88.57
1A3 Transport	**CO_2**	419.89	470.60	488.47	511.50	559.70	594.67	709.54	659.92	715.67	719.51	816.12	779.24	850.01	953.95	934.12	1081.73	1132.11
	CH_4	3.49	3.77	4.05	4.82	5.12	5.26	5.89	5.87	6.35	6.35	6.80	6.21	6.96	7.76	7.79	9.28	9.72
	N_2O	5.27	5.93	6.15	6.32	7.00	7.46	8.89	8.28	9.02	9.00	10.22	9.76	10.66	12.03	11.90	13.74	14.38
	Total	428.64	480.29	498.67	522.64	571.83	607.39	724.32	674.07	731.05	734.85	833.14	795.20	867.63	973.73	953.81	1104.75	1156.21
1A4 Other Sectors	**CO_2**	371.88	431.40	431.77	326.74	405.45	437.36	565.85	480.63	523.95	517.29	628.91	636.43	674.02	770.87	759.80	839.85	878.97
	CH_4	17.05	16.84	16.41	15.22	15.10	14.77	14.05	12.52	12.36	11.97	11.09	11.00	11.69	12.24	10.95	11.27	11.79
	N_2O	2.72	2.80	2.74	2.39	2.50	2.51	2.63	2.29	2.34	2.29	2.36	2.36	2.51	2.74	2.55	2.70	2.83
	Total	391.64	451.04	450.92	344.35	423.05	454.64	582.54	495.44	538.66	531.55	642.35	649.78	688.22	785.85	773.30	853.82	893.59
1A5 Other	**CO_2**	9.01	10.93	10.71	7.94	10.14	11.62	15.14	12.78	14.34	13.87	17.28	17.55	18.73	22.62	24.51	32.27	33.78
	CH_4	0.010	0.012	0.012	0.009	0.011	0.013	0.017	0.014	0.016	0.016	0.020	0.020	0.021	0.027	0.031	0.048	0.050
	N_2O	0.019	0.023	0.023	0.017	0.022	0.025	0.032	0.027	0.031	0.030	0.037	0.038	0.040	0.047	0.048	0.055	0.058
	Total	9.04	10.96	10.74	7.97	10.18	11.66	15.19	12.83	14.38	13.91	17.33	17.61	18.79	22.70	24.59	32.38	33.88
1B1 Solid Fuels	**CO_2**	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
	CH_4	0.0011	0.0011	0.0010	0.0019	0.0022	0.0019	0.0019	0.0018	0.0019	0.0018	0.0017	0.0017	0.0016	0.0016	0.0016	0.0016	0.0016
	N_2O	0.00002	0.00002	0.00002	0.00004	0.00004	0.00004	0.00003	0.00003	0.00004	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003
	Total	0.0011	0.0011	0.0010	0.0020	0.0022	0.0019	0.0019	0.0018	0.0019	0.0018	0.0017	0.0017	0.0016	0.0016	0.0016	0.0016	0.0017
1B2 Oil and Natural Gas	**CO_2**	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	51.11	1346.93	436.41	911.25
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	28.30	875.33	773.61	2188.66
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.05	1.45	0.49	1.10
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	79.47	2223.71	1210.51	3101.02
1B3 Other Emissions from Energy Production	**CO_2**	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1C CO_2 Transport and storage	**CO_2**	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

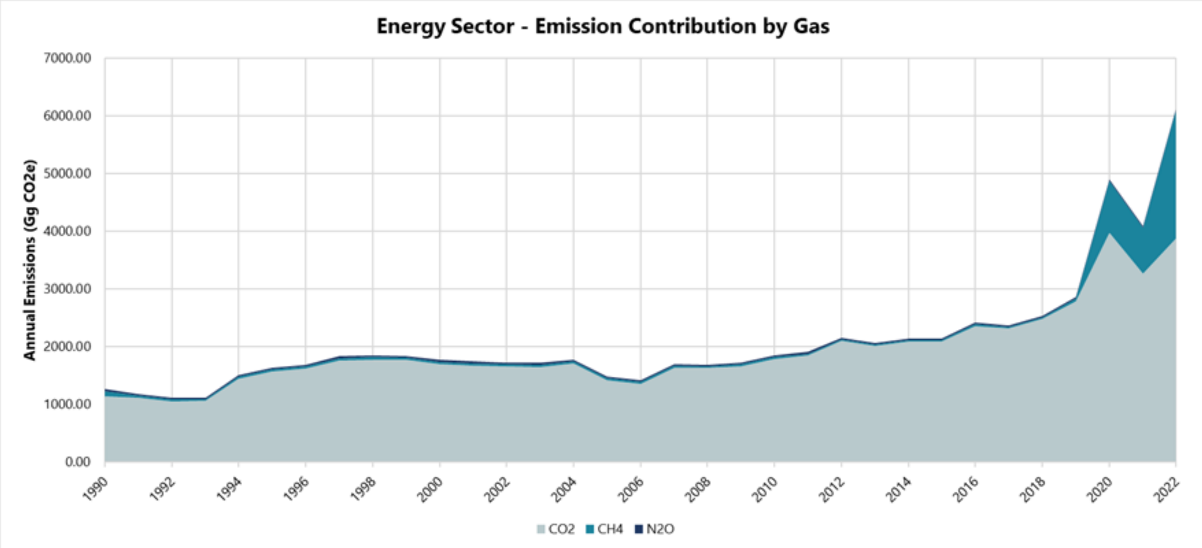

Figure 2.8. Total GHG emissions from the energy sector by gas.

Total emissions from the energy sector have increased by 383.15% from 1,265.88 Gg CO_2e in 1990 to 6,116.10 Gg CO_2e in 2022. This increase is primarily attributable to two pivotal factors. Firstly, the commencement of oil and gas production off the coast of Guyana has contributed to this increase. Secondly, there has been a gradual rise in fuel consumption within the country, closely tied to its economic growth trajectory.

The oil and gas category, a newcomer to the emissions landscape since 2018, has increased over the last few years. In 2022, emissions from this category reached 3,101.02 Gg CO_2e, constituting 50.70% of the total GHG emissions within the energy sector. Other noteworthy contributors include the transport sector, energy industries, as well as emissions from households, commercial and institutional buildings, and the agriculture, forestry, fishing, and fishing industries.

The transport sector has experienced a noteworthy increase, increasing from 271.22 Gg CO_2e in 1990 to 1,156.21 Gg CO_2e in 2022, currently representing 18.90% of the total energy sector emissions. Energy industries have similarly increased from 335.69 Gg CO_2e in 1990 to 842.83 Gg CO_2e in 2022, accounting for 13.78% of the total energy sector emissions. This growth trend is also observed in emissions from households, commercial and institutional buildings, and the agriculture, forestry, fishing, and fishing industries, collectively witnessing a 172.02% increase from 1990 to 2022, reaching 893.59 Gg CO_2e.

Contrastingly, manufacturing industries and construction have observed a decrease in emissions, declining from 329.55 Gg CO_2e in 1990 to 88.57 Gg CO_2e in 2022. Emissions from solid fuels, particularly in the context of charcoal production in Guyana, have remained relatively stable, fluctuating between 0.0010 Gg CO_2e and 0.0020 Gg CO_2e during the period spanning 1990 to 2022.

In terms of GHG composition, CO_2 emissions hold paramount significance within the energy sector. In 2022, the sector emitted a total of 3,871.61 Gg CO_2e CO_2, 2,216.97 Gg CO_2e CH_4, and 27.51 Gg CO_2e N_2O, representing 63.30%, 36.25%, and 0.45% of the overall sectoral emissions, respectively.

6.1.4. Description of Emissions by Category

Energy Industries (1A1)

This category encompasses emissions arising from fuels combusted by the fuel extraction or energy-producing industries. Guyana exhibits a significant reliance on petroleum imports, with a noteworthy increase in these imports correlating with a substantial portion of the country's GDP. Diesel, fuel oil, and gasoline constitute the principal imports, predominantly utilised by the transportation and electricity sectors. This trend in petroleum imports is mirrored in the greenhouse gas (GHG) emissions originating from energy industries, which have demonstrated an upward trend over the period spanning 1990 to 2022, as illustrated in Figure 2.9 and detailed in Table 2.20.

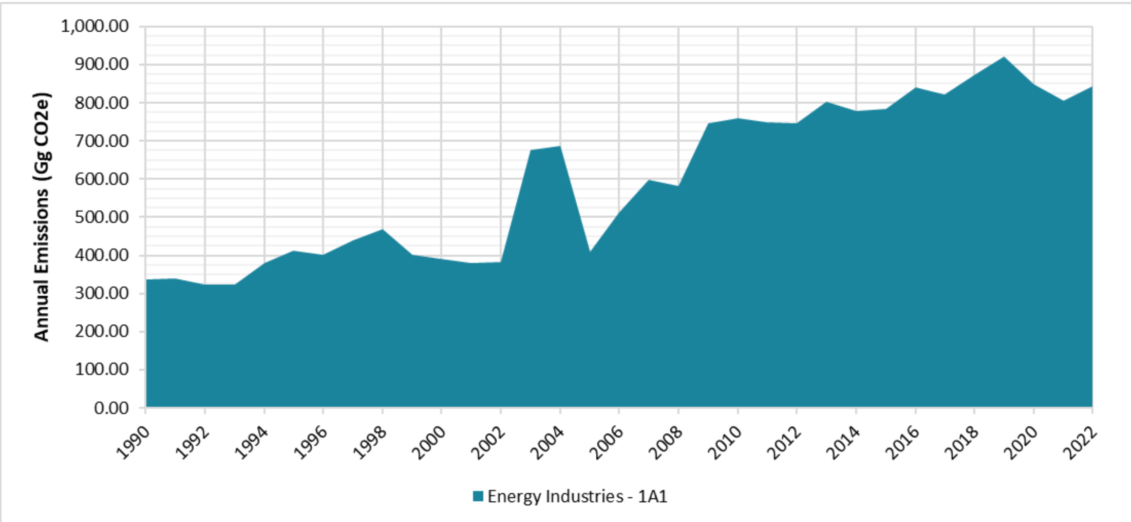

Figure 2.9. Category 1A1 GHG emissions.

Table 2.20. Summary of GHG emissions from Category 1A1 – Energy Industries.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Energy Industries – 1A1	335.69	338.27	323.86	322.99	380.88	413.02	402.15	439.40	470.07	401.36	391.16
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy Industries – 1A1	379.56	383.05	675.36	686.46	409.89	511.29	596.82	582.15	745.85	759.67	749.42
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Energy Industries – 1A1	745.58	803.86	778.08	785.06	840.57	822.54	873.82	921.32	847.82	805.32	842.83

The uncertainty associated with activity data and emission factors in category 1A1 is sourced from Chapter 2, Volume 2 of the 2006 IPCC Guidelines. Concerning activity data uncertainty, the higher value of the range for 'extrapolation' under less developed statistical systems for main activity electricity and heat production has been used considering that the sectoral consumption has been calculated based on the growth of the supply data. Regarding emission factor uncertainty, expert judgment has been employed to select the midpoint value within the range for CH_4 and N_2O. Meanwhile, for CO_2, the suggested overall uncertainty has been applied. Table 2.21 depicts the levels of uncertainty for energy industries based on these considerations.

Table 2.21. Level of uncertainty for energy industries category.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1A1 – Energy Industries	CO_2	332.98	838.97	10	7	12
1A1 – Energy Industries	CH_4	1.10	1.45	10	100	100
1A1 – Energy Industries	N_2O	1.61	2.41	10	100	100

Manufacturing industries (1A2)

This category includes emissions resulting from the combustion of fuels in industry and the combustion for the generation of electricity and heat for own use in these industries. Notably, there was a decline in emissions within this category from 1990 to 2009. Subsequently, the emissions have exhibited a period of relative stability, as illustrated in Figure 2.10 and detailed in Table 2.22.

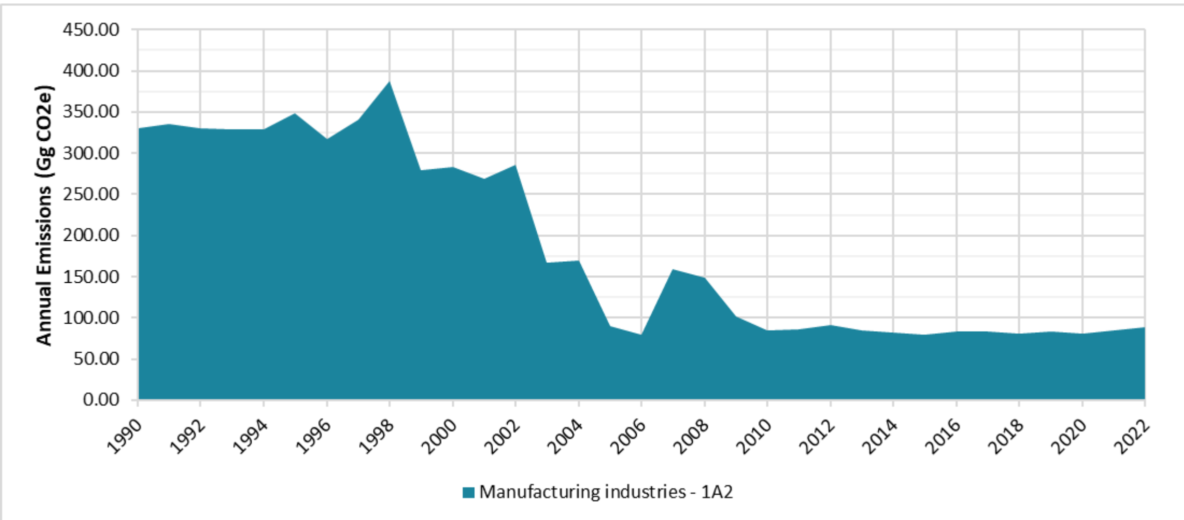

Figure 2.10. Category 1A2 GHG emissions.

Table 2.22. Summary of GHG emissions from Category 1A2 – Manufacturing industries.

	Annual Emissions in Gg CO_2e										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Manufacturing industries – 1A2	329.55	334.76	329.72	328.30	328.71	348.44	316.68	340.36	387.78	279.57	283.39
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Manufacturing industries – 1A2	268.32	285.43	167.41	168.96	90.27	79.89	159.09	148.54	101.62	84.98	86.57
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Manufacturing industries – 1A2	91.05	84.30	81.49	79.66	83.75	83.15	81.32	82.75	81.30	84.63	88.57

The uncertainty associated with activity data and emission factors in category 1A2 is sourced from Chapter 2, Volume 2 of the 2006 IPCC Guidelines.

Concerning activity data uncertainty, the higher value of the range for 'extrapolation' under less developed statistical systems for other industrial combustion has been used considering that the sectoral consumption has been calculated based on the growth of the supply data.

Regarding emission factor uncertainty, expert judgment has been employed to select the midpoint value within the range for CH_4 and N_2O. Meanwhile, for CO_2, the suggested overall uncertainty has been applied. Table 2.23 depicts the levels of uncertainty for manufacturing industries and construction based on these considerations.

Table 2.23. Level of uncertainty in the manufacturing industries and construction category.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1A2 – Manufacturing Industries and Construction	CO_2	301.18	76.54	20	7	21
1A2 – Manufacturing Industries and Construction	CH_4	12.46	5.30	20	100	102
1A2 – Manufacturing Industries and Construction	N_2O	15.91	6.73	20	100	102

Transport (1A3)

Encompassing emissions arising from the combustion and evaporation of fuel across all transportation activities (excluding military transport), this category is intricately tied to the developmental trajectory of Guyana. The predominant driving force behind this category's emissions is the substantial contribution of road transport. The increase in commuting within the transport sector linked with population growth and economic development serves as a key factor influencing the heightened fuel consumption, establishing it as one of the leading consumers of imported fuel products in Guyana and a substantial source of GHG emissions within the energy sector, as illustrated in Figure 2.11 and detailed in Table 2.24.

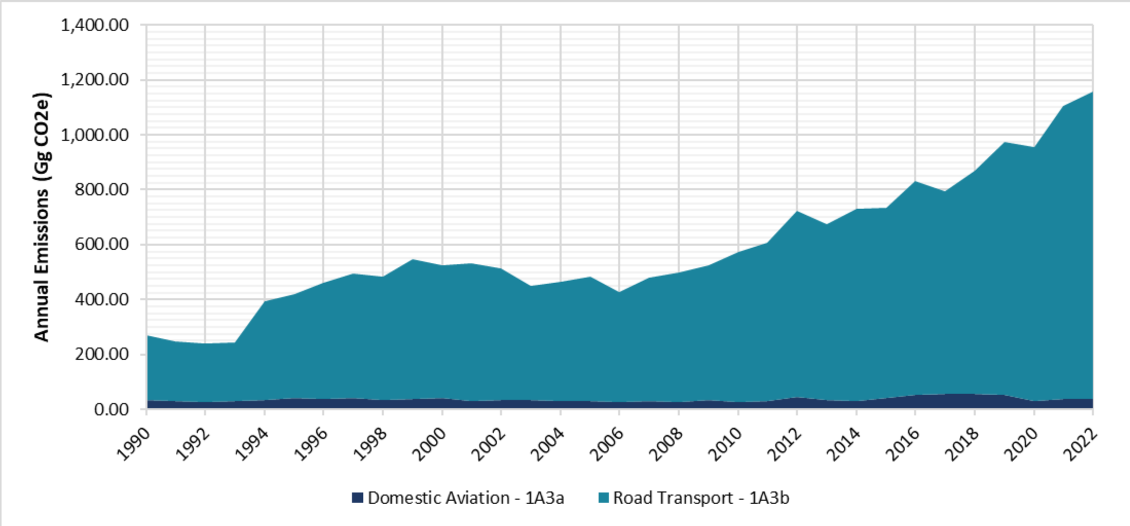

Figure 2.11. Category 1A3 GHG emissions.

Table 2.24. Summary of GHG emissions from Category 1A3 – Transport.

Annual Emissions in Gg $CO_{2}e$											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Domestic Aviation - 1A3a	34.83	31.57	27.83	29.62	34.40	42.23	36.80	41.24	32.35	37.72	41.55
Road Transport - 1A3b	236.39	216.82	211.31	213.23	358.87	376.62	422.83	454.70	450.72	510.87	483.74
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Domestic Aviation - 1A3a	32.06	33.31	32.71	31.33	30.99	26.59	28.40	27.96	34.39	27.60	29.96
Road Transport - 1A3b	498.21	478.53	415.23	433.72	452.51	402.05	451.90	470.71	488.25	544.23	577.44
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Domestic Aviation - 1A3a	46.57	32.60	29.55	40.92	53.56	57.23	55.75	54.30	30.01	36.00	37.67
Road Transport - 1A3b	677.75	641.48	701.49	693.93	779.58	737.97	811.88	919.43	923.80	1,068.76	1,118.54

The uncertainty associated with activity data and emission factors in category 1A3 is sourced from Chapter 3, Volume 2 of the 2006 IPCC Guidelines. For domestic aviation, activity data uncertainty is allocated using expert judgement considering that the sectoral consumption has been calculated based on the growth of the supply data. Concerning emission factor uncertainty, expert judgment is applied to opt for the higher value for CH_4 and the midpoint value for N_2O. For CO_2, a value is selected based on expert judgment, taking into account the suggested ±5% uncertainty. Given the similarity in data quality to that used in energy industries and manufacturing industries and construction, and with the aim of maintaining consistency in the inventory, identical uncertainty values have been applied across the various transport categories.

Table 2.25 depicts the levels of uncertainty for the transport categories based on these considerations.

Table 2.25. Level of uncertainty in the transport categories.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1A3a – Domestic Aviation	CO_2	34.56	37.39	10	7	12
1A3a – Domestic Aviation	CH_4	0.01	0.01	10	100	100
1A3a – Domestic Aviation	N_2O	0.26	0.28	10	100	100
1A3b – Road Transport	CO_2	231.33	1094.72	10	7	12
1A3b – Road Transport	CH_4	2.09	9.71	10	100	100
1A3b – Road Transport	N_2O	2.97	14.10	10	100	100

Other Sectors (1A4)

This category includes emissions from a variety of end-use sectors, including the residential, commercial, and institutional sectors, as well as the emissions from fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. In Guyana, there is a noticeable upswing in emissions within this category, aligned with the heightened fuel consumption trends in the country, as illustrated in Figure 2.12 and outlined in Table 2.26.

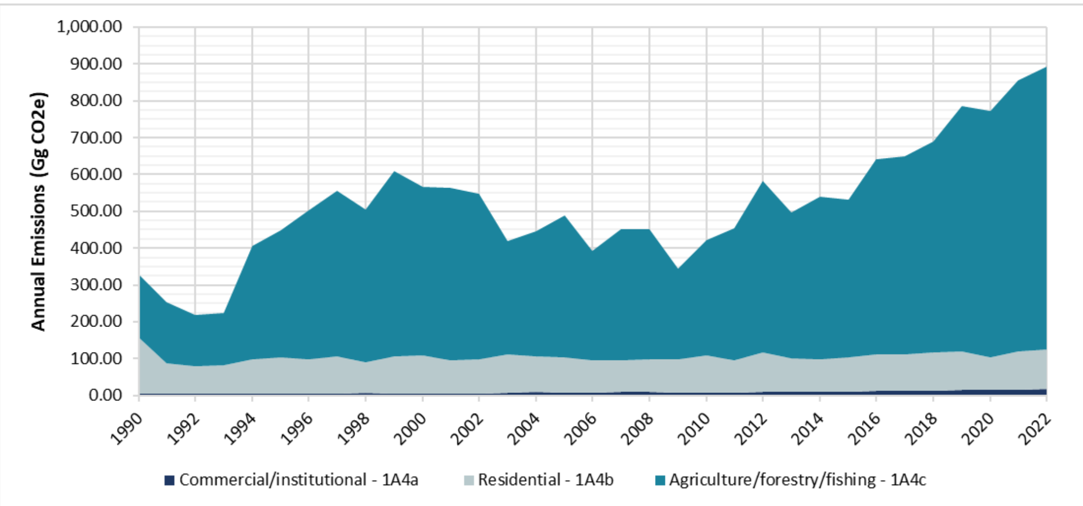

Figure 2.12. Category 1A4 GHG emissions.

Table 2.26. Summary of GHG emissions from Category 1A4 – Other Sectors.

Annual Emissions in Gg CO_2e											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Commercial/ institutional - 1A4a	5.85	5.85	5.66	5.67	5.92	5.85	5.54	5.95	6.64	5.14	5.06
Residential - 1A4b	150.58	81.97	73.56	76.83	91.62	96.66	93.89	101.35	84.25	101.67	103.10
Agriculture/ forestry/ fishing - 1A4c	172.07	165.81	139.42	141.18	309.02	346.99	401.84	447.29	412.82	502.90	457.77
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Commercial/ institutional - 1A4a	4.88	5.25	8.56	8.91	8.23	6.75	8.80	8.83	6.96	8.03	8.62
Residential - 1A4b	90.06	93.95	101.78	97.35	94.12	88.69	86.48	90.67	90.63	101.51	87.70
Agriculture/ forestry/ fishing - 1A4c	468.92	447.05	309.23	340.55	386.56	296.20	355.76	351.41	246.77	313.52	358.31
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Commercial/ institutional - 1A4a	10.67	9.57	10.31	10.03	11.84	11.81	12.63	14.33	14.52	16.11	16.86
Residential - 1A4b	106.73	91.62	86.63	93.97	99.46	99.51	103.41	105.06	88.52	104.37	109.23
Agriculture/ forestry/ fishing - 1A4c	465.13	394.26	441.72	427.56	531.06	538.46	572.18	666.46	670.25	733.34	767.50

The uncertainty associated with activity data and emission factors in category 1A4 is sourced from Chapter 2, Volume 2 of the 2006 IPCC Guidelines.

Concerning activity data uncertainty, the higher value of the range for 'extrapolation' under less developed statistical systems for commercial, institutional, residential combustion has been used considering that the sectoral consumption has been calculated based on the growth of the supply data.

Regarding emission factor uncertainty, expert judgment has been employed to select the midpoint value within the range for CH_4 and N_2O. Meanwhile, for CO_2, the suggested overall uncertainty has been applied. Table 2.27 depicts the levels of uncertainty for energy industries based on these considerations.

Table 2.27. Level of uncertainty for the other sectors category.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1A4 – Other Sectors	CO_2	242.31	878.97	25	7	26
1A4 – Other Sectors	CH_4	76.20	11.79	25	100	103
1A4 – Other Sectors	N_2O	10.00	2.83	25	100	103

Other (1A5)

This category covers all remaining emissions from fuel combustion that are not specified elsewhere. It also incorporates emissions from fuel supplied to the military within the country and to the military of other nations not involved in multilateral operations. These details are visually represented in Figure 2.13 and elaborated in Table 2.28.

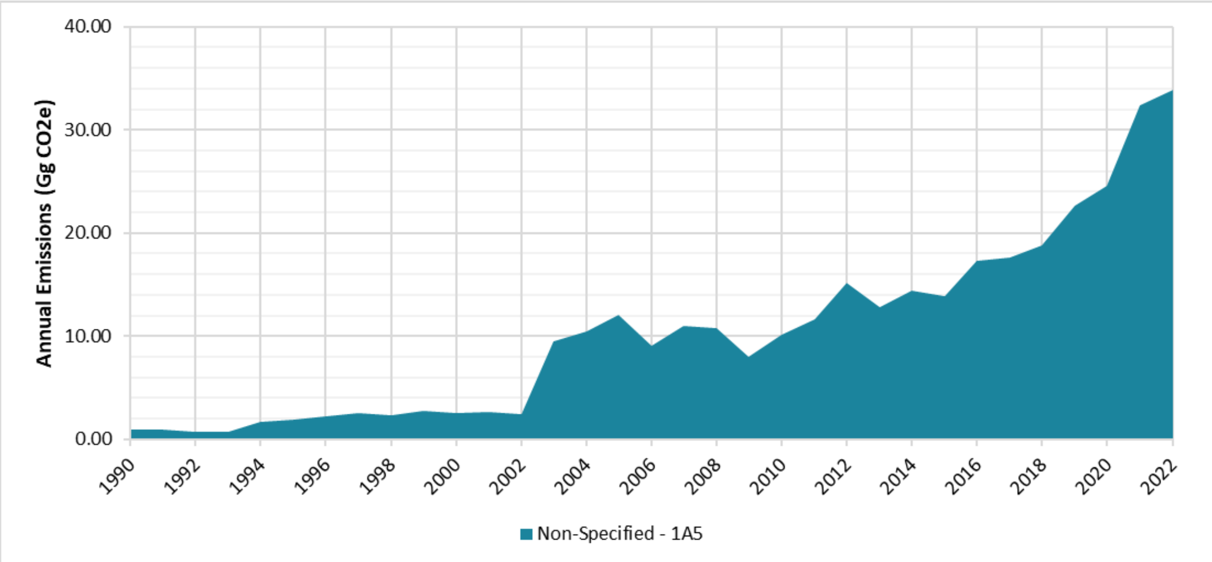

Figure 2.13. Category 1A5 GHG emissions.

Table 2.28. Summary of GHG emissions from Category 1A5 – Other.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Non-Specified - 1A5	0.92	0.89	0.73	0.74	1.69	1.91	2.22	2.48	2.27	2.79	2.53
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Non-Specified - 1A5	2.59	2.47	9.45	10.49	12.04	9.04	10.96	10.74	7.97	10.18	11.66
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Non-Specified - 1A5	15.19	12.83	14.38	13.91	17.33	17.61	18.79	22.70	24.59	32.38	33.88

The uncertainty associated with activity data and emission factors in category 1A4 is sourced from Chapter 2, Volume 2 of the 2006 IPCC Guidelines.

Concerning activity data uncertainty, the higher value of the range for 'extrapolation' under less developed statistical systems for main activity electricity and heat production has been used considering that the sectoral consumption has been calculated based on the growth of the supply data.

Regarding emission factor uncertainty, expert judgment has been employed to select the midpoint value within the range for CH_4 and N_2O. Meanwhile, for CO_2, the suggested overall uncertainty has been applied. Table 2.29 depicts the levels of uncertainty for the non-specified category based on these considerations.

Table 2.29. Level of uncertainty for non-specified category.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1A5 – Other	CO_2	0.92	33.78	10	7	12
1A5 – Other	CH_4	0.001	0.05	10	100	100
1A5 – Other	N_2O	0.002	0.06	10	100	100

Fuel Transformation (1B1c)

Intentional or unintentional release of greenhouse gases may occur during the extraction, processing, transformation, and delivery of fossil fuels to the point of final use, constituting what is known as fugitive emissions. Transformation occurs by physical or chemical conversion into a product whose intrinsic properties differ from those of the original product.

Specifically, this category addresses fugitive emissions during the transformation of fuel for charcoal production. CO_2 emissions are reported as memo items since carbon released from charcoal (or biochar) production is biogenic in origin.

In the context of Guyana, where charcoal production is exceedingly limited, emissions from this category are minimal, as depicted in Figure 2.14 and detailed in Table 2.30.

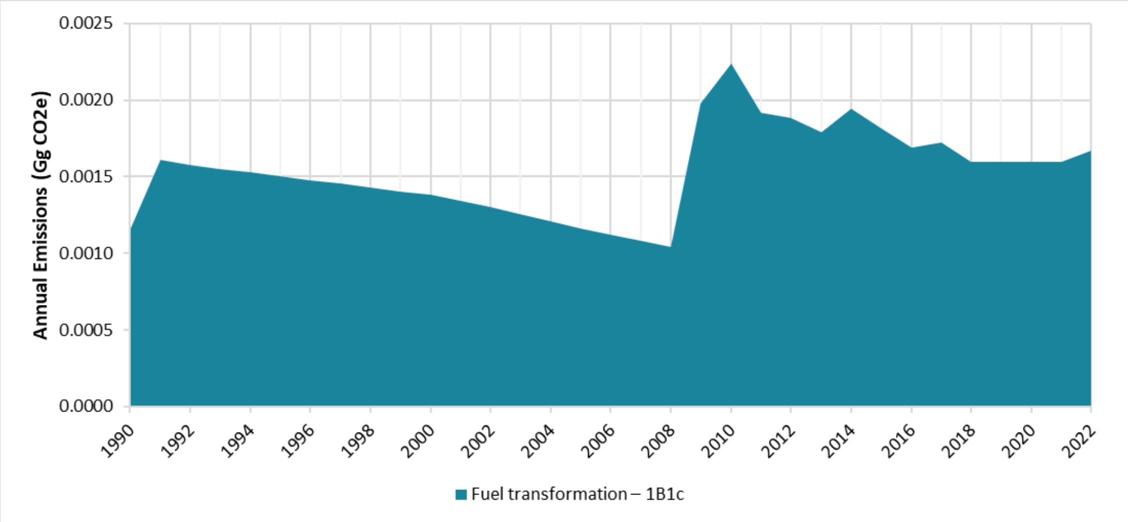

Figure 2.14. Category 1B1c GHG emissions.

Table 2.30. Summary of GHG emissions from Category 1B1c – Fuel transformation.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fuel transformation – 1B1c	0.0011	0.0016	0.0016	0.0016	0.0015	0.0015	0.0015	0.0015	0.0014	0.0014	0.0014
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fuel transformation – 1B1c	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0010	0.0020	0.0022	0.0019
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Fuel transformation – 1B1c	0.0019	0.0018	0.0019	0.0018	0.0017	0.0017	0.0016	0.0016	0.0016	0.0016	0.0017

The uncertainty associated with activity data and emission factors in category 1B1c is based on the information provided in Chapter 4, Volume 2 of the 2019 Refinement to the 2006 IPCC Guidelines.

Concerning activity data uncertainty, expert judgement is used to select the uncertainty value considering that generally the use of this fuel is not accurately recorded at national level and that the uncertainty value is therefore considered high.

Regarding emission factor uncertainty, expert judgement has been employed to select the high value of the uncertainty ranges provided in Table 4.3.3 of Chapter 4, Volume 2 of the 2019 Refinement to the 2006 IPCC Guidelines.

Table 2.31 depicts the levels of uncertainty for the fuel transformation category based on these considerations.

Table 2.31. Level of uncertainty for fuel transformation category.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2-eq		%	%	%
1B1 – Solid Fuels	CO_2	IE	IE	25	60	65
1B1 – Solid Fuels	CH_4	0.00113	0.00164	25	121	124
1B1 – Solid Fuels	N_2O	0.00002	0.00003	25	163	165

Oil and Natural Gas (1B2)

This category encompasses fugitive emissions originating from oil and natural gas systems. As previously mentioned, Guyana has recently embarked on oil and natural gas production, with all operations taking place offshore. In 2020, the country initiated offshore oil production in the Stabroek Block through the Liza Phase 1 Project, marking the onset of fugitive emissions from oil and natural gas systems. Following this, Guyana has extended its oil production activities within the Stabroek Block, launching a second FPSO vessel under the Liza Phase 2 Project. This expansion has led to a notable increase in GHG emissions associated with oil and natural gas systems, as illustrated in Figure 2.15 and outlined in Table 2.32.

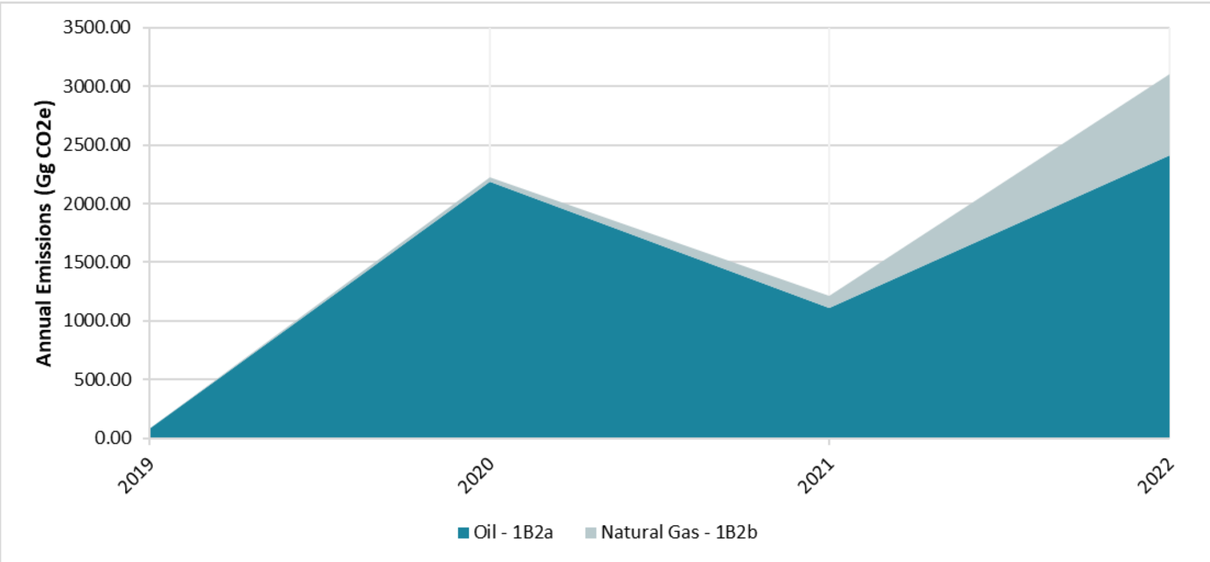

Figure 2.15. Category 1B2 GHG emissions.

Table 2.32. Summary of GHG emissions from Category 1B2 – Oil and Natural Gas.

Annual Emissions in Gg CO_2e				
	2019	2020	2021	2022
Oil - 1B2a	79.47	2188.38	1108.44	2414.52
Natural Gas - 1B2b	0.00	35.33	102.07	686.50

The uncertainty associated with activity data and emission factors in category 1B2 is based on the information provided in Chapter 4, Volume 2 of the 2019 Refinement to the 2006 IPCC Guidelines.

Concerning activity data uncertainty, expert judgement is used to select the value associated with the sales volumes.

For the emission factor uncertainty, expert judgement has been employed to select an average value of the default uncertainties provided in Tables 4.2.4 through 4.2.4k considering the relevant oil and natural gas segments in Guyana.

Table 2.33 depicts the levels of uncertainty for the oil and natural gas categories based on these considerations.

Table 2.33. Level of uncertainty for the oil and natural gas categories.

IPCC category	Gas	Base year emissions (1990)	Year 2022 emissions	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
		Gg of CO_2e		%	%	%
1B2a - Oil	CO_2	NO	873.44	15	40	43
1B2a - Oil	CH_4	NO	1540.15	15	40	43
1B2a - Oil	N_2O	NO	0.93	15	100	101
1B2b – Natural Gas	CO_2	NO	37.81	15	20	25
1B2b – Natural Gas	CH_4	NO	648.52	15	20	25
1B2b – Natural Gas	N_2O	NO	0.17	15	100	101

Additionally, the oil and natural gas category generate NMVOC emissions, as depicted in Figure 2.16 and detailed in Table 2.34.

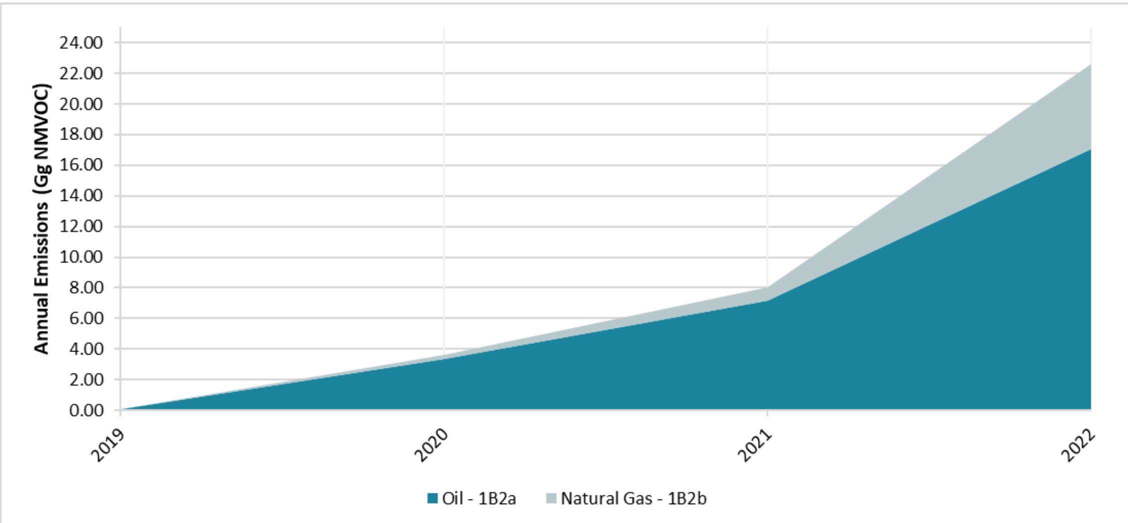

Figure 2.16. Category 1B2 NMVOC emissions.

Table 2.34. Summary of NMVOC emissions from Category 1B2 – Oil and Natural Gas.

Annual Emissions in Gg NMVOC				
	2019	2020	2021	2022
Oil - 1B2a	0.07	3.35	7.19	17.08
Natural Gas - 1B2b	0.00	0.28	0.82	5.51

6.1.5. Comparison Between Reference and Sectoral Approach

The 2006 IPPC guidelines recommend employing both a sectoral approach and a reference approach to estimate a country's CO_2 emissions resulting from fuel combustion, facilitating a comparison of results derived from these two independent methods.

The sectoral approach involves utilizing values specific to each category, collectively summing up to the national total within the energy sector. On the other hand, the reference approach is a top-down methodology, relying on a country's energy supply data to compute CO_2 emissions primarily from the combustion of fossil fuels. This approach serves as an independent check on the sectoral method and can offer a preliminary estimate of national GHG emissions, especially in scenarios with limited resources and data structures.

The reference approach is estimated using following the tier 1 approach from 2006 IPCC Guidelines, using the energy balance of the country, and considering the considering the apparent consumption of fuels and the excluded carbon following 5 steps:

- Step 1: Estimate apparent fuel consumption in original units
- Step 2: Convert to a common energy unit
- Step 3: Multiply by carbon content to compute the total carbon
- Step 4: Compute the excluded carbon
- Step 5: Correct for carbon unoxidized and convert to CO_2 emissions

In the case of Guyana, the sectoral consumption has been calculated based on the growth of the supply data. As such, the percentage difference between the sectoral and the reference approach is going to be the same for the years 2017-2022. The comparison between the CO_2 emissions calculated with the reference and sectoral approaches is provided in Table 2.35.

Table 2.35. Comparison between the reference and sectoral approach (Gg CO_2).

	1990	1991	1992	1993	1994	1995	1996	1997	1998
CO_2 emissions reference approach	1296	1267	1254	1410	1401	1596	1637	1796	1810
CO_2 emissions sectoral approach	1143	1116	1052	1059	1447	1567	1617	1766	1780
% Difference	13.36	13.54	19.15	33.15	-3.21	1.82	1.26	1.71	1.69
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CO_2 emissions reference approach	1798	1612	1547	1592	1705	1564	1446	1274	1645
CO_2 emissions sectoral approach	1774	1703	1679	1659	1654	1708	1423	1360	1636
% Difference	1.37	-5.36	-7.84	-4.03	3.10	-8.44	1.64	-6.31	0.55
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
CO_2 emissions reference approach	1482	1591	1665	1725	1962	1928	2010	2050	2252
CO_2 emissions sectoral approach	1631	1663	1791	1845	2097	2015	2089	2089	2362
% Difference	-9.13	-4.34	-7.01	-6.48	-6.45	-4.33	-3.79	-1.88	-4.65

6.1.6. International Bunkers

National energy statistics allocate all fuel consumption in the aviation industry to domestic aviation. Similarly, for national navigation, the entirety of fuel consumption is attributed to the domestic sector. However, the potential fuel consumption associated with international aviation and navigation remains indeterminate. It is unclear whether this consumption is aggregated with the reported amount for domestic aviation and navigation or if it is excluded from the overall statistics. In this edition of the inventory, all fuel consumption is assumed to be domestic for aviation and navigation. Ascertaining the amount of fuel consumption linked to international aviation and navigation is incorporated into the improvement plan.

6.2. Industrial processes and product use (IPPU)

The Industrial Processes and Product Use (IPPU) sector covers GHG emissions occurring from industrial processes, from the use of GHGs in products, and from non-energy use of fossil fuel carbon. As such, GHG emissions associated with the IPPU sector can be produced from a wide variety of industrial activities and originate from the use of various types of product applications, both in industry and by end-consumers. This section presents the GHG emissions in Guyana associated with the IPPU sector.

6.2.1. Description of Sector

The IPPU sector in Guyana is limited. The activities within this sector are solely associated with the use of products.

Emissions arising from the mineral industry, associated with the utilisation of carbonate raw materials in the manufacturing and use of various mineral industry products, are absent within the country, as all materials are imported. Although liming is used in Guyana to reduce soil acidity and improve plant growth, the emissions resulting from these activities are accounted for in Category 3C2 Liming. Additionally, Guyana does not engage in chemical, metal, or electronic production, importing all chemicals, metals, and electronic industry components from other countries.

However, emissions do occur in Guyana related to the first use of fossil fuels as a product for primary purposes other than combustion for energy purposes and use as feedstock or reducing agent. This includes products such as lubricants, paraffin waxes, bitumen/asphalt, and solvents. Guyana employs lubricants and grease for various industrial and transportation applications, while solvents find usage in areas such as paints, cosmetics, household products, and pesticides, among others.

Furthermore, HFCs and PFCs are used in Guyana as substitutes for phasing out CFCs, halons, carbon tetrachloride, methyl chloroform, and, ultimately, HCFCs under the Montreal Protocol. Guyana acceded to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer on August 12, 1993 and subsequently ratified the London Amendment, Copenhagen Amendment and Montreal Amendment on July 23, 1999. The National Ozone Action Unit (NOAU) within the Hydrometeorological Service is responsible for coordinating and monitoring all activities towards the smooth phase-out of man-made Ozone Depleting Substances (ODS) in Guyana.

Emissions from the manufacture and use of electrical equipment and several other products also occur in Guyana. This is predominantly associated with the use of sulphur hexafluoride (SF_6) for electrical insulation and interruption in equipment utilised in electricity transmission and distribution. Additionally, N_2O emissions arise from product usage in various applications, including medical services throughout the healthcare sector.

Finally, other industries which have not been accounted for elsewhere in the IPPU sector also occur in Guyana. These encompass the pulp and paper industry, as well as the food and beverage industry.

6.2.2. Coverage of Sector

In line with the 2006 IPCC Guidelines, Figure 2.17 depicts the categories that are covered in the IPPU sector of Guyana. It delineates the estimated categories and provides indications for those that have not been estimated or cannot be reported in the tables, using notation keys.

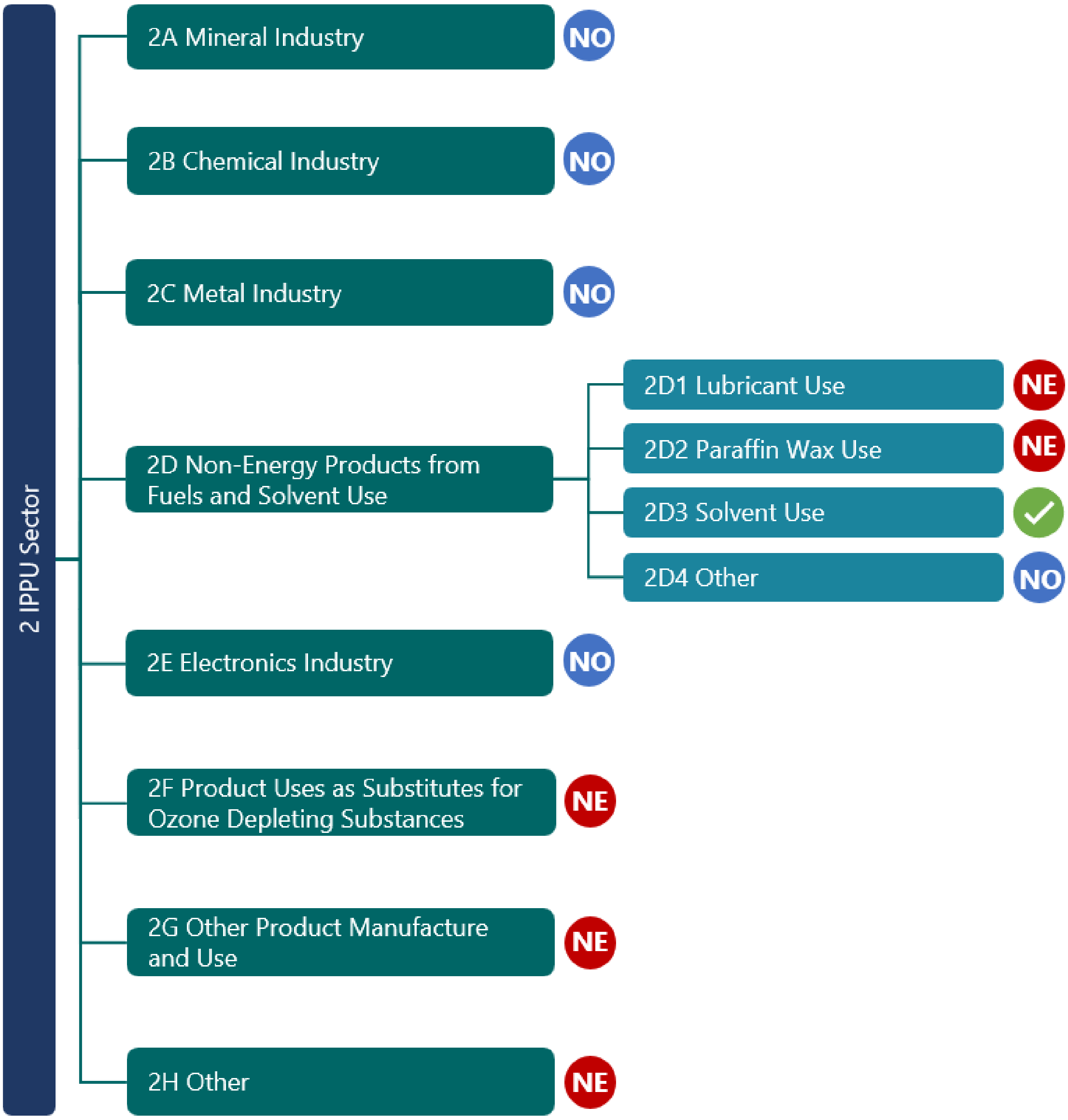

Figure 2.17. Coverage of the IPPU sector in Guyana.

The national GHG inventories in Guyana's initial national communication, second national communication, and the currently third national communication indicated that GHG emissions in the industrial sector were primarily limited to NMVOC emissions. However, as evident in the preceding figure, emissions are occurring across various sectors in the country, extending beyond NMVOC emissions. These emissions will be primarily associated with product uses serving as substitutes for ODS.

Due to data unavailability, emissions from these categories have not been estimated. This poses a constraint on the IPPU sector, given that emissions from product uses as substitutes for ODS are anticipated and should ideally be included in the GhG reporting. An improvement plan is being developed to address this.

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6.2.3. Summary of Sector Emissions

GHG emissions associated with categories within the IPPU sector occurring in Guyana have not been estimated due to data being unavailable. As such, within this national GHG inventory as part of Guyana's first BUR, the IPPU sector emissions represent 0% of the national total GHG emissions of the country.

In this national GHG inventory as part of Guyana's first BUR, only NMVOC emissions are estimated for category 2D3a related to domestic solvent use including fungicides.

6.2.4. Description of Emissions by Category

Non-energy Products from Fuels and Solvent Use (2D) – Domestic Solvent Use Including Fungicides (2D3a)

Non-energy products from fuels and solvent use refers to emissions from the first use of fossil fuels as a product for primary purposes other than combustion for energy purposes and use as feedstock or reducing agent.

The use of solvents manufactured using fossil fuels as feedstocks can lead to evaporative emissions of various NMVOC, which are subsequently further oxidised in the atmosphere.

The methodologies for estimating the NMVOC emissions from solvent use (2D3) are reported in the EMEP/CORINAR Emission Inventory Guidebook. It is treated as a separate category because the nature of this source requires a slightly different approach to emissions estimation than that used for calculating other emission categories in the 2006 IPCC Guidelines. Nonetheless, the identical overarching methodology is employed, wherein NMVOC emissions are estimated by applying default emission factors to the overall solvent activity data.

This subcategory addresses NMVOC emissions from the domestic use of solvent-containing products, with the total NMVOC emissions from domestic solvent use in Guyana illustrated in Figure 2.18 and detailed in Table 2.36.

Emissions from this category amounted to 0.90 Gg NMVOC in the base year of 1990 and increased slightly to 0.97 Gg NMVOC in 2022. This marginal increase is linked to the ongoing population growth in Guyana, upon which the estimations are grounded, and which has been steadily rising over time.

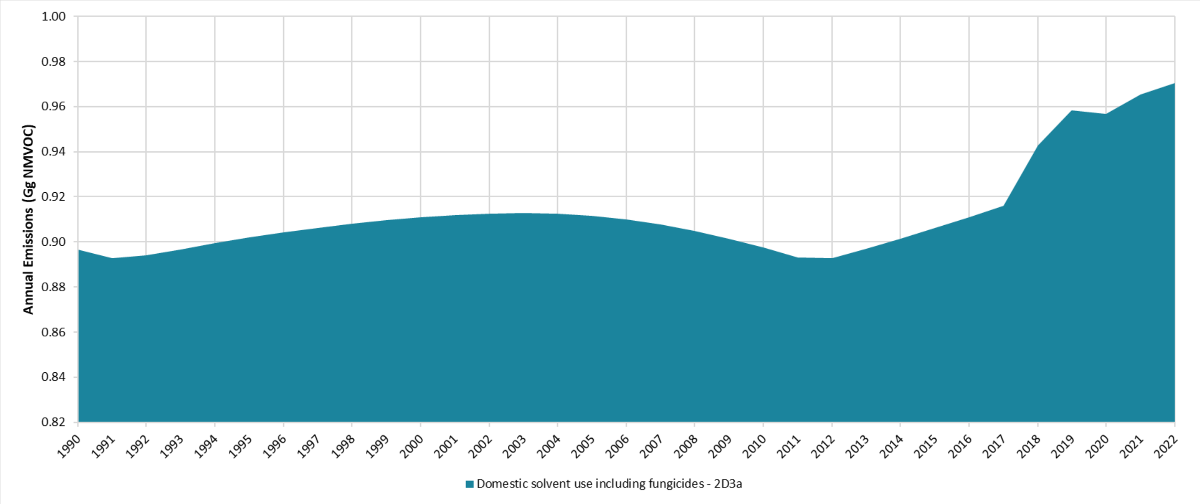


Figure 2.18. Category 2D3a NMVOC emissions.

Table 2.36. Summary of NMVOC emissions from Category 2D3a – Domestic Solvent Use Including Fungicides.

Annual Emissions in Gg NMVOC											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Domestic Solvent Use – 2D3a	0.90	0.89	0.89	0.90	0.90	0.90	0.90	0.91	0.91	0.91	0.91
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Domestic Solvent Use – 2D3a	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.89
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Domestic Solvent Use – 2D3a	0.89	0.90	0.90	0.91	0.91	0.92	0.94	0.96	0.96	0.97	0.97

6.3. Agriculture, forestry, and other land use (AFOLU)

The Agriculture, Forestry, and Other Land Use (AFOLU) sector covers GHG emissions and removals occurring in managed ecosystems that concern the key greenhouse gases CO_2, N_2O and CH_4. As described in the 2006 IPCC Guidelines, CO_2 fluxes between the atmosphere and ecosystems are primarily controlled by uptake through plant photosynthesis and releases via respiration, decomposition and combustion of organic matter. N_2O is primarily emitted from ecosystems as a by-product of nitrification and denitrification, while CH_4 is emitted through methanogenesis under anaerobic conditions in soils and manure storage, through enteric fermentation, and during incomplete combustion while burning organic matter. Indirect emissions from precursor gases are also considered in this category, including the ones associated with leaching or runoff of nitrogen compounds. This section presents the GHG emissions in Guyana associated with the AFOLU sector.

6.3.1. Description of Sector

The Agriculture, Forestry, and Other Land Use (AFOLU) sector holds substantial economic significance in Guyana. In 2022, the Gross Domestic Product (GDP) of Agriculture, forestry and fishing reached the 307,794 G$ millions (Bureau of Statistics, 2024). AFOLU serves as a primary economic contributor to the country's economy, it is a source of employment for a considerable portion of the population, and it plays a crucial role in the country's exports and trade, enhancing economic stability. As such, this sector helps stimulating rural development, it contributes to economic diversification by supporting various subsectors and, additionally, forestry and agriculture contribute to the maintenance of ecosystem services, such as water regulation, provision of food and materials, and biodiversity.

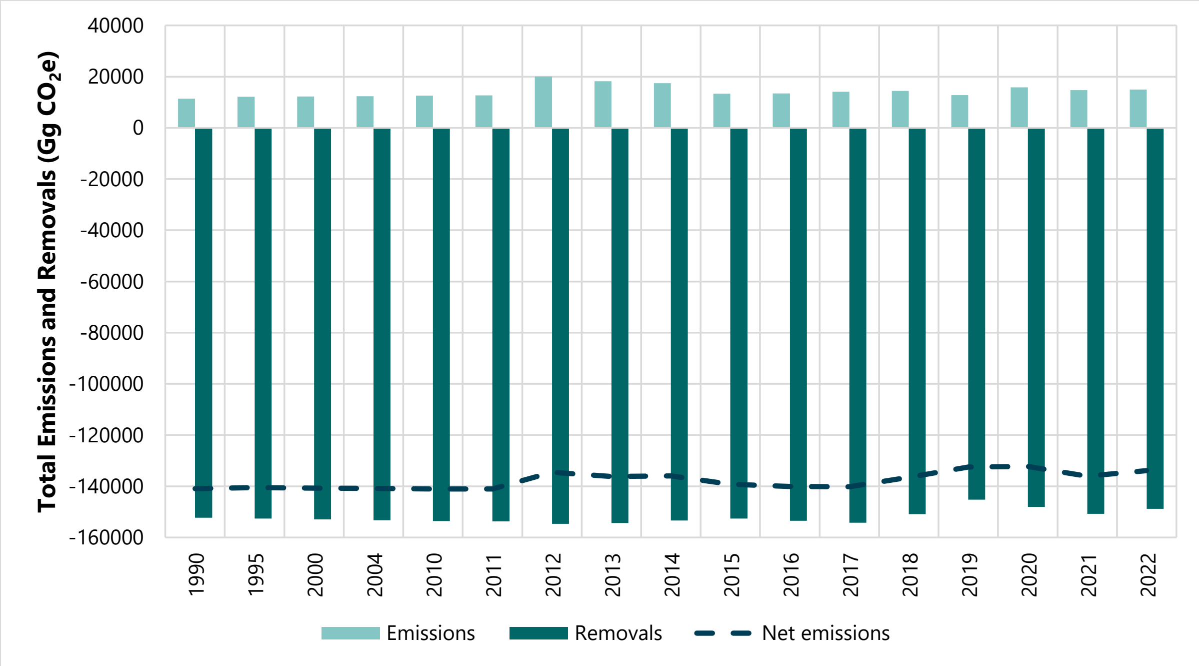
AFOLU stands out as a crucial sector contributing to greenhouse gas emissions and significantly to removals in the country.

Removals

GHG emissions are strongly influenced by Guyana's management of its extensive national forest cover, and the consequent absorption of CO_2 from the atmosphere. Over the last two decades, Guyana has maintained a vast net carbon sink, with a negative emission level, surpassing -130 Mg of CO_2-eq per annum for the entire period from 1990 to 2022. To include removals from forests remaining forests, country-specific annual increments over 20 years were utilized (1993 to 2013). Country-specific growth increments were referenced from Roopsind et al., 2018: *Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity, 2017*[5]**.**

Roopsind et al., 2018, form the baseline for estimating removals in Guyana, estimated at 154 $MtCO_2$.

[5] Roopsind A, Caughlin TT, van der Hout P, Arets E, Putz FE. ***Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity***. Glob Chang Biol. 2018 Jul;24(7):2862-2874. doi: 10.1111/gcb.14155. Epub 2018 May 22. PMID: 29603495. (Available at: https://pubmed.ncbi.nlm.nih.gov/29603495/)



GHG emissions and removals of Guyana – 1990-2022.

In Guyana's case, all approximately 18 million hectares are under sustainable management through the National Forest Policy and Codes of Practice. Comprising sustainable management of this area are 12 million hectares of State Forest Estate under direct management through Codes of Practices, 3 million hectares under Site Management Plan as Protected Areas and State Lands Management, and 3 million hectares under Village Sustainability Plans under Indigenous Village management structures. Each category is managed under either Codes of Practice, Site Management Plans or Village Sustainability Plans.

The CH_4 emissions, especially when expressed as CO2e, derive mainly from the Agriculture sector, principally from the rice cultivation and domestic animals' subsectors. On the other hand, the CO_2 removals derive exclusively from the Forestry and Land Use Change and sector (Government of Guyana, 2012). The 2006 IPCC Guidelines - Volume 4 addresses the GHG emissions/removals for the AFOLU sector: Agriculture, Forestry and Other Land Uses. The three subsectors under the AFOLU sector and their codes are Livestock (3A), Land (3B) and Aggregated and Non-CO2 Emissions Sources (3C). GHG emissions/removals are divided in the different subsectors, emissions/removals sources/sinks, categories, and subcategories. Greenhouse gas fluxes in the AFOLU sector can be estimated in two ways: 1) as net changes in C stocks over time (used for most CO_2 fluxes) and 2) directly as gas flux rates to and from the atmosphere (used for estimating non-CO_2 emissions and some CO_2 emissions and removals) (IPCC, 2006, Volume 4).

Agriculture

Agriculture is one of the main economic sectors in Guyana. It generates around 15% of total national GDP and covers less than 2% of the country. It also accounts for 33% of employment in the country and plays a significant role in export earnings. Approximately 8.53% of Guyana's land is currently used for agricultural activities and is projected to grow in the medium term. Most of the agricultural activities are carried out on the Coastal Plain in Regions 2, 3, 4, 5, and 6. An estimated 1.74 million hectares are under agrarian production with rice, sugar, and coconut (90,000, 48,000, and 25,000 hectares, respectively). Non-traditional crops (crops other than rice and sugarcane) occupy 40,000 hectares (EPA, 2016).

One of the most important agricultural industries in Guyana is the rice industry. The Guyana Rice Development Board (GRDB) is part of the Ministry of Agriculture in Guyana and seeks to develop the rice industry in Guyana, conducting the export trade of the product and the research to provide a better quality and higher volume of grain, as well as greater resistance to pests, diseases, and weather fluctuations. The paddy production in 2020 was 1,057,752 tonnes. (GRDB, n.d.)

Sugar production has also been a significant contributor to the national economy historically, although the sector has faced challenges, including fluctuating international prices and changes in the global sugar market. The Guyana Sugar Corporation (GUYSUCO), owned by the Government of Guyana, is the largest cultivator and producer of pure cane sugar in Guyana. In 2020, the sugar production from the Corporation was 88,868 mt and which was extracted from 1,217,154 mt of canes (GUYSUCO, n.d.).

In recent years, there has been a growing interest in diversifying the agricultural sector and promoting non-traditional crops. Additionally, efforts have been made to improve infrastructure, technology adoption, and sustainable farming practices. The National Agricultural Research & Extension Institute (NAREI) is the premier organisation responsible for spearheading agricultural research and extension activities for productivity enhancement and diversification of the non- traditional crops sector (fruits and vegetables), biofuel development, as well as for plant quarantine services. [34]

Livestock activities in the country are dominated by poultry and non-dairy cattle and, to a lesser extent, swine, sheep and goats (EPA, 2016). They take place along the Coastal Plain and in the Intermediate and Rupununi Savannahs and is largely self-sufficient (EPA, 2016). The Guyana Livestock Development Authority (GLDA), under the Ministry of Agriculture, delivers public services related to animal production, animal health, animal genetics, marketing, training and extension services, as well as regulatory services. [34]

CH_4 and N_2O emissions in Guyana are primarily originated from the livestock related activities and agricultural soil management activities. In 2016, emissions from the agricultural sector were about 1119 Gg CO_2e, which equal 32% of the total national greenhouse gas emissions (excluding FOLU). Enteric fermentation from livestock and rice cultivation were the largest sources of emissions in 2016 for the agriculture sector, responsible for 360 Gg CO_2e and 631 Gg CO_2e respectively (EPA, 2016).

Forestry and Other Land Use

Guyana's land area covers approximately 21.1 million hectares for which 18.39 million hectares are covered by tropical rainforests, mangrove forests, swamp and marsh forests, savannah grasslands and shrubs. Guyana is considered to be a high forest cover, low deforestation country with a historic deforestation rate of less than 1% (0.02-0.079%) for the past twenty years (EPA, 2016). There is a total of 1.1 million ha designated as Protected Areas (GFC, 2023a).

In 2009 Guyana developed a framework for a national Monitoring Reporting and Verification System (MRVS) for REDD+. The MRVS was established by Guyana Forestry Commission to provide a national system to monitor, report and verify forest carbon emissions from deforestation and forest degradation in the country. The largest emissions in this sector are due to removal from soil. For the year 2022, CO_2 Forest management related emissions were 10664.46 Gg CO_2. In 2022, the country had an annualised deforestation rate of 0.036%, corresponding to 6,470 ha. 82% of deforestation is associated with mining and mining infrastructure, 14% with agriculture and 3.5% with road infrastructure. The primary sources of degradation include forest management-related losses (including selective harvesting of timber, logging damage) and forest degradation surrounding mining sites and road infrastructure (GFC, 2023a). The FOLU sector generates significant annual removals in Guyana. The largest removals of CO_2 occur in forest land, totalling -153,071.66 Gg CO_2 in 2022. The net emissions in 2022 were -140,480.18 Gg CO_2e.

6.3.2. Coverage of Sector

Figure 2.19 illustrates the coverage of the Guyana AFOLU sector GHG emissions inventory.

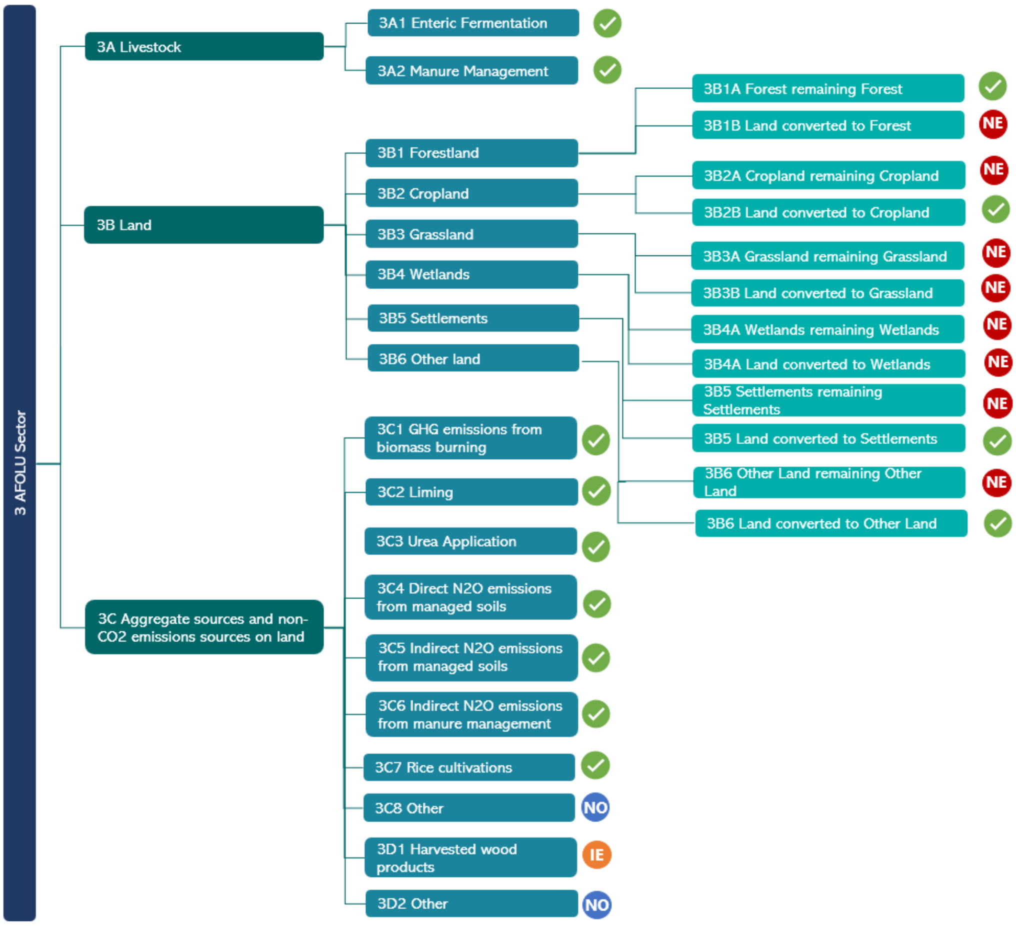


Figure 2.19. Coverage of the Guyana AFOLU sector GHG emissions inventory. NE – not Estimated; NO – not occurring; IE – included elsewhere; NA – not applicable.

Categories not estimated "NE" are due to the approach followed to estimate the emissions of the category 3B, detailed in the REDD+ technical Annex. The transition periods from these sub-categories do not meet the transition period criteria of the inventory and/or their emissions could be considered negligible.

Category 3A - Livestock covers the N_2O and CH_4 emissions associated to livestock and the management practice. **Category 3A1 – Enteric Fermentation** covers the CH_4 emission from livestock. **Category 3A2 – Manure management** covers the N_2O and CH_4 emissions from manure management systems.

Category 3B - Land covers the CO_2 caused by losses of organic matter from terrestrial ecosystems, and CO_2 removals from the atmosphere as uptake by vegetation and stored in the organic matter. The category also covers non-CO_2 emissions from burning and, depending on the land-use category, emissions from other specific sources (e.g. CH_4 emissions from rice). Carbon stock changes and emission/removal estimations can involve five carbon pools: Above-ground biomass, below-ground biomass, deadwood, litter, soil organic matter.

Category 3B1a – Forest Land Remaining Forest Land covers CO2 emissions and non-CO2 emissions (CH4, CO, N_2O, NO_X) due to changes in biomass, dead organic matter and soil organic carbon on Forest Land remaining Forest Land. The subcategory Forest Land remaining Forest Land also includes emissions from forest degradation from logging, mining and forestry infrastructure. Afforestation and reforestation data are not available thus Land converted to Forest Land has not been estimated.

Category 3B2b – Land Converted to Cropland covers CO2 emissions due to changes in biomass, dead organic matter and soil organic carbon on Forest Land converted to Cropland.

Category 3B5b – Land Converted to Settlements covers CO2 emissions from above-ground and below-ground biomass, dead organic matter, and soils on Forest Land converted to Settlements.

Category 3B6b – Land Converted to Other Land covers CO2 emissions and non-CO2 emissions from changes in carbon stocks from the three main pools (biomass, dead organic matter and soil organic carbon). Other Land includes bare soil, rock, ice, and all land areas that do not fall into any of the other five land-use categories. In the case of Guyana, the category considers Forest Land converted to bare soil for mining.

Category 3C – Aggregated and non-CO_2 Emissions Sources regroups several categories linked to Agriculture but not counted for in Livestock (3A) nor in Cropland (3B2). It covers the CO_2, N_2O and CH_4 emissions associated to various activities described as follows.

Category 3C1 – Emissions from Biomass Burning covers the N_2O and CH_4 emissions due to biomass burning occurring in both cropland (sugarcane and rice crops were considered) and forestland. The CO_2 emissions are reported in the category 3B (see above).

Category 3C2 – Liming covers the CO_2 emissions from the lime application as fertilizer to the soil. Only lime applied to sugarcane crops was considered due to lack of data on other crops.

Category 3C3 – Urea application covers the CO_2 emissions from the urea application as fertilizer to the soil.

Category 3C4 – Direct N2O Emissions from Managed Soils covers the addition of nitrogen enhancing the two processes responsible for N_2O emissions: nitrification and denitrification. The nitrogen (N) sources included in the methodology for estimating direct N2O emissions from managed soils are the synthetic N fertilisers (F_{SN}), the organic N applied as fertiliser (only the animal manure was considered due to lack of data on other types of organic fertilizers) (F_{ON}), the urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP}) and the N in crop residues (above-ground and below-ground), including various crops in the country (F_{CR}).

Category 3C5 – Indirect N2O Emissions from Managed Soils covers volatilisation of NH3 and NOx and leaching and runoff of nitrogen. The parameters considered equal the ones in Category 3C4.

Category 3C6 – Indirect N2O Emissions from Manure Management covers the N_2O emissions from volatile nitrogen losses that occur primarily in the forms of ammonia (NH_3) and nitric oxide (NOx).

Category 3C7 – Rice cultivations covers the CH_4 emissions from rice cultivations in Guyana.

6.3.3. Summary of Sector Removals and Emissions

In 2022, the AFOLU sector represented 56.13% of total emissions in Guyana, being the largest source of GHG emissions in the country, as illustrated in Figure 2.20. The AFOLU sector accounts for 34.96% of the total national CH_4 emissions, 92.55% of the total national N_2O emissions, and 62.61% of the total national CO_2 emissions. That being said, however, GHG removals from forest lands remaining forest lands are approximately 10 times greater than national GHG emission totals, contributing to Guyana being a net carbon sink.

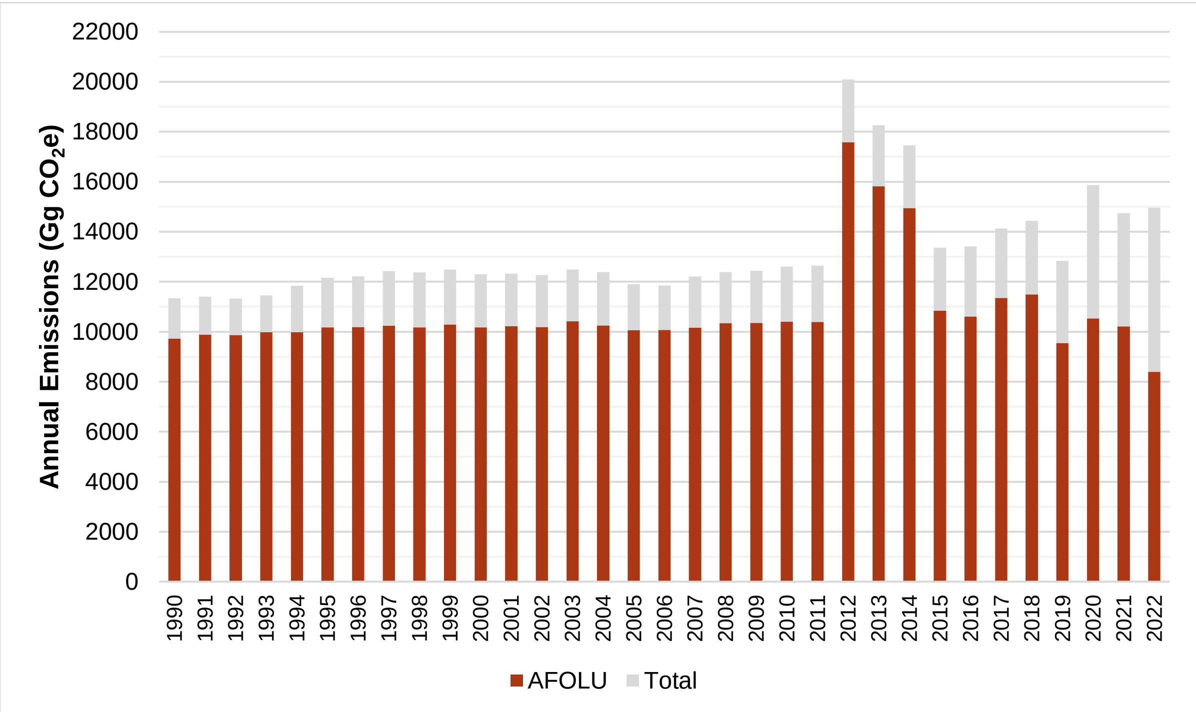


Figure 2.20. Contribution of AFOLU sector emissions to national emission totals.

Figure 2.21 depicts the emissions from the sector by category, while Figure 2.22 shows total removals. Furthermore, Table 2.37 provide further details on sectoral emission trends by category and gas.

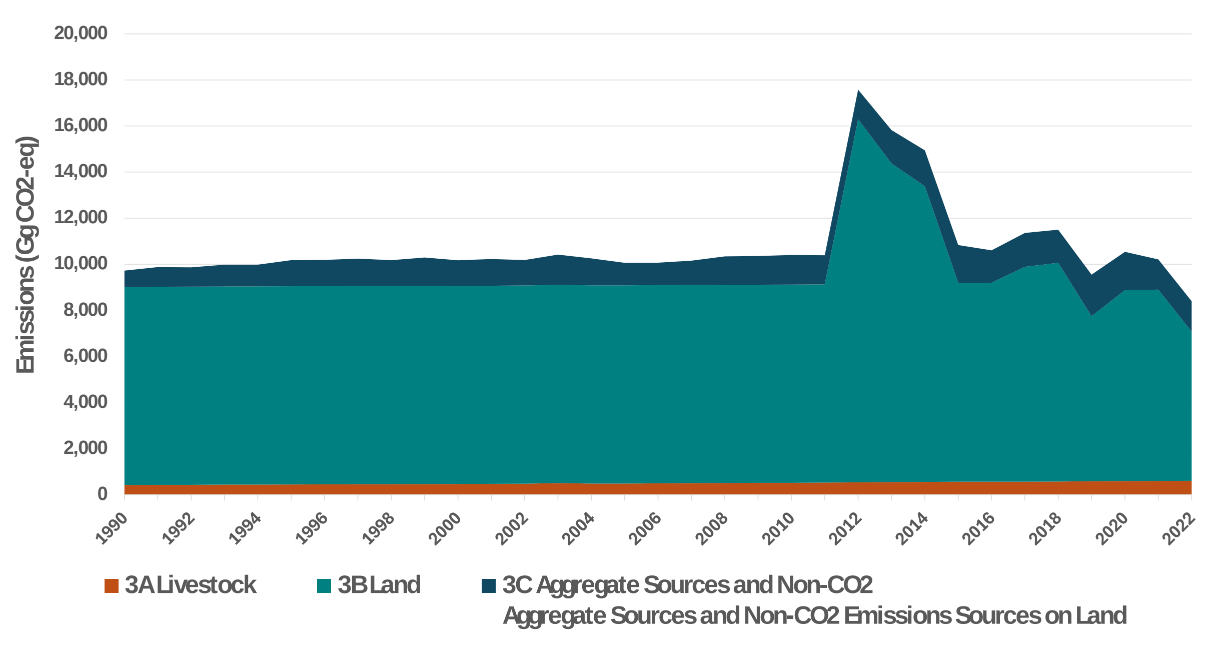


Figure 2.21. Total GHG emissions from the AFOLU sector by category.

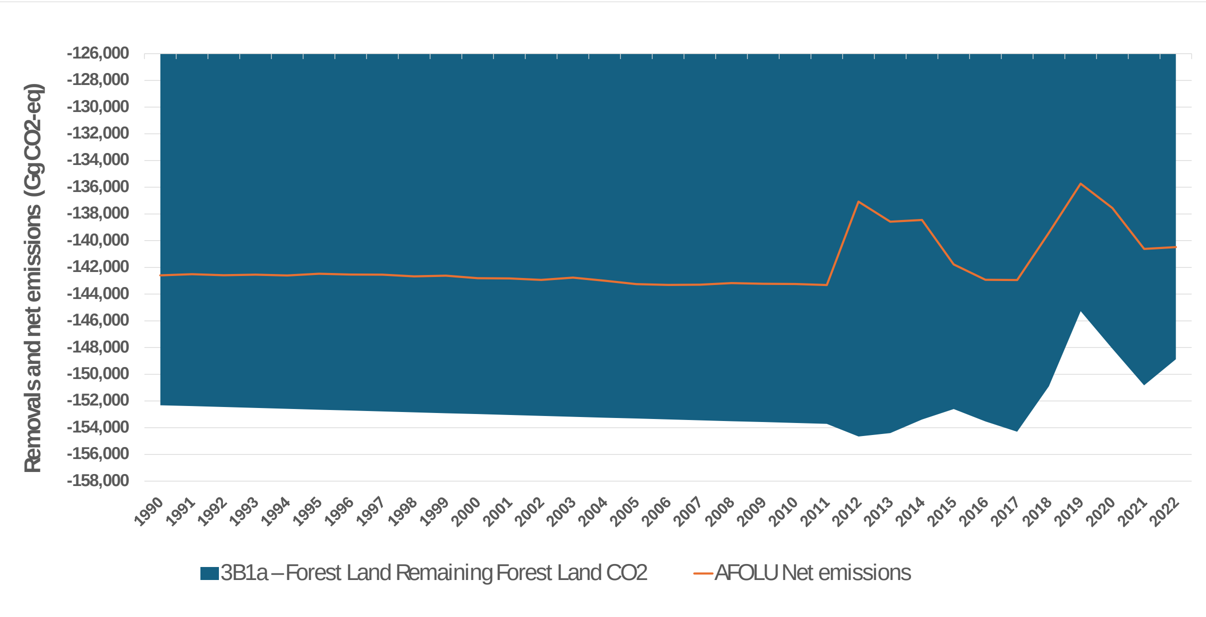


Figure 2.22. Total removals from the AFOLU sector.

Removals

GHG emissions are strongly influenced by Guyana's management of its extensive national forest cover, and the consequent absorption of CO_2 from the atmosphere. Over the last two decades, Guyana has maintained a vast net carbon sink, with a negative emission level, surpassing -130 Mg of CO_2-eq per annum for the entire period from 1990 to 2022. To include removals from forests remaining forests, country-specific annual increments over 20 years were utilized (1993 to 2013). Country-specific growth increments were referenced from

Roopsind et al., 2018: *Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity, 2017*[6]**.**

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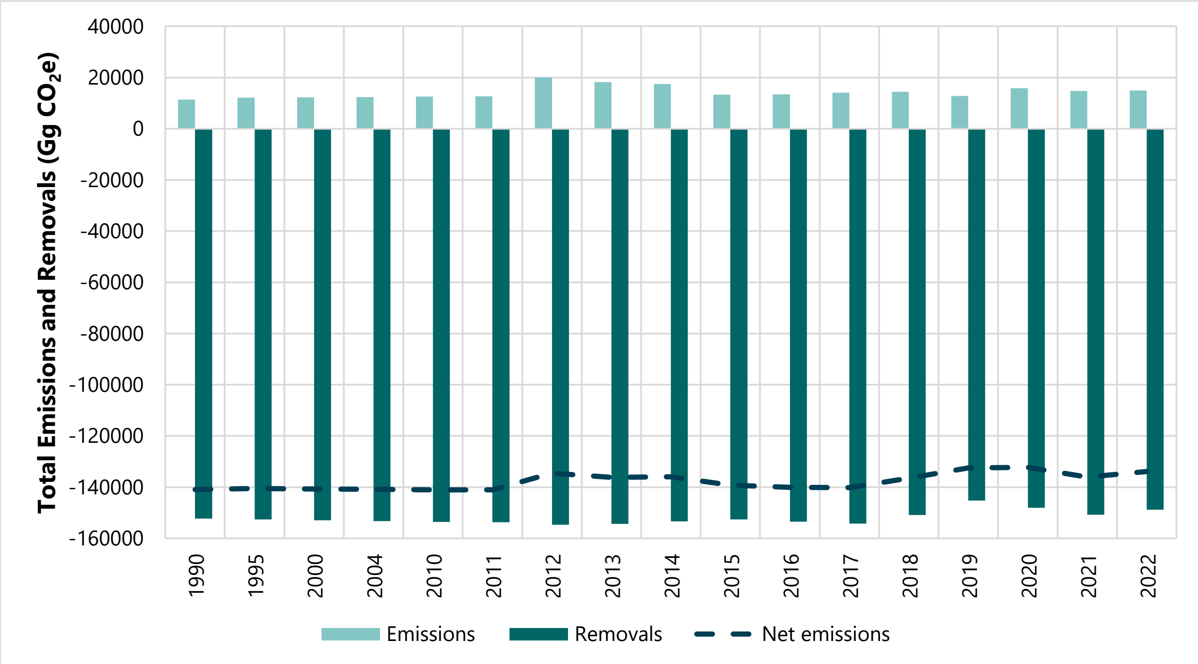

GHG emissions and removals of Guyana – 1990-2022.

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[6] Roopsind A, Caughlin TT, van der Hout P, Arets E, Putz FE. ***Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity***. Glob Chang Biol. 2018 Jul;24(7):2862-2874. doi: 10.1111/gcb.14155. Epub 2018 May 22. PMID: 29603495. (Available at: https://pubmed.ncbi.nlm.nih.gov/29603495/)

Table 2.37. Total GHG emissions from the AFOLU sector by gas and category.

Category	Gas	Annual emissions in Gg CO_2e															
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3 AFOLU	CO_2	-143699,39	-143761,00	-143828,77	-143895,77	-143963,44	-144029,70	-144096,33	-144163,10	-144226,63	-144290,75	-144360,74	-144425,16	-144481,98	-144555,62	-144590,76	-144691,56
	CH_4	708,44	834,01	845,43	951,90	955,83	1126,62	1146,40	1187,94	1123,33	1214,63	1069,89	1116,54	1043,35	1165,25	1090,09	1043,86
	N_2O	396,62	417,90	397,62	402,16	401,20	426,39	418,67	433,34	428,17	453,04	479,46	483,59	504,51	622,46	506,26	395,71
	Total	-142594,34	-142509,09	-142585,72	-142541,71	-142606,41	-142476,69	-142531,26	-142541,82	-142675,13	-142623,09	-142811,39	-142825,03	-142934,12	-142767,91	-142994,41	-143251,99
3A1 Enteric Fermentation	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	381,22	385,26	389,35	395,05	398,98	401,10	404,85	409,59	409,87	412,79	418,56	422,81	429,77	453,91	435,02	433,95
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	381,22	385,26	389,35	395,05	398,98	401,10	404,85	409,59	409,87	412,79	418,56	422,81	429,77	453,91	435,02	433,95
3A2 Manure management	CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	36,75	37,42	38,10	38,87	39,57	40,19	40,90	41,67	42,25	42,96	43,81	44,61	45,54	47,28	47,04	47,65
	N_2O	0,014	0,014	0,014	0,015	0,015	0,015	0,015	0,015	0,014	0,014	0,014	0,015	0,015	0,021	0,015	0,013
	Total	36,76	37,43	38,12	38,89	39,58	40,21	40,92	41,69	42,26	42,97	43,83	44,62	45,55	47,30	47,06	47,66
3B1 Forest Land	CO_2	-152319,30	-152385,64	-152451,97	-152518,31	-152584,64	-152650,98	-152717,31	-152783,65	-152849,98	-152916,32	-152982,65	-153048,99	-153115,32	-153181,66	-153248,00	-153314,33
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	-152319,30	-152385,64	-152451,97	-152518,31	-152584,64	-152650,98	-152717,31	-152783,65	-152849,98	-152916,32	-152982,65	-153048,99	-153115,32	-153181,66	-153248,00	-153314,33
3B2 Cropland	CO_2	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80	564,80
3B3 Grassland	CO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetland	CO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	CO_2	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02	320,02
3B6 Other Land	CO_2	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75
3C1 Emissions from Biomass Burning	CO_2	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)
	CH_4	63,16	74,09	75,80	84,05	85,13	99,68	101,33	104,86	98,30	108,07	94,77	97,92	90,57	99,14	95,86	90,34
	N_2O	16,26	18,94	19,36	21,38	21,65	25,22	25,62	26,49	24,88	27,28	24,01	24,79	22,98	25,09	24,28	22,93
	Total	79,42	93,04	95,16	105,43	106,78	124,90	126,96	131,35	123,18	135,35	118,78	122,70	113,55	124,23	120,14	113,27
3C2 Liming	CO_2	11,35	11,72	12,46	12,24	12,99	13,07	13,29	13,58	12,96	14,44	14,24	13,96	13,71	13,93	14,94	13,89
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	11,35	11,72	12,46	12,24	12,99	13,07	13,29	13,58	12,96	14,44	14,24	13,96	13,71	13,93	14,94	13,89
3C3 Urea application	CO_2	6,98	11,34	9,16	8,72	6,63	6,63	6,11	5,39	8,81	9,54	6,10	8,29	18,06	10,54	40,72	7,30
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	6,98	11,34	9,16	8,72	6,63	6,63	6,11	5,39	8,81	9,54	6,10	8,29	18,06	10,54	40,72	7,30
3C4 Direct N2O Emissions from Managed Soils	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	269,75	282,97	267,59	268,99	267,78	283,31	277,09	286,75	284,06	300,14	321,30	323,38	339,39	422,12	339,19	259,67
	Total	269,75	282,97	267,59	268,99	267,78	283,31	277,09	286,75	284,06	300,14	321,30	323,38	339,39	422,12	339,19	259,67
3C5 Indirect N2O Emissions	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	103,71	108,97	103,54	104,43	104,30	110,41	108,41	112,39	111,65	118,00	126,31	127,45	133,87	165,57	134,49	105,03

Category	Gas	Annual emissions in Gg CO_2e															
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
from Managed Soils	Total	103,71	108,97	103,54	104,43	104,30	110,41	108,41	112,39	111,65	118,00	126,31	127,45	133,87	165,57	134,49	105,03
3C6 Indirect N2O Emissions from Manure Management	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	6,89	7,00	7,12	7,35	7,45	7,44	7,54	7,70	7,56	7,60	7,83	7,95	8,25	9,66	8,29	8,07
	Total	6,89	7,00	7,12	7,35	7,45	7,44	7,54	7,70	7,56	7,60	7,83	7,95	8,25	9,66	8,29	8,07
3C7 Rice Cultivations	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	227,31	337,23	342,18	433,93	432,15	585,63	599,32	631,82	572,91	650,80	512,74	551,21	477,48	564,92	512,17	471,91
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	227,31	337,23	342,18	433,93	432,15	585,63	599,32	631,82	572,91	650,80	512,74	551,21	477,48	564,92	512,17	471,91
3C8 Other	CO_2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3D Harvested Wood Products	CO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Category	Gas	Annual emissions in Gg CO_2e																
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
3 AFOLU	CO_2	-144755,65	-144821,87	-144866,58	-144951,89	-145008,44	-145086,59	-138865,42	-140531,81	-140521,10	-143943,86	-144864,38	-144948,23	-141350,72	-138062,91	-139763,76	-142494,47	-142380,53
	CH_4	1035,78	1056,37	1133,74	1162,10	1191,86	1252,26	1279,52	1388,97	1506,24	1594,38	1394,22	1457,55	1449,86	1755,71	1659,26	1399,57	1421,29
	N_2O	406,33	475,20	559,27	564,86	569,54	511,69	507,71	562,92	564,19	575,84	544,88	545,64	502,60	576,73	553,18	477,42	479,06
	Total	-143313,54	-143290,30	-143173,57	-143224,93	-143247,04	-143322,65	-137078,19	-138579,92	-138450,66	-141773,64	-142925,28	-142945,04	-139398,26	-135730,46	-137551,32	-140617,47	-140480,18
3A1 Enteric Fermentation	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	442,57	449,50	456,37	459,56	459,95	469,70	477,86	487,64	496,48	503,45	500,98	504,26	508,37	518,92	524,44	530,03	535,68
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	442,57	449,50	456,37	459,56	459,95	469,70	477,86	487,64	496,48	503,45	500,98	504,26	508,37	518,92	524,44	530,03	535,68
3A2 Manure management	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	48,71	49,71	50,71	51,55	52,28	53,45	54,56	55,77	56,94	58,05	58,74	59,71	60,74	62,07	63,20	64,35	65,51
	N_2O	0,015	0,015	0,016	0,016	0,015	0,016	0,017	0,019	0,020	0,021	0,019	0,019	0,019	0,020	0,021	0,021	0,021
	Total	48,73	49,73	50,72	51,56	52,29	53,46	54,58	55,79	56,97	58,07	58,76	59,73	60,75	62,09	63,22	64,37	65,53
3B1 Forest Land	CO_2	-153380,67	-153447,00	-153513,34	-153579,67	-153646,01	-153712,34	-154655,69	-154400,49	-153390,70	-152606,83	-153529,34	-154301,17	-150894,85	-145275,52	-148089,19	-150827,94	-148875,77
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	-153380,67	-153447,00	-153513,34	-153579,67	-153646,01	-153712,34	-154655,69	-154400,49	-153390,70	-152606,83	-153529,34	-154301,17	-150894,85	-145275,52	-148089,19	-150827,94	-148875,77
3B2 Cropland	CO_2	564,80	564,80	564,80	564,80	564,80	564,80	1007,85	990,08	1426,47	940,12	940,12	1048,93	1027,02	726,57	1125,86	653,06	476,21
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	564,80	564,80	564,80	564,80	564,80	564,80	1007,85	990,08	1426,47	940,12	940,12	1048,93	1027,02	726,57	1125,86	653,06	476,21
3B3 Grassland	CO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B4 Wetland	CO_2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3B5 Settlements	CO_2	320,02	320,02	320,02	320,02	320,02	320,02	385,84	730,67	437,35	565,61	565,61	451,02	452,07	315,40	376,24	473,10	457,89
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	320,02	320,02	320,02	320,02	320,02	320,02	385,84	730,67	437,35	565,61	565,61	451,02	452,07	315,40	376,24	473,10	457,89
3B6 Other Land	CO_2	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	14365,35	12109,20	10969,56	7130,11	7130,11	7823,99	8015,33	6119,78	6783,28	7175,32	5534,47
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	7716,75	7716,75	7716,75	7716,75	7716,75	7716,75	14365,35	12109,20	10969,56	7130,11	7130,11	7823,99	8015,33	6119,78	6783,28	7175,32	5534,47
3C1 Emissions from Biomass Burning	CO_2	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)	IE (3B1 & 3B2)
	CH_4	89,01	88,70	96,57	98,65	98,13	106,61	112,61	116,27	134,09	188,62	169,66	131,33	140,18	387,89	249,87	111,84	111,48
	N_2O	22,60	22,52	24,45	24,97	24,84	26,92	28,58	29,36	33,96	49,10	44,45	33,63	35,94	104,75	66,22	28,19	28,04
	Total	111,61	111,22	121,02	123,62	122,97	133,53	141,19	145,63	168,04	237,71	214,11	164,96	176,12	492,64	316,09	140,03	139,52
3C2 Liming	CO_2	14,01	13,09	14,34	14,34	12,37	15,17	14,55	13,65	15,14	14,43	13,16	14,71	14,79	14,87	14,95	15,03	15,11
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	14,01	13,09	14,34	14,34	12,37	15,17	14,55	13,65	15,14	14,43	13,16	14,71	14,79	14,87	14,95	15,03	15,11
3C3 Urea application	CO_2	9,42	10,46	30,84	11,87	23,62	9,00	16,67	25,07	21,08	12,70	15,95	14,29	34,93	35,99	25,12	16,97	11,56
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	9,42	10,46	30,84	11,87	23,62	9,00	16,67	25,07	21,08	12,70	15,95	14,29	34,93	35,99	25,12	16,97	11,56
3C4 Direct N2O Emissions from Managed Soils	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	266,99	316,62	375,87	379,24	382,59	338,24	333,49	372,37	369,26	366,14	346,99	353,06	316,37	319,31	330,24	299,45	299,92
	Total	266,99	316,62	375,87	379,24	382,59	338,24	333,49	372,37	369,26	366,14	346,99	353,06	316,37	319,31	330,24	299,45	299,92
3C5 Indirect N2O Emissions from	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	108,25	127,27	149,88	151,52	153,11	137,05	135,78	150,86	150,22	149,55	142,71	148,16	139,40	141,25	145,10	137,95	139,06
	Total	108,25	127,27	149,88	151,52	153,11	137,05	135,78	150,86	150,22	149,55	142,71	148,16	139,40	141,25	145,10	137,95	139,06

Category	Gas	Annual emissions in Gg CO_2e																
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Managed Soils																		
3C6 Indirect N2O Emissions from Manure Management	**CO_2**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	8,47	8,77	9,06	9,11	8,98	9,46	9,83	10,31	10,73	11,02	10,71	10,77	10,88	11,41	11,61	11,81	12,02
	Total	8,47	8,77	9,06	9,11	8,98	9,46	9,83	10,31	10,73	11,02	10,71	10,77	10,88	11,41	11,61	11,81	12,02
3C7 Rice Cultivations	**CO_2**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	455,49	468,46	530,09	552,34	581,51	622,49	634,50	729,29	818,73	844,26	664,84	762,24	740,58	786,83	821,75	693,35	708,62
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	455,49	468,46	530,09	552,34	581,51	622,49	634,50	729,29	818,73	844,26	664,84	762,24	740,58	786,83	821,75	693,35	708,62
3C8 Other	**CO_2**	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N_2O	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	Total	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3D Harvested Wood Products	**CO_2**	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH_4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N_2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

6.3.4. Description of Removals and Emissions by Category

The Volume 4: Agriculture, Forestry and Other Land Use of the IPCC Guidelines provide approaches, methodologies, and technical guidance for preparing a GHG inventory for the AFOLU sector, providing a default approach and default data if necessary.

Enteric Fermentation (3A1)

Enteric fermentation produces CH_4 as part of the digestion process in the alimentary canal of herbivores. Microbes in the animal's digestive system ferment feed ingested by the livestock which generates CH_4. CH_4 production is dependent on animal population, weight, and age of the animals as well as the quantity and quality of feed. The type and efficiency of the animals' digestive system also influence CH_4 production. The quantity of CH_4 production in ruminant livestock is more than that produced by non-ruminant livestock.

The main activity data for the Tier 1 method of this livestock category to estimate CH_4 emissions is the annual livestock population in number of heads for all the species and sub-groups of the country. Default emission factors are presented for each of the recommended population subgroups.

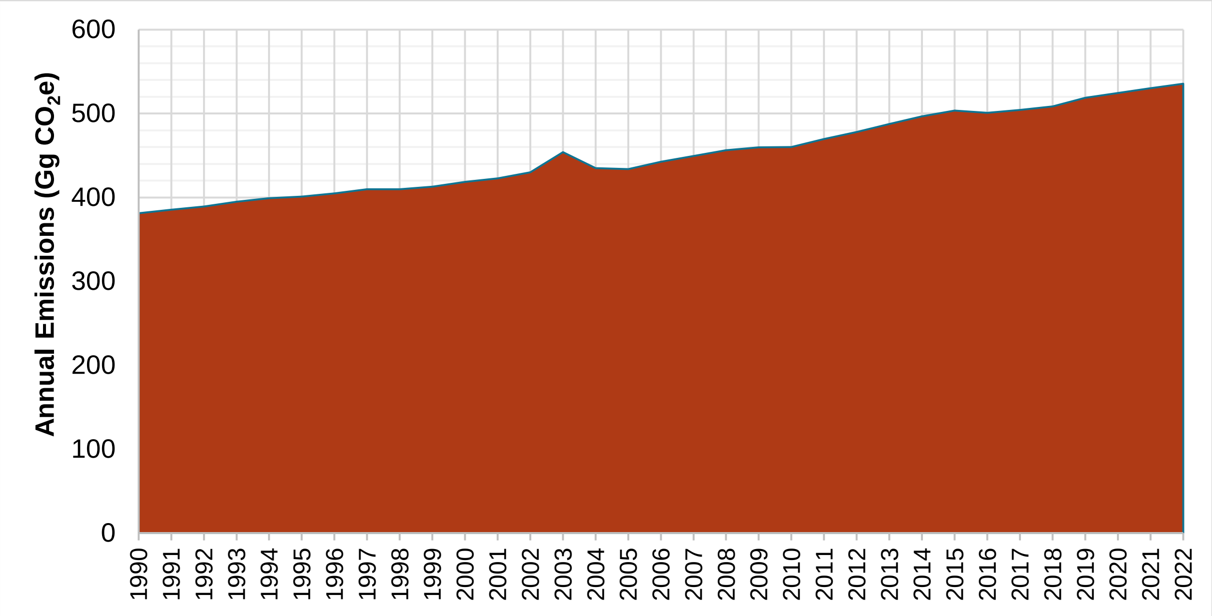

Figure 2.23. Category 3A1 GHG emissions.

Table 2.38. Summary of GHG emissions from Category 3A1 – Enteric Fermentation.

	Annual Emissions in Gg CO_2e										
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Enteric Fermentation – 3A1	381,22	385,26	389,35	395,05	398,98	401,10	404,85	409,59	409,87	412,79	418,56
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Enteric Fermentation – 3A1	422,81	429,77	453,91	435,02	433,95	442,57	449,50	456,37	459,56	459,95	469,70
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Enteric Fermentation – 3A1	477,86	487,64	496,48	503,45	500,98	504,26	508,37	518,92	524,44	530,03	535,68

The trends for the Category 3A1 – Enteric Fermentation reveal an increase of GHG emissions over the period 1990 to 2022 growing by about 40% or from 381,22 Gg CO_2 eq. to 535,68 Gg CO_2 eq., which makes this category a relevant source of CH_4 emissions for the AFOLU sector. With minor differences in the percentage increases by year, the trends show a relatively constant pattern, registering a small peak of emissions in 2003 followed by the only instances of a reduction of emissions in 2004 and 2005 between two consecutive years. Overall, the trend increase in GHG emissions is linked to the growing of the livestock population in Guyana between 1990 and 2022 as the key underlying factor.

Manure Management (3A2)

This section estimates the CH_4 produced during the storage and treatment of manure, and from manure deposited on pasture. The decomposition of manure under anaerobic conditions (i.e., in the absence of oxygen), during storage and treatment, produces CH_4. This category also estimates the N_2O produced directly during the storage and treatment of manure before it is applied to land or otherwise used for feed, fuel, or construction purposes. The indirect N_2O emissions from manure management are treated in Category 3C6. The term 'manure' is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock.

The N_2O emissions generated by manure in the system 'pasture, range, and paddock' occur directly and indirectly from the soil and are therefore reported under the Categories 3C4 & 3C5 – Direct and Indirect N_2O Emissions from Managed Soils. The emissions associated with the burning of dung for fuel are to be reported under Volume 2 (Energy), or under Volume 5 (Waste) if burned without energy recovery.

In Guyana, the CH_4 emissions are estimated with the Tier 1 methodology from the 2019 Refinement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. They are estimated by multiplying the livestock population by the emission factor for the defined livestock population.

The direct N_2O emissions from manure management in Guyana are estimated with the Tier 1 method. This method consists in multiplying the total amount of nitrogen (N) excretion (from all livestock species/categories) in each type of manure management system by an emission factor for that type of manure management system from the 2019 Refinement of the 2006 IPCC Guidelines. Emissions are then summed over all manure management systems. The Tier 1 method is applied using IPCC default N2O emission factors, default nitrogen excretion data, and default manure management system data.

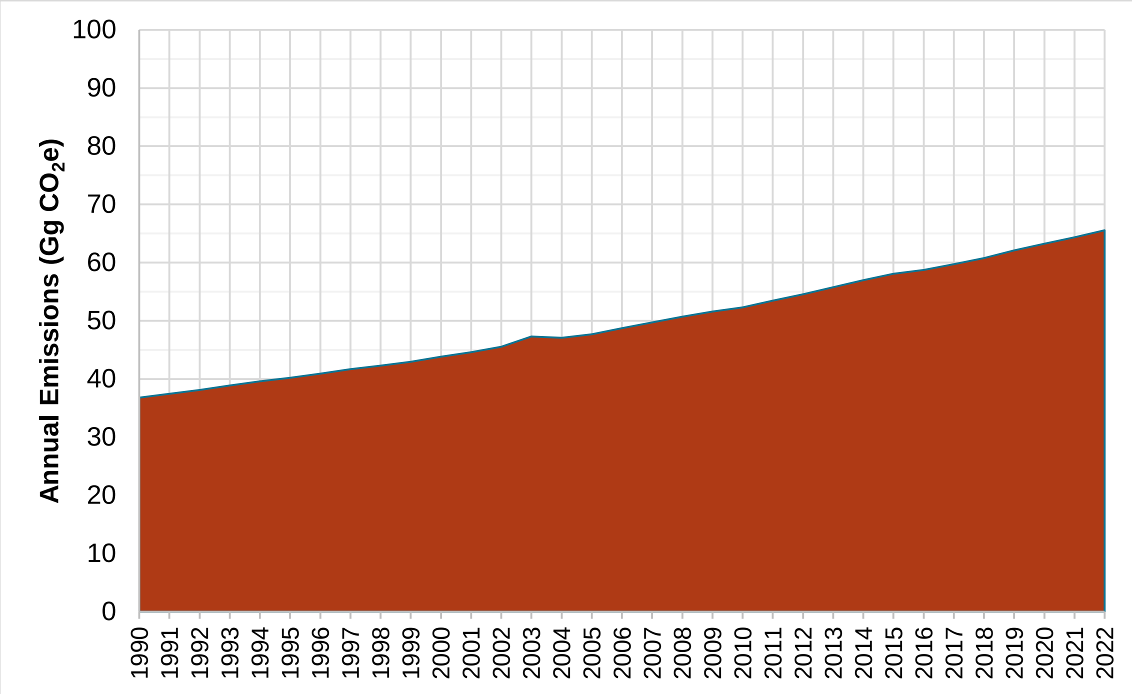

Figure 2.24. Category 3A2 GHG emissions.

Table 2.39. Summary of GHG emissions from Category 3A2 – Manure Management.

Annual Emissions in Gg CO_2e											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Manure Management – 3A2	36,76	37,43	38,12	38,89	39,58	40,21	40,92	41,69	42,26	42,97	43,83
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Manure Management – 3A2	44,62	45,55	47,30	47,06	47,66	48,73	49,73	50,72	51,56	52,29	53,46
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Manure Management – 3A2	54,58	55,79	56,97	58,07	58,76	59,73	60,75	62,09	63,22	64,37	65,53

The GHG emissions of Category 3A2 – Manure Management have a relatively minor contribution to the country's emissions total. However, in the reported period the GHG emissions in this sector almost doubled from 36,76 Gg CO_2 eq. to 65,53 Gg CO_2 eq. between 1990 and 2022. The trend observed in this increase shows a constant growth pattern with GHG emissions increasing roughly by 1 Gg CO_2 eq. per year which is strongly aligned with the growing of the livestock population in Guyana over the analysed period. An exception is the year 2003 in which a slightly stronger increase was registered and after which emissions again marginally dropped, before resuming the stable growth pattern.

Table 2.40. Uncertainty in GHG Emissions from Category 3A – Livestock.

Parameter	Uncertainty
Enteric fermentation emission factor	40%
CH4 manure management emission factor	30%
Default values for N excretion rate (N_{rate})	50%
Default values for live weights for animal categories (TAM)	30%
Default emission factors for direct N2O emissions from manure management	100%

Forest Land Remaining Forest Land (3B1a)

In this category, the changes in carbon stocks from five carbon pools (i.e., above-ground biomass, belowground biomass, dead wood, litter, and soil organic matter) are estimated for managed forests that have been under the Forest Land category for over 20 years.

Gains in carbon stocks include total (above-ground and below-ground) biomass growth. Carbon losses have been estimated based on activity data on the drivers of forest degradation as presented in the REDD+ technical annex. The drivers that have been considered in this calculation are logging, skid trails for logging activities, buffer zones for mining, and fires. The buffer area is typically a zone surrounding a protected forest or conservation area, and it serves as a transitional zone where certain human activities may be allowed but are subject to specific regulations to minimize their impact on the core forest.

Removals

GHG emissions are strongly influenced by Guyana's management of its extensive national forest cover, and the consequent absorption of CO_2 from the atmosphere. Over the last two decades, Guyana has maintained a vast net carbon sink, with a negative emission level, surpassing -130 Mg of CO_2-eq per annum for the entire period from 1990 to 2022. To include removals from forests remaining forests, country-specific annual increments over 20 years were utilized (1993 to 2013). Country-specific growth increments were referenced from Roopsind et al., 2018: **Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity, 2017**[7]**.** Roopsind et al., 2018, form the baseline for estimating removals in Guyana, estimated at 154 $MtCO_2$.

[7] Roopsind A, Caughlin TT, van der Hout P, Arets E, Putz FE. ***Trade-offs between carbon stocks and timber recovery in tropical forests are mediated by logging intensity***. Glob Chang Biol. 2018 Jul;24(7):2862-2874. doi: 10.1111/gcb.14155. Epub 2018 May 22. PMID: 29603495. (Available at: https://pubmed.ncbi.nlm.nih.gov/29603495/)

The CO_2 emissions are estimated following the equations provided by 2006 Guidelines for the Tier 1 methodology. However, the activity data and parameters are derived through an extensive monitoring reporting and verification system, as detailed in the REDD+ Technical Annex, with further details provided in Chapter 4 of the BUR. Therefore, the estimations for CO_2 could be considered a more advanced tier approach (T2/T3). Carbon gains or CO_2 removals are estimated by multiplying the total area remaining Forest Land by the average gross periodic annual increment (country-specific factor). The carbon losses are estimated separately for each driver of degradation due to activity specific emission factors. Losses from logging have been estimated by multiplying the total volume harvested by the Logging Damage Factor (LDF), which is the country-specific emission factor for this activity. The losses from logging skid trails have been calculated by multiplying the length of skid trails by the Logging Infrastructure Factor (LIF). The losses from mining infrastructure (buffer zones) were estimated by multiplying the buffer zone total area by the country-specific emission factor.

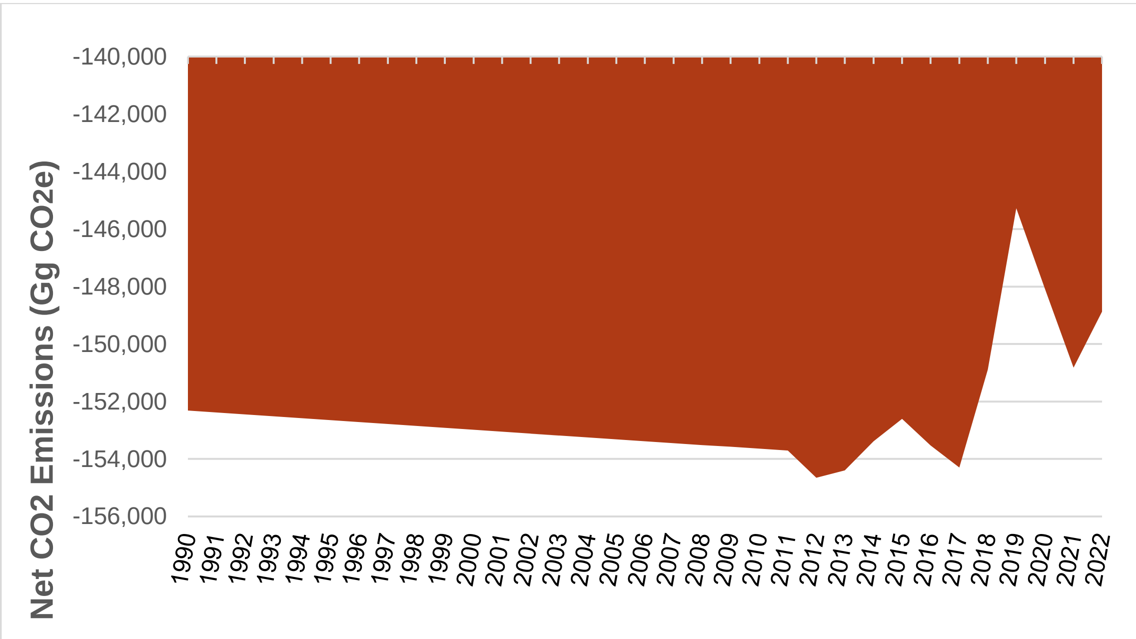

Figure 2.25. Category 3B1a GHG emissions.

Table 2.41. Summary of GHG emissions from Category 3B1a – Forest Land Remaining Forest Land.

Annual Emissions in Gg CO_2e									
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
FL-FL 3B1a	-152319	-152385	-152451	-152518	-152584	-152650	-152717	-152783	-152849
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
FL-FL 3B1a	-152916	-152982	-153048	-153115	-153181	-153247	-153314	-153380	-153447
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
FL-FL 3B1a	-153513	-153579	-153646	-153712	-154655	-154400	-153390	-152606	-153529
	2017	**2018**	**2019**	**2020**	**2021**	**2022**			
FL-FL 3B1a	-154301	-150894	-145275	-148089	-150827	-148875			

Over the past 32 years, annual emissions consistently show a negative trend, indicating a persistent carbon sink. Nonetheless, the potential for removal of annual emissions has decreased, which can be due to an increase in emissions from other sectors such as energy or waste or due to significant disturbances such as wildfires. Sinks grew until 2017, with peaks in 2012, 2013, and 2017. Post-2017, there's increased fluctuation, hitting a low in 2019, showing a diminishing trend over the last 5 years. These fluctuations could be caused by changes in data collection and sampling methods, recently Guyana has revised its Forest Reference Level for the REDD+ programme, where information on the total forest cover and deforestation drivers has been collected using specialized sampling systems, satellite imagery and GIS. The average annual emissions are -152,521.08 Gg CO_2, underscore the critical role of Guyana's forests as a significant carbon sink, highlighting their importance in mitigating climate change.

Forest Land Converted to Cropland (3B2b)

This category estimates the CO_2 emissions from Forest Land converted to Cropland. The estimations include annual changes in carbon stocks in all carbon pools. To calculate emissions from this category, the tier 1 methodology has been followed. Deforestation in Guyana due to permanent agriculture is assumed to result in the complete removal of all vegetation. On the other hand, pioneer shifting cultivation has a long-term post deforestation carbon stock. The carbon stocks have been estimated at the national level and an emission factor for deforestation from shifting cultivation has been developed. The calculation of emissions from these categories has been carried out separately, using the activity specific emission factors and the total forest area cleared.

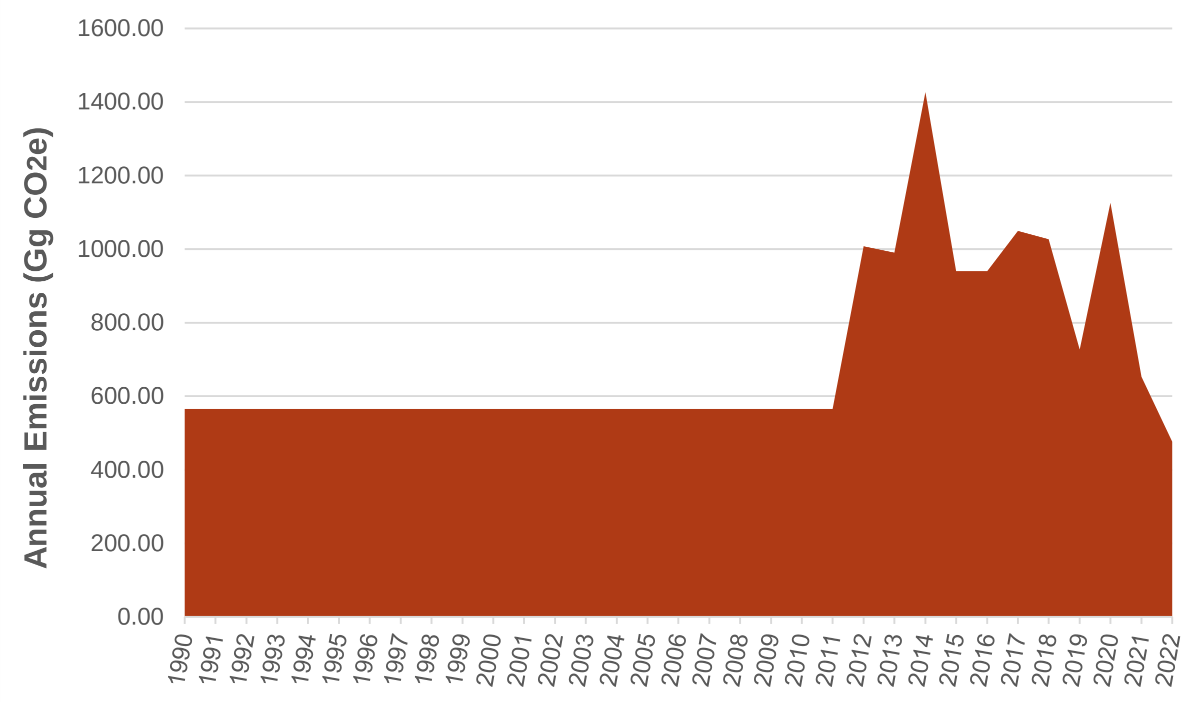

Figure 2.26. Category 3B2b GHG emissions.

Table 2.42. Summary of GHG emissions from Category 3B2b – Forest Land Converted to Cropland.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Forest Land Converted to Cropland - 3B2b	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Forest Land Converted to Cropland - 3B2b	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80	564.80
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Forest Land Converted to Cropland - 3B2b	1007.85	990.08	1426.47	940.12	940.12	1048.93	1027.02	726.57	1125.86	653.06	476.21

Annual emissions for this category reveal a positive trend, averaging 690.54 over the 32 years observed. The values remain steady until 2012, attributed to missing data that required backward gap-filling. In this case, the value calculated for 2011 was used for the years 1990-2010, leading to an adjusted average of 910.59 for the period from 2011 to 2022. In 2012, there's a notable surge in emissions, followed by an overall increase until the early years, peaking in 2014 at approximately 1.5 times the average.

Emissions decrease in 2019, likely influenced by COVID-19-related economic changes. They rebound in 2020 with economic recovery, but the last two years (2021 and 2022) witness a decline. In 2022, emissions drop below the reported historical value, reaching a minimum of 476.21.

Forest Land Converted to Settlements (3B5b)

This category estimates the CO_2 emissions from Forest Land converted to Settlements. The estimations include annual changes in carbon stocks in all carbon pools. To calculate emissions from this category, the tier 1 methodology has been followed. The calculations include emissions from three different drivers of deforestation, which are: forest land cleared for settlements, infrastructure and forestry infrastructure. Emissions from these drivers have been calculated separately due to specific emission factors for each activity.

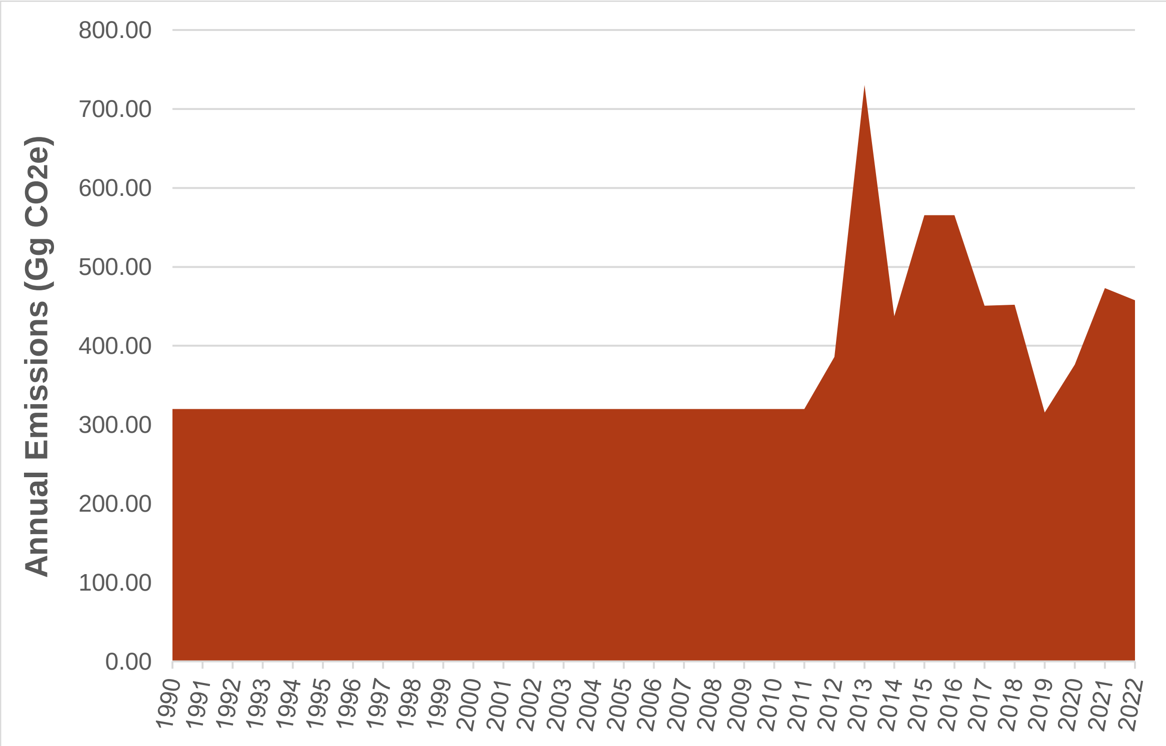

Figure 2.27. Category 3B5b GHG emissions.

Table 2.43. Summary of GHG emissions from Category 3B5b – Forest Land Converted to Settlements.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Forest Land Converted to Settlements - 3B5b	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Forest Land Converted to Settlements - 3B5b	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024	320.024
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Forest Land Converted to Settlements - 3B5b	385.838	730.673	437.353	565.615	565.615	451.020	452.071	315.399	376.236	473.098	457.891

Like the previous category, data gaps were filled using 2011 values for 1990-2010. From 2011 to 2022, the average emissions are 473.71 Gg CO_2, significantly higher than the gap-filled 2011 value. The highest annual emissions occur in 2013, while the lowest is in 2019, possibly due to the economic impact of COVID-19. Mirroring the sinks of the first category, the recent years show the most fluctuation, with the lowest emissions observed in the last five years.

Forest Land Converted to Other Land (3B6b)

This category estimates the CO_2 emissions from Forest Land converted to Other Land. The estimations include annual changes in carbon stocks in all carbon pools. To calculate emissions from this category, the tier 1 methodology has been followed. The category considers the deforestation caused by small, medium and large-scale mining activities.

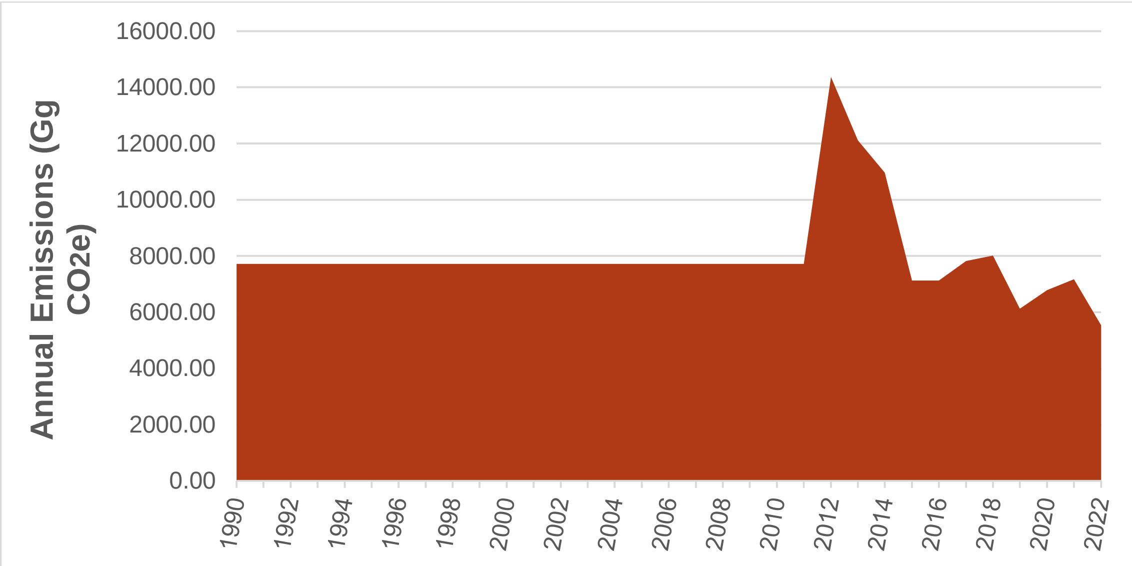

Figure 2.28. Category 3B6b GHG emissions.

Table 2.44. Summary of GHG emissions from Category 3B6b – Forest Land Converted to Other Land.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Forest Land Converted to Other Land - 3B6b	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Forest Land Converted to Other Land - 3B6b	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75	7716.75
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Forest Land Converted to Other Land - 3B6b	14365.35	12109.20	10969.56	7130.11	7130.11	7823.99	8015.33	6119.78	6783.28	7175.32	5534.47

This category focuses on deforestation resulting from mining activities in Guyana. To address data gaps from 1990 to 2010, we utilized the 2011 value as a constant. From 2011 onwards, emissions display varying trajectory, averaging 8468.77 units annually. Notably, emissions increased in 2012, and remained at a similar level to 2012 until 2014. A decline ensued in 2015, persisting until a slight rise in 2016. In the most recent years (2019-2022), emissions show a downward trend, possibly influenced by the economic repercussions of the COVID-19 crisis. Particularly noteworthy is the significant deviation in 2022, with emissions 2934.30 units below the adjusted 2011-2022 average. It is important to highlight that this category represents the highest emissions related to land use and land-use change.

Table 2.45. Uncertainty in GHG Emissions from Category 3B – Land.

Parameter	Uncertainty
Forestry infrastructure Emission Factor	35.37%
Agriculture Emission Factor	35.37%
Mining (medium and large scale) Emission Factor	35.37%
Mining infrastructure Emission Factor	35.37%
Infrastructure Emission Factor	35.37%
Settlements Emission Factor	35.37%
Fire-Biomass burning Emission Factor	35.37%
Logging Damage Factor	0.29%
Wood Density of timber harvested Emission Factor	0.01%
LIF (Skid Trails)	5.87%
Gross PAI of aboveground carbon	48.72%

Emissions from Biomass Burning (3C1)

In this category, the CH_4 and N_2O emissions associated to biomass burning are estimated. It occurs in both cropland and forestland in Guyana. Burning of sugarcane and rice residues is common in Guyana and was considered for the calculation, as they represent the most important crops of the country. The rest of the crop biomass burning was not considered due to lack of data. On the other hand, CH_4 and N_2O emissions associated to biomass combustion due to wildfires was also calculated in this section. Therefore, while CO_2 emissions from biomass burning are included in the category Land 3B, the non-CO_2 emissions are included in the section 3C1. For both cropland and forestland, the Tier 1 method is used for the estimation the GHG emissions (CH_4 and N_2O gases), where the area burnt is the activity data and the default values come from the 2006 IPCC Guidelines.

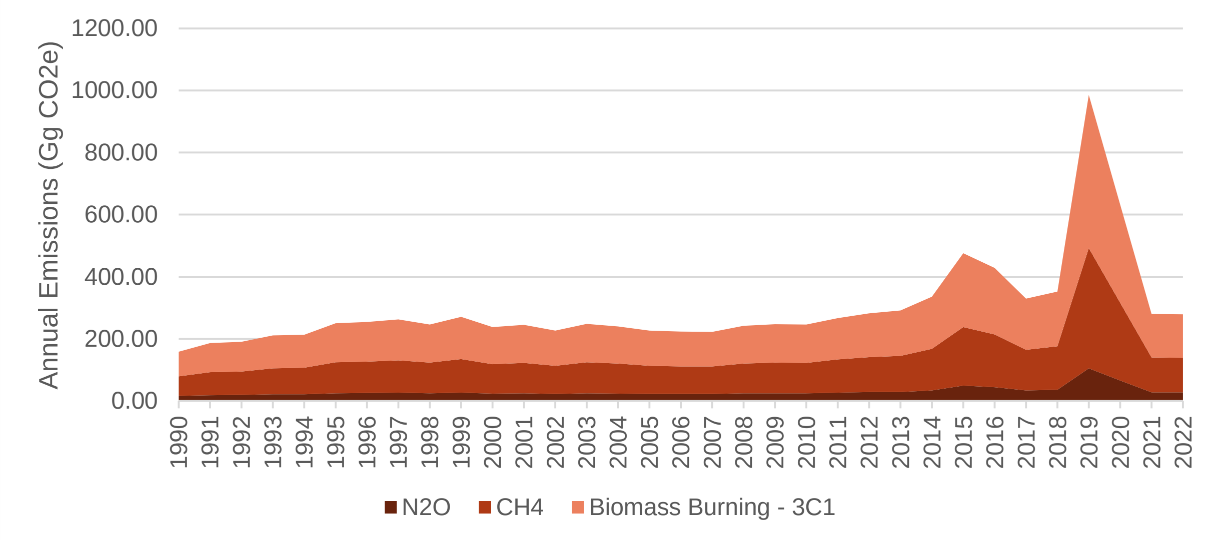

Figure 2.29. Category 3C1 GHG emissions.

Table 2.46. Summary of GHG emissions from Category 3C1 – Emissions from Biomass Burning.

Annual Emissions in Gg CO_2e											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Emissions from Biomass Burning – 3C1	79,42	93,04	95,16	105,43	106,78	124,90	126,96	131,35	123,18	135,35	118,78
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Emissions from Biomass Burning – 3C1	122,70	113,55	124,23	120,14	113,27	111,61	111,22	121,02	123,62	122,97	133,53
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Emissions from Biomass Burning – 3C1	141,19	145,63	168,04	237,71	214,11	164,96	176,12	492,64	316,09	140,03	139,52

Over the period 1990 to 2022, the GHG emissions in the category 3C1 – Emissions from Biomass Burning fluctuated substantially while overall showing an increase over the years that have shown a percentual increase of 75,67%. After a relatively constant growth period, the emissions fluctuated between 131,35 Gg CO_2 eq. in 1997 and 111,61 Gg CO_2 eq. in 2011 after which it, with some fluctuations increased steadily until 2016 reaching its highest value thus far of about 214,11 Gg CO_2 eq. This can be explained by a possible wildfire that caused that increase of burnt hectares. This was followed by a relatively stark drop in GHG emissions only then to almost triple from 176,12 Gg CO_2 eq. in 2018 to 492,64 Gg CO_2 eq. in 2019. Since then, however, the GHG emission rapidly declined again reaching 139,52 Gg CO_2 eq. in 2022.

Liming (3C2)

Liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., calcic limestone ($CaCO_3$), or dolomite ($CaMg(CO_3)2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3^-$), which evolves into CO_2 and water (H_2O). The Tier 1 estimations for CO_2 emissions from lime addition to soils requires to know the amount of limestone and dolomite applied per year. In the case of Guyana, only the limestone applied in the sugarcane crops was considered, due to lack of data relating lime application on other crops. Default emission factors (EF) are 0.12 for limestone.

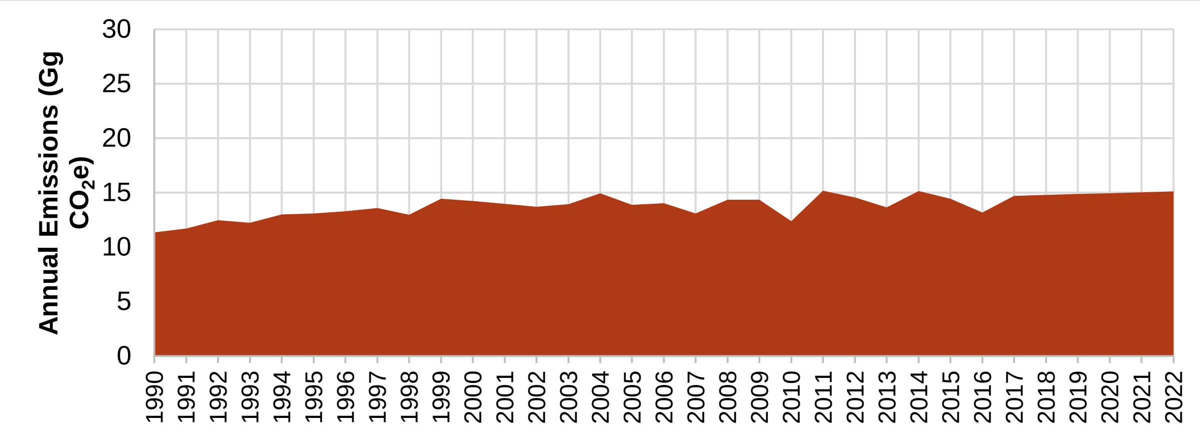

Figure 2.30. Category 3C2 GHG emissions.

Table 2.47. Summary of GHG emissions from Category 3C2 – Liming.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Liming – 3C2	11,35	11,72	12,47	12,24	12,99	13,07	13,30	13,58	12,96	14,44	14,24
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Liming – 3C2	13,96	13,71	13,93	14,94	13,89	14,01	13,09	14,35	14,34	12,37	15,17
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Liming – 3C2	14,55	13,65	15,14	14,43	13,16	14,71	14,79	14,87	14,95	15,03	15,11

Category 3C2 – Liming only considers the lime applied to the sugarcane crops and that fact contributes to the minor emissions impact of this category in Guyana. The emissions trend reveals a slight increase over the period 1990 to 2022, with minor fluctuations marking in particular the period from 2004 to 2016. However, the relative differences in the GHG emissions over the years are small with the minimum being reported at 11,35 Gg CO_2 eq. in 1990, the maximum of 15,14 Gg CO_2 eq. in 2014 and with the most recent level estimated at around 15,11 Gg CO_2 eq. in 2022.

<u>Urea application (3C3)</u>

Urea is a form of nitrogen fertilizer used in agriculture that can cause CO_2 emissions when applied to the soil. During the manufacturing process of urea, CO_2 is removed from the atmosphere. This CO_2 is accounted for in the IPPU sector. Therefore, the emissions resulting from urea application are included in the emissions of the AFOLU sector. After the application of urea (CO(CH2)2) is converted to ammonium (NH4+), which is the fertilizing chemical, hydroxyl ion (OH-) and bicarbonate (HCO3-). Following soil chemical reactions, bicarbonate evolves into CO_2 and water.

The Tier 1 estimations for CO_2 emissions from urea requires to know the amount of urea fertilizer applied per year. Data on imported urea in Guyana was available from the Guyana Authority Revenue (GRA) for the period 2020-2022 of the inventory. Surrogate data from FAOSTAT was used to complete the time series back until 1990. For urea, the default emission factor estimates that 0.2 ton of carbon are lost as CO_2 emissions per ton of urea applied.

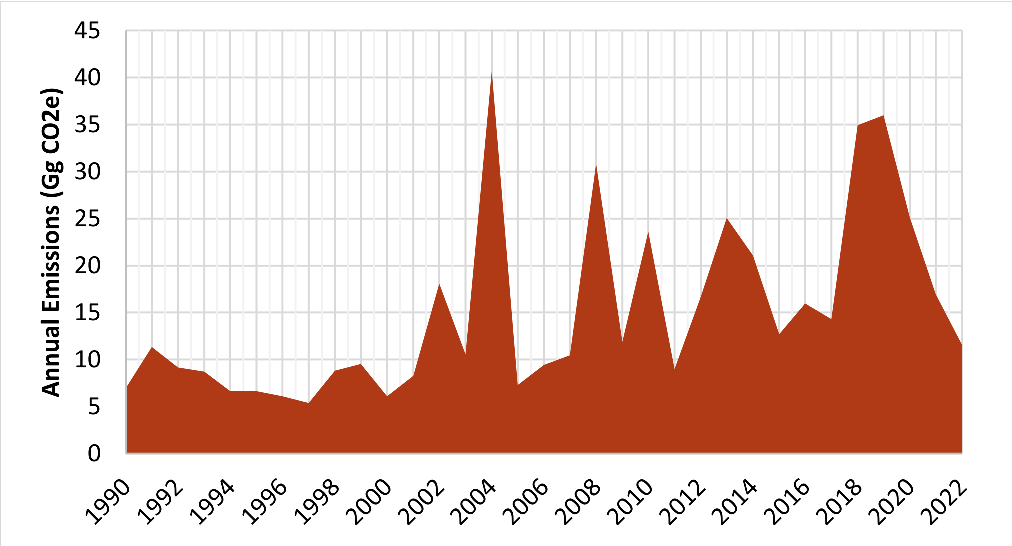

Figure 2.31. Category 3C3 GHG emissions.

Table 2.48. Summary of GHG emissions from Category 3C3 – Urea Application.

Annual Emissions in Gg CO_2e											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Urea Application – 3C3	6,98	11,34	9,16	8,72	6,63	6,63	6,11	5,39	8,81	9,54	6,10
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Urea Application – 3C3	8,29	18,06	10,54	40,72	7,30	9,42	10,46	30,84	11,87	23,62	9,00
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Urea Application – 3C3	16,67	25,07	21,08	12,70	15,95	14,29	34,93	35,99	25,12	16,97	11,56

With levels estimated at 11,56 Gg CO_2 in 2022, the GHG emissions for category 3C3 – Urea Application currently represent a small fraction of Guyana´s GHG inventory. Nevertheless, the pattern over the time period 1990 to 2022 is marked by strong peaks and equally stark drops in GHG emissions as observed in 2004 where emissions rose by about 400% to 40,72 Gg CO_2 eq. compared to the previous year and after which a decrease to 7,30 Gg CO_2 is observed. Similar, albeit slightly less pronounced fluctuations, are again observed for the years 2008, 2010, and 2018 each marking a peak compared to the respective previous and subsequent years. While the emissions in 2022, are estimated at about 11 CO_2 eq. in 2019 they had been at almost 36 Gg CO_2.

The observed trend can be attributed to the absence of national data on urea application in crops before the year 2020. To address this, there is a need to supplement the data by relying on international sources for fertilizer imports. Establishing a consistent and continuous collection of data on urea application or fertilizer imports at the national level has been identified as a crucial step. This proactive approach will contribute to minimizing significant fluctuations in emissions from this category in future inventories, ensuring more accurate and reliable assessments.

Direct N_2O Emissions from Managed Soils (3C4)

In most soils, the addition of nitrogen enhances the two processes responsible for N_2O emissions: nitrification and denitrification. The addition of nitrogen can come from several sources. The IPCC methodology includes the following:

- synthetic N fertilisers (F_{SN});
- organic N applied as fertiliser (e.g., animal manure, compost, sewage sludge, rendering waste) (F_{ON});
- urine and dung N deposited on pasture, range and paddock by grazing animals (F_{PRP});
- N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal (F_{CR});
- N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils (F_{SOM}); and
- drainage/management of organic soils (F_{OS}).

In the case of Guyana, the Tier 1 methodology was used first to estimate the factors cited above (except the factors related to organic soils (F_{SOM} & F_{OS}), given the absence of data for that management system). The organic N applied as fertilizer (F_{ON}) was equivalent in this case to the amount of animal manure N applied to soils (F_{AM}), given the absence of data on total sewage N and total compost N applied to soils. The total direct N_2O emissions is the sum of emissions produced from nitrogen inputs and from urine and dung inputs to grazed soils.

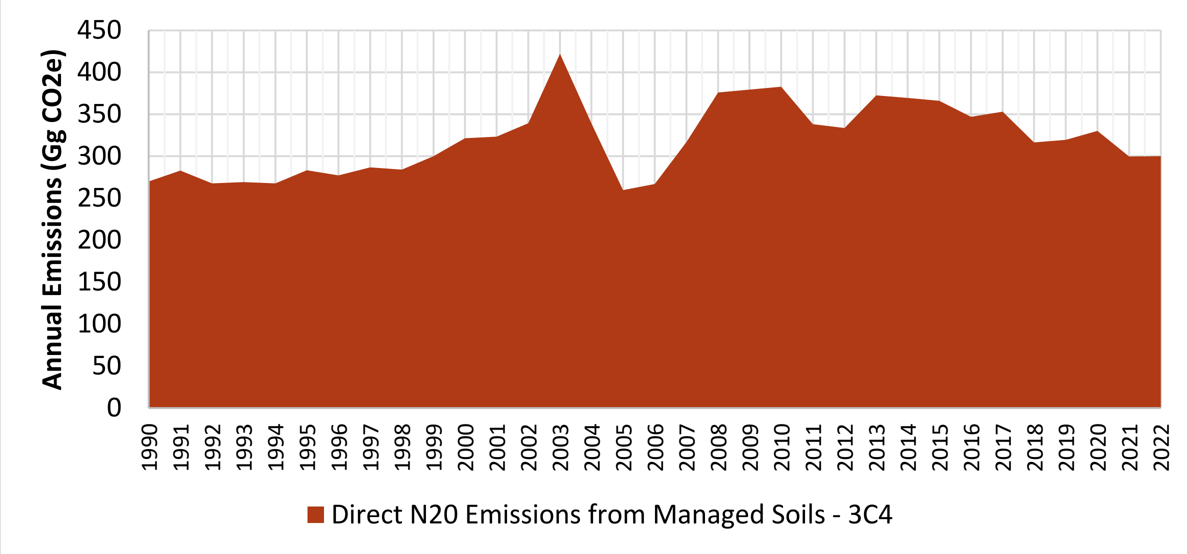

Figure 2.32. Category 3C4 GHG emissions.

Table 2.49. Summary of GHG emissions from Category 3C4 – Direct N2O Emissions from Managed Soils.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Direct N2O Emissions from Managed Soils – 3C4	269,75	282,97	267,59	268,99	267,78	283,31	277,09	286,75	284,06	300,14	321,30
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Direct N2O Emissions from Managed Soils – 3C4	323,38	339,39	422,12	339,19	259,67	266,99	316,62	375,87	379,24	382,59	338,24
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Direct N2O Emissions from Managed Soils – 3C4	333,49	372,37	369,26	366,14	346,99	353,06	316,37	319,31	330,24	299,45	299,92

Over the period 1990 to 2003, GHG emissions in category 3C4 – Direct N20 Emissions from Managed Soils were increasing steadily with minor fluctuations until reaching its peak in 2003 with emissions estimated at 422,12 Gg CO_2 eq. Following this peak, emissions generally showed higher levels than in the pre 2000s period, but, with fluctuating levels between the years, are showing an overall decreasing trend since 2013. This category constitutes a relevant source of N20 emissions for the AFOLU sector.

<u>Indirect N_2O Emissions from Managed Soils (3C5)</u>

There are two paths for indirect emissions of N_2O from managed soils:

1. Following **volatilisation** of NH_3 and NOx from managed soils and from fossil fuel combustion and biomass burning, and the subsequent re-deposition of these gases and their products NH_4^+ and NO_3^- to soils and waters; and

2. After **leaching and runoff** of nitrogen from managed soils. The nitrification and denitrification processes transform some of the NH_4^+ and NO_3^- to N_2O.

For Guyana, the estimations followed the Tier 1 methodology, in addition to the default emission factors provided from the 2006 IPPC Guidelines. The N sources of indirect N_2O emissions from managed soils are the same as for Category 3C4.

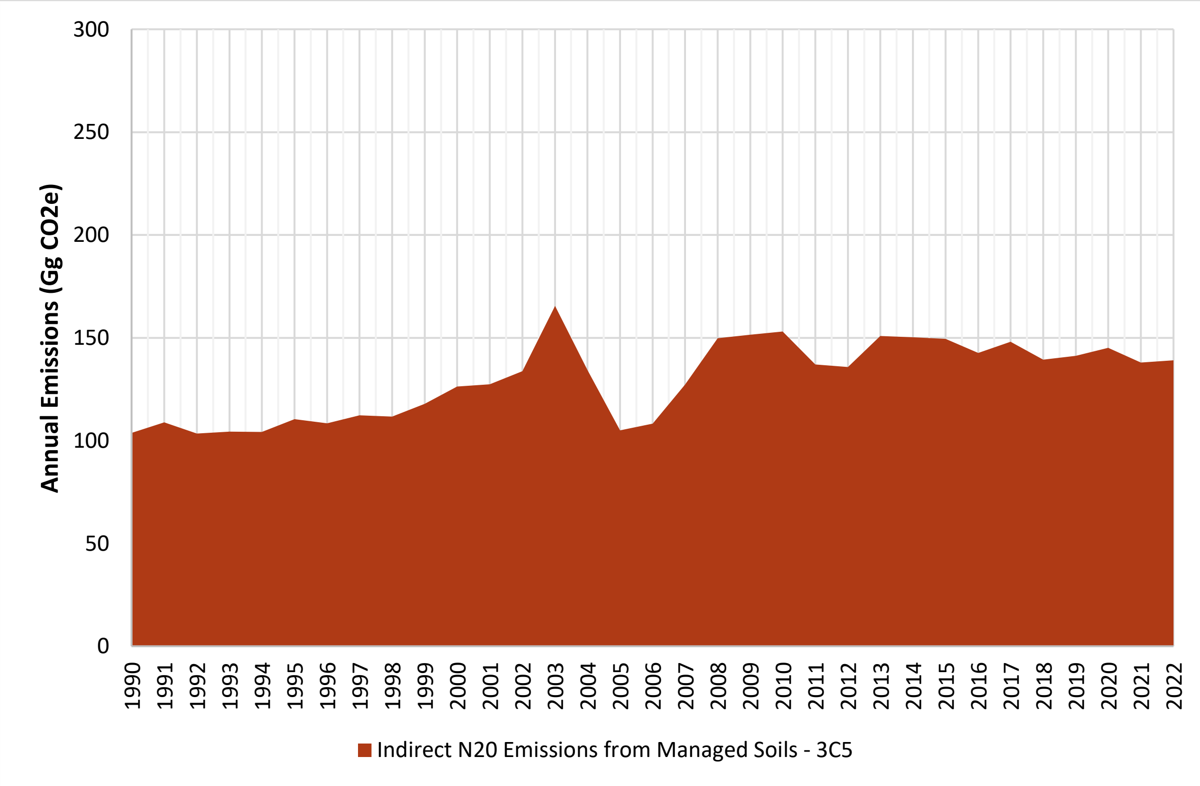

Figure 2.33. Category 3C5 GHG emissions.

Table 2.50. Summary of GHG emissions from Category 3C5 – Indirect N2O Emissions from Managed Soils.

Annual Emissions in Gg CO_2e											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Indirect N2O Emissions from Managed Soils – 3C5	103,71	108,97	103,54	104,43	104,30	110,41	108,41	112,39	111,65	118,00	126,31
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Indirect N2O Emissions from Managed Soils – 3C5	127,45	133,87	165,57	134,49	105,03	108,25	127,27	149,88	151,52	153,11	137,05
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Indirect N2O Emissions from Managed Soils – 3C5	135,78	150,86	150,22	149,55	142,71	148,16	139,40	141,25	145,10	137,95	139,06

GHG emissions in Category 3C5 – Indirect N2O Emissions from Managed Soils hovered between the minimum 103,71 Gg CO_2 eq. in 1990 and the maximum of 165,57 Gg CO_2 eq. in 2003 over the course of the assessment period. The annual trends from the period 1990 to 2002 reveal a relatively steady increase until a stark rise in 2003, after which emissions dropped almost to 1990 levels in 2005. Between 2005 and 2022, the GHG emissions are estimated as relatively steady with somewhat stronger fluctuations observed between 2009 and 2013. In 2022, GHG emissions reached a level of 139,06 Gg CO_2 eq.

Indirect N_2O Emissions from Manure Management (3C6)

In addition to the emissions from manure management treated above, nitrogen losses can occur indirectly, primarily in the form of ammonia and NOx. During manure collection and storage, a fraction of excreted organic nitrogen is mineralized to ammonia nitrogen. The quantity depends on the time of storage and to a lesser degree on temperature. Ammonia nitrogen is however very volatile, meaning it easily diffuses in the air. This process, called volatilization, is the first cause of indirect N_2O emissions. The second process, through leaching or run-off, occurs when nitrogen is transported outside of the manure management system.

In the case of Guyana, the Tier 1 method was used for the calculation of N volatilisation in forms of NH3 and NOx from manure management systems. It is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each manure management system by a fraction of volatilised nitrogen from the 2019 Refinement of the 2006 IPCC Guidelines. N losses are then summed over all manure management systems.

The Tier 1 calculation of N leached and runoff from manure management systems is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each manure management system by a fraction of nitrogen leached, in analogy to the approach to estimate nitrogen volatilisation.

The Tier 1 method is applied using default nitrogen excretion data, default manure management system data and default fractions of N losses from manure management systems due to volatilisation from the 2019 Refinement of the 2006 IPCC Guidelines.

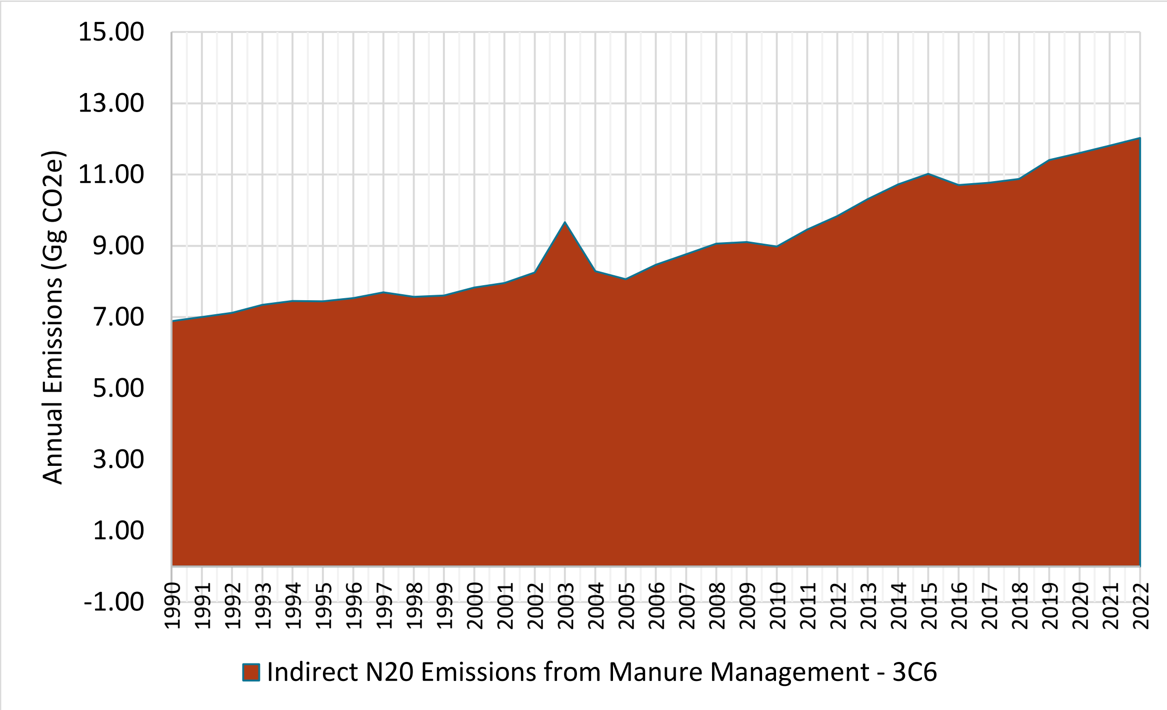

Figure 2.34. Category 3C6 GHG emissions.

Table 2.51. Summary of GHG emissions from Category 3C6 – Indirect N2O Emissions from Manure Management.

	Annual Emissions in Gg $CO_{2}e$										
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Indirect N2O Emissions from Manure Management – 3C6	6,89	7,00	7,12	7,35	7,45	7,44	7,54	7,70	7,56	7,60	7,83
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Indirect N2O Emissions from Manure Management – 3C6	7,95	8,25	9,66	8,29	8,07	8,47	8,77	9,06	9,11	8,98	9,46
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Indirect N2O Emissions from Manure Management – 3C6	9,83	10,31	10,73	11,02	10,71	10,77	10,88	11,41	11,61	11,81	12,02

The emissions associated to the Category 3C6 - Indirect N_2O Emissions from Manure Management represent a minimal fraction of Guyana´s GHG inventory. The trends observed from 1990 to 2002 indicate a generally consistent upward trajectory, marked by a significant surge in 2003, followed by a more moderate increase in 2005. The values have doubled from 1990 to 2022, underscoring a substantial overall growth.

Rice cultivations (3C7)

Rice production in different ecosystems can produce CH_4 emissions at varied levels depending on flooded soil environment and agricultural practices. The emissions are caused by anaerobic decomposition of organic material in flooded rice fields which escape to the atmosphere by transport through the rice plants. Those cultivated in lowland have the higher potential to produce CH_4 because of the aerobic condition created by intermittent inundation of the rice field. The determining factors of CH_4 emission in upland rice system or under irrigation are the slope and the dwell time of available water to the rice.

Therefore, the potential of CH_4 emissions from rice cultivation is influenced by the fraction of the total rice cultivation areas under rain fed, irrigation and upland, the prevailing management practices which include the number and duration of crops grown, water regimes before and during cultivation period, and organic and inorganic soil amendments and the environmental conditions such as soil type and temperature.

The Tier 1 methodology was deployed for estimating CH_4 emissions from rice in Guyana, and the default parameters provided in Chapter 5 of the AFOLU sector dedicated to Cropland. The water cultivation of rice was obtained from the Guyana Rice Development Board (GRDB), it follows mainly an irrigated regime with two cultivation seasons of 80-85 days per year.

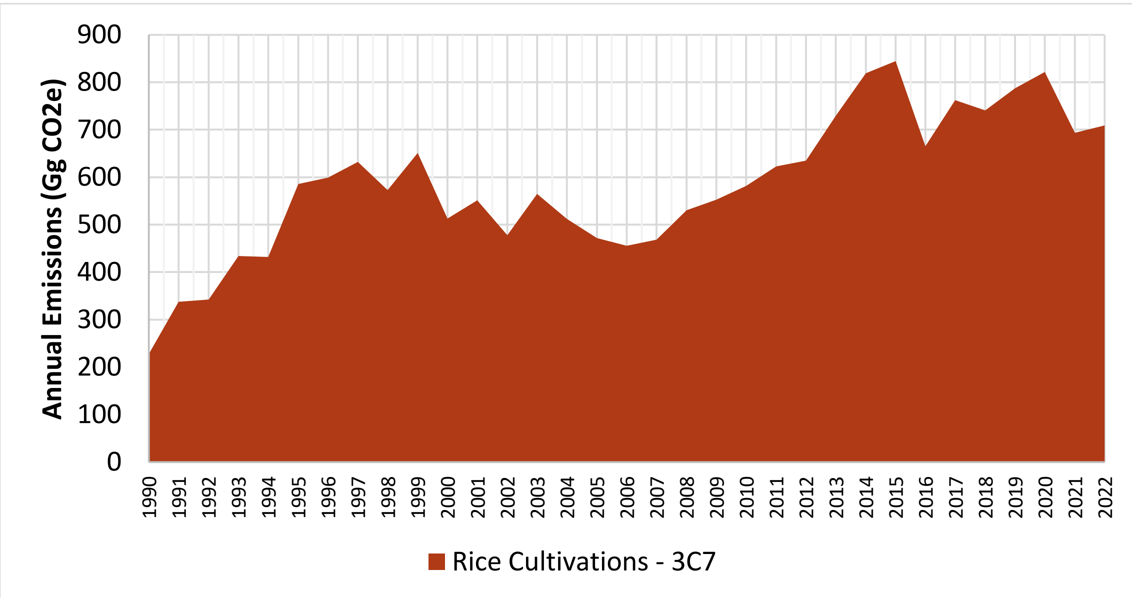

Figure 2.35. Category 3C7 GHG emissions.

Table 2.52. Summary of GHG emissions from Category 3C7 – Rice Cultivations.

	Annual Emissions in Gg CO_2e										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Rice Cultivations – 3C7	227,31	337,23	342,18	433,93	432,15	585,63	599,32	631,82	572,91	650,80	512,74
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Rice Cultivations – 3C7	551,21	477,48	564,92	512,17	471,91	455,49	468,46	530,09	552,34	581,51	622,49
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Rice Cultivations – 3C7	634,50	729,29	818,73	844,26	664,84	762,24	740,58	786,83	821,75	693,35	708,62

The GHG emissions from Category 3C7 – Rice Cultivations constitute the largest source of CH_2 emissions in the AFOLU sector and emissions have increased between 1990 and 2022. The increase has been marked by a steady growth of emissions from 227,31 Gg CO_2 eq. in 1990 to 650,80 Gg CO_2 eq. in 1999 after which a significant drop was observed in 2000. The emissions only reached the 1999 levels again in 2013 and have since then fluctuated, growing to its maximum level of 844,26 Gg CO_2 in 2015 and reaching about 708,62 Gg CO_2 eq. in 2022.

Table 2.53. Uncertainty in GHG Emissions from Category 3C – Aggregated sources and non-CO_2 sources from land.

Parameter	Uncertainty
Fuel biomass consumption value for fires (N_2O & CH_4)	141%
Emission factor for dry matter burnt	116%
Global Warming Potential (N_2O & CH_4)	71%
Emission factor for liming	-50%
Emission factor for urea	-50%
EF_1 for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil as a result of loss of soil carbon	80%
EF_{1FR} for flooded rice fields	363%
$EF_{3PRP, CPP}$ for cattle (dairy, non-dairy and buffalo), poultry and pigs	175%
$EF_{3PRP, SO}$ for sheep and 'other animals'	167%
Default values for N excretion rate (N_{rate})	50%
Default values for live weights for animal categories (TAM)	30%
Emission factor N volatilisation and re-deposition (EF_4)	21%
Emission factor N leaching/runoff (EF_5)	91%
Emission factor for the category 3C7	39%
Default CH4 emission scaling factors for water regimes during the cultivation period relative to continuously flooded fields	28%
Default CH4 emission scaling factors for water regimes before the cultivation period	12%
Default conversion factor for type of organic amendment	16%

6.4. Waste

6.4.1. Description of Sector

The waste sector of Guyana encompasses all GHG emissions arising from the treatment and disposal of both solid wastes and liquid wastes in the country. The waste sector of Guyana has undergone a transformational change over the past five decades and continues evolving towards the attainment of national long-term sustainable and low-carbon development goals as stipulated in the National Solid Waste Management Strategy.

Solid Waste

Solid waste management in Guyana is an important source of CH_4 emissions from the anaerobic decomposition of organic matter at solid waste disposal sites (SWDS). Combustion of all types of waste is also a significant source of CH_4 and N_2O emissions, in addition to CO_2 from the combustion of fossil-based (non-biogenic) waste fractions.

There are three main types of waste generated and treated in Guyana, namely municipal solid waste (MSW), industrial and hazardous waste, and healthcare waste. Due to limited information on industrial, hazardous, and healthcare waste generation, composition, and disposal practices in the country, the present edition of the GHG inventory of Guyana only accounts for MSW.

Municipal solid waste is defined as all waste that is typically collected by local authorities generated from households, commercial institutions, public institutions, as well as green (garden/park) waste, and wastes from construction and demolitions sites. According to the Guyana Solid Waste Management Strategy (Ministry of Local Government and Regional Development, 2013), the MSW generation rates in Guyana varies by region, depending on the share of urban and rural population and the presence of waste from commerce and institutions. For regions 1, 3, 5, 7, 8, and 9, household waste generation rates up to 2010 were estimated at 0.5 kg/person/day and expected to gradually increase to 0.59 kg/person/day by 2024. For regions 2, 4, 6, and 10, the household and commercial waste generation rates up to 2010 were estimated at 0.73 kg/person/day and 0.71 kg/person/day, expected to gradually increase to 0.86 kg/person/day and 0.84 kg/person/day by 2024, respectively.

A comprehensive study was conducted in 2010 by Hydropal-CEMCO Inc. on the MSW composition for Georgetown (Hydroplan CEMCO, Inc., 2010), whereby half of the total waste generated is comprised of food waste, 10% comprised of paper and cardboard, and 25% comprised of plastics and insert wastes, as detailed in Figure 2.36. Such waste distribution was adopted throughout the time series for the entire country, in absence of additional data.

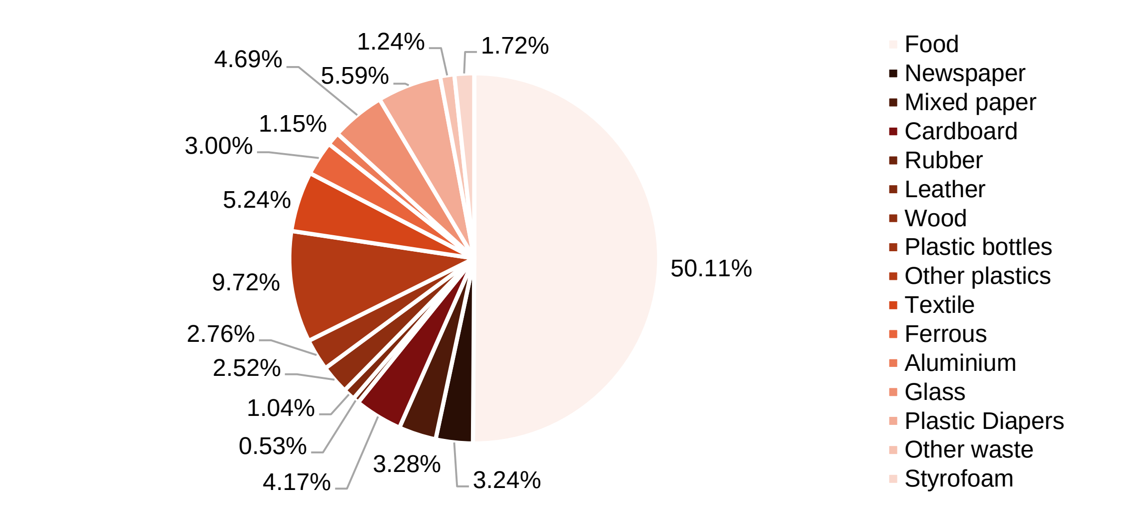

Figure 2.36. Municipal solid waste composition in Georgetown in 2010. Source: (Hydroplan CEMCO, Inc., 2010)

The main MSW disposal methods in Guyana are sanitary landfilling, controlled dumping, open dumping, and open burning.

Approximately 83% of all MSW is deposited at solid waste disposal sites (SWDS). Until 2011, approximately 60% of SWDS were considered controlled dumps with organized waste disposition, compacting and soil coverage at various development conditions. The remaining 40% were considered open dumps, whereby open burning may be observed on particular instances, particularly in rural areas, as per the IPCC default. This includes instances of littering and illegal dumping in drains, parapets, and vacant lots. Efforts are being made to enforce existing legislation marking the illegality of such activities and several ongoing nationwide anti-littler and clean-up campaigns. Due to a lack of information on particular operating conditions at controlled and open dumps, these were classified as “uncategorized SWDS” with a methane correction factor (MCF) of 0.6 as per the IPCC definition. The Haags Bosch Sanitary Landfill was commissioned in 2011 at Eccles in Region 4, covering an area of 50 hectares with a waste fill area of 26 hectares. With an expected lifetime of 25 years, operating conditions at the Haags Bosch landfill are classified at “managed anaerobic SWDS” as per the IPCC definition, featuring waste compaction, application of daily and intermediate soil cover, and leachate treatment, for a methane correction factor (MCF) of 1.0. No CH_4 recovery or flaring takes place at the site. Since commissioning in 2011, the landfill maintains detailed records (Haags Bosch Landfill Operators, 2023) of waste quantities and composition deposited on a monthly basis, including institutional, industrial, commercial, healthcare, household, and construction and demolition wastes. The amount of waste received at the landfill has significantly increased since commissioning, whereby MSW represents approximately 60% of the total quantity of waste deposited at the site. Upon commissioning in 2011, the site received an approximate 350 tonnes of waste on a daily basis, increasing to over 600 tonnes by 2019 and 750 tonnes by 2023. In all instances, it is assumed no oxidation takes place in soil layers as per the IPCC default. It is worth noting that Guyana is conducting ongoing efforts over the past several years to rehabilitate open dumps and expand access to waste collection services.

An approximate 13% of all MSW is directly opened burned in Guyana, particularly in rural communities according to recent evaluation of waste dynamics at the local level (Oyedotun et al., 2021).

The remaining 4% of MSW is either recycled, composted, or treated under unspecified methods at pilot or local scales seeking to commercialize or being large-scale deployment across the country, as envisioned by the Guyana Solid Waste Management Strategy (Ministry of Local Government and Regional Development, 2013). Due to a lack of information on these practices, associated emissions have not been included in the present edition of the Guyana GHG inventory. Some of these ongoing activities include:

- Beverage bottle return programme by Banks DIH.
- Cardboard recycling programme by Caribbean Container Incorporated treating approximately 51% of the total cardboard waste generated in Georgetown.
- Scrap metal recycling coordinated through the Guyana Recycler´s Association.
- Pilot-scale recycling programmes by the Institute of Applied Science and Technology for plastics and sawdust, conversion of vegetable and animal waste into biodiesel and biogas, and processing used tyres for alternate pavement manufacturing.
- Pilot-scale composting programmes for homes, schools, and communities.

Figures 2.37 and 2.38 summarize the MSW management streams for Guyana before and after the commissioning of the Haags Bosch landfill in 2011.

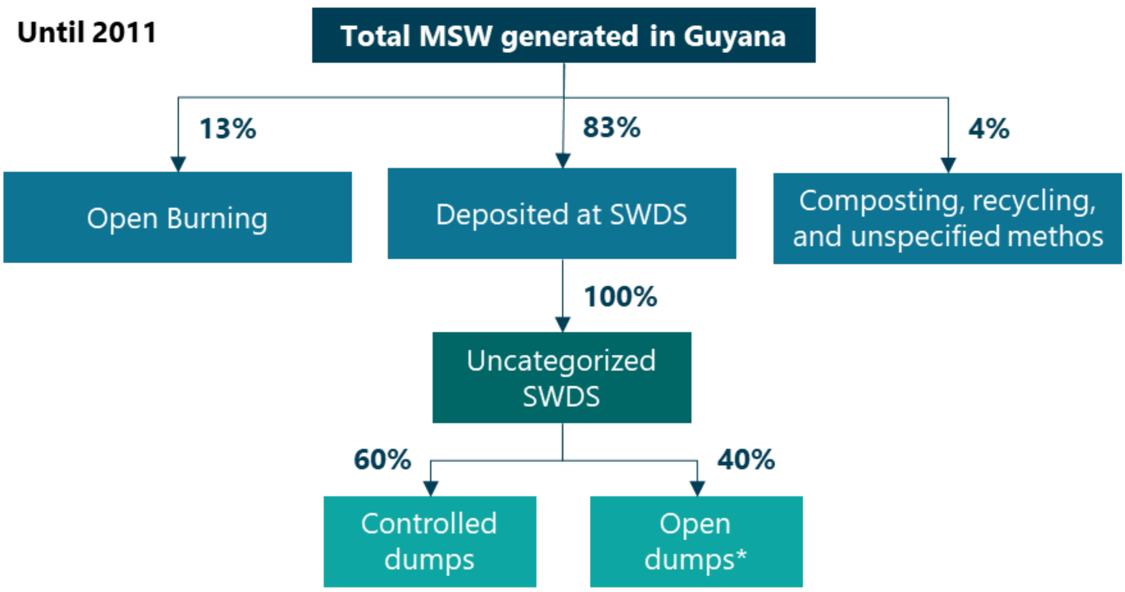

*Figure 2.37. MSW treatment systems in Guyana until commissioning of Haags Bosch Landfill in 2011. *Assuming sporadic occurrences of open burning at open dumps as per IPCC default.*

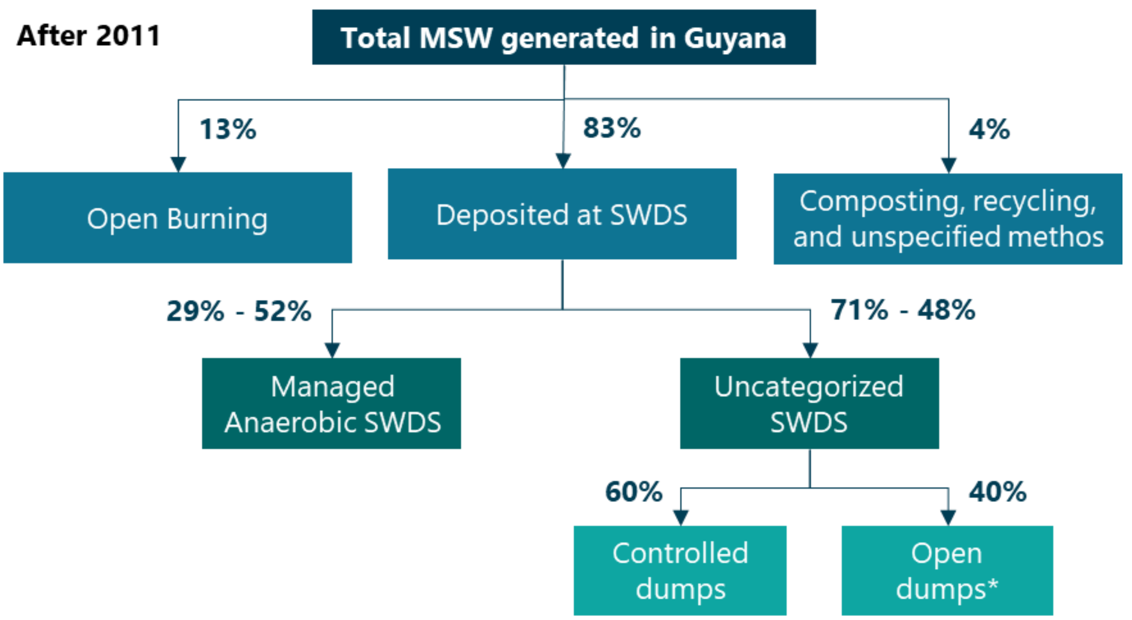

*Figure 2.38. MSW treatment systems in Guyana following commissioning of Haags Bosch Landfill in 2011. *Assuming sporadic occurrences of open burning at open dumps as per IPCC default.*

CH_4 emissions from MSW decomposition at SWDS were estimated using the IPCC First Order Decay (FOD) model implementing the above country-specific activity data for a complete historic time series starting in the year 1950. Default IPCC parameters were adopted in terms of degradable organic carbon (DOC), fraction of DOC dissimilated (DOCf), and CH_4 generation rate constant (k) for each waste component, as summarized in Table 2.54. The default 6-month delay time, 50% fraction of CH_4 in developed biogas, and tropical wat & moist climate zone were also adopted.

Table 2.54. Default IPCC waste characteristics parameters applied in the FOD model.

Waste component	Degradable organic carbon (DOC)	Fraction of DOC dissimilated (DOCf)	Methane generation rate constant (k)
Food	0.15	0.5	0.40
Garden	0.20	0.5	0.17
Paper	0.40	0.5	0.07
Wood	0.43	0.5	0.035
Textiles	0.24	0.5	0.07
Nappies	0.24	0.5	0.17
Plastic & Inerts	NA	NA	NA
Source	2006 IPCC Guidelines	2019 IPCC Refinement	2019 IPCC Refinement

CO_2 emissions from open burning of MSW were estimated using2006 IPCC default values of dry matter content, carbon fraction in dry matter, and fossil carbon fraction in total carbon as summarized Table 2.55, in addition to a default oxidation factor of 0.71 from the 2019 IPCC Refinement. A default CH_4 emission factor of 0.0065 kg CH_4/ kg MSW wet basis and N_2O emission factor of 0.00015 kg N_2O/ kg MSW dry basis were adopted.

Table 2.55. Default IPCC waste characteristics parameters applied for estimating emissions from open burning of waste.

Waste component	Dry matter content (dm)	Carbon fraction in dry matter (CF)	Fossil carbon fraction in total carbon (FCF)
Food	0.40	0.38	0.00
Paper	0.90	0.46	0.01
Wood	0.85	0.50	0.00
Textile	0.80	0.50	0.20
Nappies	0.40	0.70	0.10
Rubber & Leather	0.84	0.67	0.20
Plastics	1.00	0.75	1.00
Metal	1.00	NA	NA
Glass	1.00	NA	NA
Other Inert	0.90	0.03	1.00
Source	2006 IPCC Guidelines	2006 IPCC Guidelines	2006 IPCC Guidelines

Industrial and hazardous waste is defined as all waste that is generated by industrial facilities and disposed of together or separately with MSW at open and controlled dumps throughout the country. There is limited information available on industrial waste generation and treatment in Guyana, and as such, associated emissions have not been estimated in the present edition of the GHG inventory. A hazardous waste inventory was conducted in 2007 by the Caribbean Environmental Health Institute (Caribbean Environmental Health Institute, 2009) on selected industrial sectors, excluding mining, revelling annual generation of 317 tonnes of waste oils and hydrocarbon mixtures and emulsions, 180 tonnes of organic solvent by-products, and 0.53 tonnes of acidic solutions or solids. Another study (SENES Consultants Ltd., 2010) for some sectors was conducted for Region 4 in 2010 revealed an annual 515 tonnes of industrial solid waste and 494 tonnes of semi-solid hazardous waste. However, it is believed actual generation rates may be higher as these surveys did not capture all sectors and economic activity in the country has since significantly expanded.

Healthcare waste is defined as waste generated from healthcare facilities, comprised of approximately 80% non-hazardous components similar to MSW and 20% hazardous components including infectious and pathological waste (15%), sharps (1%), chemicals, and pharmaceuticals (3%), and genotoxic and radioactive fractions (1%) (WHO, 2011). There is limited information available on healthcare waste generation and treatment in Guyana, and as such, associated emissions have not been estimated in the present GHG inventory edition. For planning purposes, the World Health Organization (WHO, 2011) suggests that low-income countries generate between 0.2 and 0.8 kg of hazardous waste per hospital bed per day. According to the Guyana Bureau of Statistics (2013), there are a total 1,932 hospital beds in the country, translating to an estimated 141-564 tonnes of healthcare waste generated on an annual basis.

Guyana´s principal healthcare facilities implement Hydroclaves to sterilize infectious waste fractions, disposed of as inert waste as part of MSW. Other larger facilities have rudimentary on-site waste incinerators at various states of despair to treat infectious wastes, while others conduct open burning. Most pharmaceutical wastes are either incinerated under supervision of the Ministry of Health´s Food and Drug Department. In general, there are no appropriate protocols or systems in place to manage other non-infectious healthcare waste fractions.

Liquid Waste

Wastewater treatment and discharge in Guyana is an important source of CH_4 emissions from the anaerobic decomposition of organic matter in wastewater (sewage), as well as N_2O emissions from the subsequent nitrification and denitrification of nitrogen in effluent released to rivers and estuaries attributed to dietary protein consumption. The governance of water resources is guided by the Water and Sewerage Act 2002, and primarily managed by Guyana Water Incorporated (GWI). Currently, investment in water and sanitation is based on the guidance of the Water and Sanitation Sector Strategic Plan 2017 – 2021.There are three main types of domestic wastewater treatment and discharge pathways in Guyana, namely sewerage systems, septic systems, and latrines, whereby no CH_4 recovery or flaring takes place. The current sewerage system in Guyana covers only a limited proportion of the population in Georgetown, with the collected wastewater directly released into the ocean environment at sewage outfalls at a default IPCC methane correction factor (MCF) of 0.11. The remainder of the population utilizes on-site decentralized treatment systems such as septic tanks (default MCF of 0.50) and latrines (default MCF of 0.70). Sanitation methods have substantially improved over the past three decades, with a significant proportion of the population upgrading from pit latrines to septic sewage systems as illustrated in Figure 2.39.

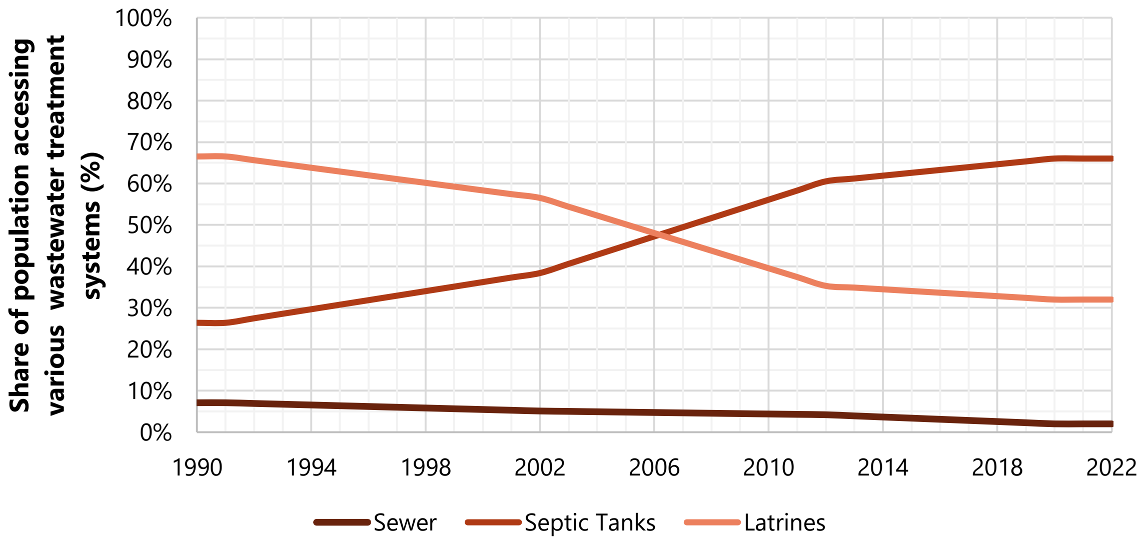

Figure 2.39. Sare of population accessing various wastewater treatment systems in Guyana, extracted from the Guyana Bureau of Statistics 2002 and 2012 census, and the Guyana Country Estimate report for SDG6 Monitoring.
Source: (WHO, 2020).

Both GWI and the Puran Brothers conduct sludge collection services from septic systems throughout the country, to be deposited at SWDS, treated separately, or applied to agricultural fields as soil amendment. However, records of sludge collection rates and application methods are extremely limited and have only become scarcely available since 2017. As such, the present edition of the Guyana GHG emission inventory does not account for sludge removal as per the IPCC default.

Accurate records on wastewater characteristics, in terms of Biochemical Oxygen Demand (BOD), are also limited for which the default IPCC value of 40 g/person/day for the Latin America Region has been adopted. The IPCC default maximum CH_4 producing capacity (Bo) of 0.6 kg CH_4/kg BOD has also been adopted.

Information on industrial wastewater generation and treatment is more notably scarce, for which associated emission have not been estimated in the present edition of the Guyana GHG inventory. However, the potential disposal industrial wastewater into domestic treatment systems has been accounted for through the IPCC default correction factor for additional industrial BOD discharged into domestic systems (I) of 1.25 for sewerage systems and 1.0 for septic systems and latrines.

According to FAO statistics (2023), the dietary protein supply in Guyana steadily increased between 1990 and 2022 from 66 to 108 g/person/day. Using the 2019 IPCC default correction factor for protein consumption as a fraction of protein supply for the Latin American Region of 0.92, this is translated to a dietary protein consumption of 22 g/person/day in 1990, increased to 36 g/person/day by 2022.

Default parameters from the 2019 IPCC Refinement were adopted to estimate associated N_2O emissions from effluent, including:

- Additional nitrogen from household chemicals, N_{HH} = 1.1
- Factor for non-consumed protein added to the wastewater, $F_{NON\text{-}CON}$ =1.04
- Factor for industrial and commercial co-discharged protein, $F_{IND\text{-}COM}$ = 1.25 for sewerage and 1.0 for septic systems and latrines.
- Fraction of N removed by treatment system (N_{REM}) = 0 for sewerage and direct ocean disposal, 0.15 for septic systems, and 0.12 for latrines
- EF effluent = 0.005 kg N_2O-N/kg N

6.4.2. Coverage of Sector

Figure 2.40 illustrates the coverage of the Guyana waste sector GHG emissions inventory.

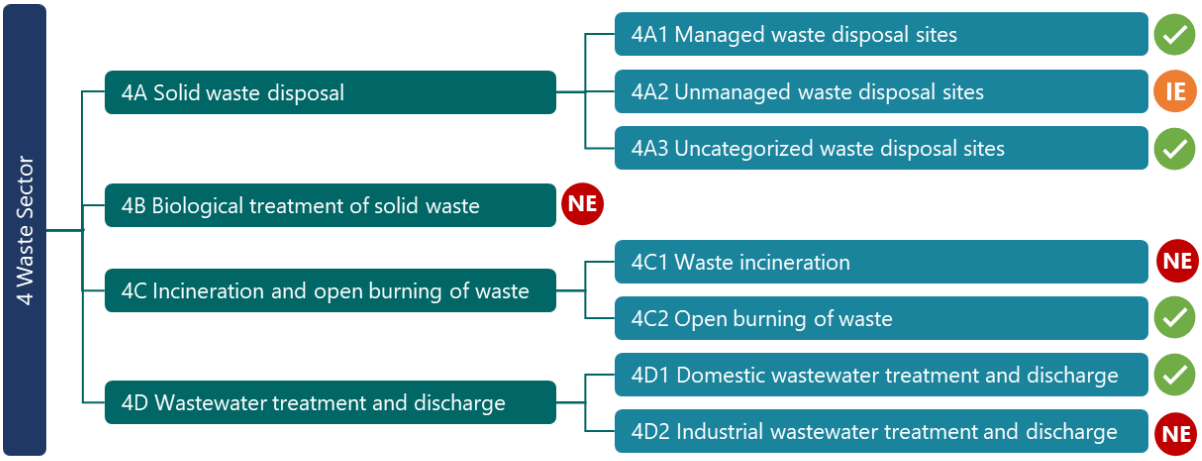

Figure 2.40. Coverage of the Guyana Waste sector GHG emissions inventory. NE – not Estimated; NO – not occurring; IE – included elsewhere; NA – not applicable.

Category 4A - Solid Waste Disposal covers the CH_4 emissions from the anaerobic decomposition of degradable fractions of municipal solid waste (MSW). **Category 4A1 – Managed Solid Waste Disposal Sites** covers includes emissions from the Haags Bosch Landfill operating since 2011. **Category 4A3 – Uncategorized Solid Waste Disposal Sites** covers emissions from Guyana´s controlled and open dumps, which were unable to be classified as per IPCC definitions due to limited information of the site´s operating conditions.

While small-scale composting initiatives exist throughout Guyana, associated emissions under **Category 4B - Biological Treatment of Solid Waste** were not estimated due to a significant lack of reliable data.

Category 4C - Incineration and Open Burning of Waste covers the CH_4, N_2O, and non-biogenic CO_2, emissions from open burning of waste directly taking place throughout the country, as well as the sporadic instances of open burning possibly occurring in Guyana´s open dumps, under **Category 4C2.** While incineration of healthcare waste occurs to a limited degree across Guyana´s healthcare facilities, associated emissions under **Category 4C1** were not estimated due to a significant lack of data.

Category 4D - Wastewater Treatment and Discharge covers the CH_4 emissions from domestic wastewater and discharge and N_2O emissions from the decomposition of nitrogen compounds in effluent under **Category 4D1**. **Category 4D2** was not estimated as no information is currently available on the existence of in-situ industrial wastewater treatment within industrial sites in Guyana.

6.4.3. Summary of Sector Emissions

In 2022, the waste sector represented 2.97% of total emissions in Guyana, being the third largest source of GHG emissions in the country following the energy and AFOLU sectors, as illustrated in Figure 2.41. The waste sector accounts for 10.51% of the total national CH_4 emissions, 2.13% of the total national N_2O emissions, and only 0.06% of the total national CO_2 emissions.

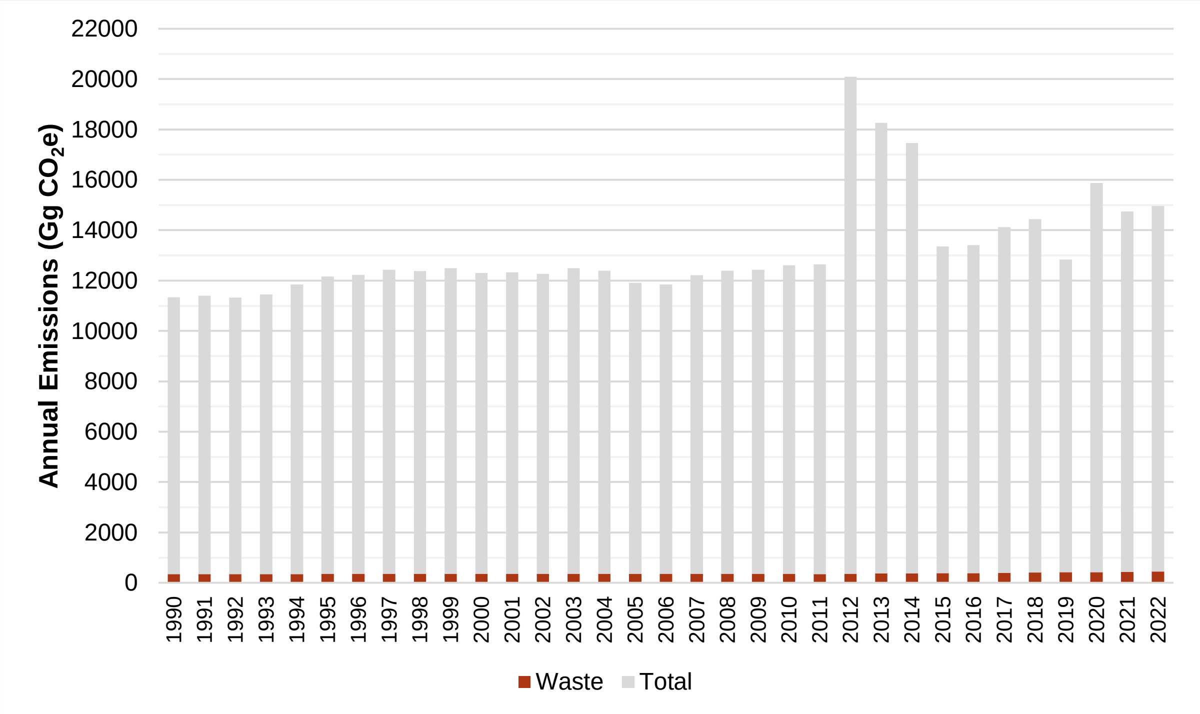

Figure 2.41. Contribution of waste sector emissions to national emission totals.

Figures 2.42 and 2.43 and Table 2.56 summarize sectoral emission trends by category and gas.

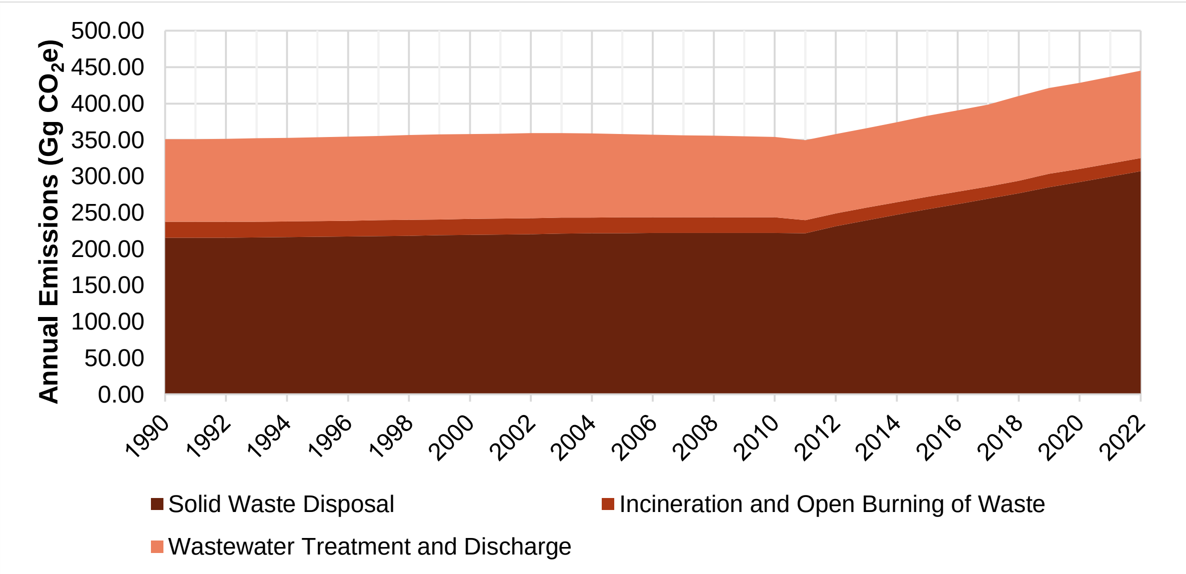

Figure 2.42. Total GHG emissions from the waste sector by category.

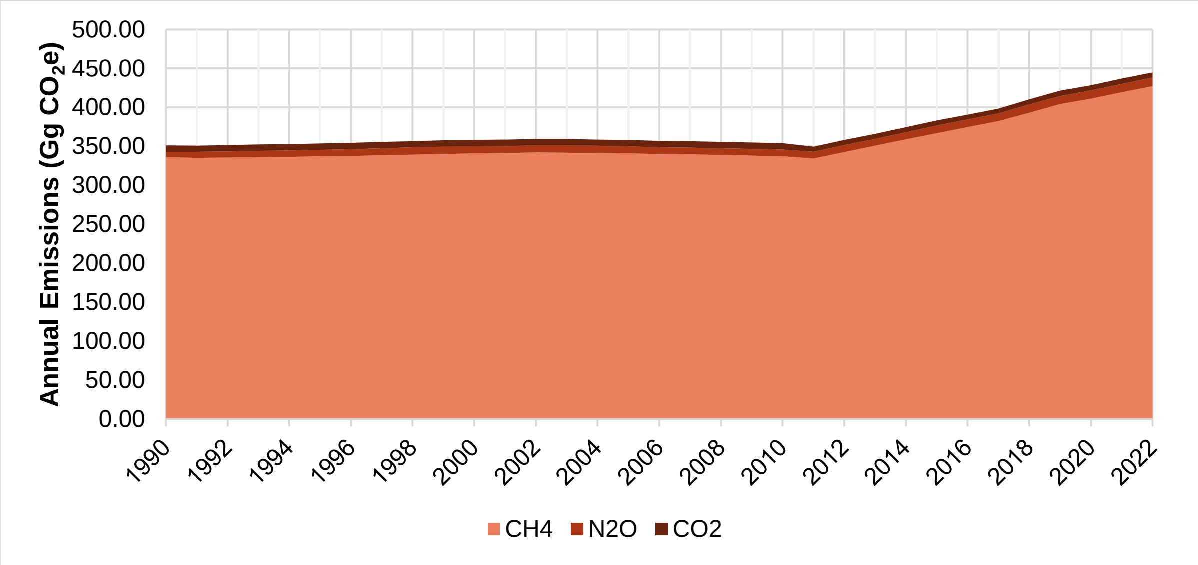

Figure 2.43. Total GHG emissions from the waste sector by gas.

Total emissions from the waste sector have increased by 26.75% from 351.04 Gg CO_2e in 1990 to 444.94 Gg CO_2e in 2022. Such increase is due to a significant increment in emissions from solid waste disposal (Category 4A) attributed to population growth, a continued increase in solid waste generation rates, and the commissioning of the Haags Bosch Landfill in 2011. While the landfill is a significant milestone for improved sanitation contributing to both environmental and human health, its anaerobic operating conditions have significantly increased the CH_4 generation potential of waste deposited therein. In 1990, Category 4A accounted for 215.51 Gg CO_2e (61.39% of total sectoral emissions), increasing by 42.44% to 306.98 Gg CO_2e (68.99% of total sectoral emissions) by 2022.

Emissions from wastewater treatment and discharge (Category 4D) have remained fairly stable with a 5.54% growth from 113.82 Gg CO_2e in 1990 to 120.12 Gg CO_2e in 2022. However, the share of Category 4D emissions on sectoral totals has actually decreased from 32.42% in 1990 to 27.00% in 2022, attributed to improved sanitation facilities.

On the other hand, emissions from open burning of waste (Category 4C) observed a notable 17.85% reduction from 21.72 Gg CO_2e in 1990 to 17.85 Gg CO_2e by 2022, attributed to ongoing rehabilitation of open dumps and anti-litter and illegal dumping campaigns reducing the incidence of open burning in the country. As such, the contribution of Category 4C to sectoral totals have decreased from 6.19% in 1990 to 4.01% in 2022.

CH_4 remains the most important GHG in the Waste Sector. In 2022, a total of 427.28 Gg CO_2e of CH_4, 11.05 Gg CO_2e of N_2O and 6.62 Gg CO_2e of CO_2 were emitted, representing 96.03%, 2.48%, and 1.49% of total sectoral emissions, respectively.

Table 2.56. Total GHG emissions from the waste sector by category and gas.

Category	Gas	Annual emissions in Gg CO_2e															
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4 WASTE	CO_2	8.05	8.01	8.03	8.04	8.05	8.07	8.08	8.09	8.11	8.12	8.13	8.15	8.16	8.14	8.13	8.11
	CH_4	335.79	335.32	335.51	335.91	336.45	337.08	337.76	338.48	339.21	339.95	340.69	341.43	342.16	341.90	341.47	340.92
	N_2O	7.21	7.44	7.98	8.36	8.28	8.41	8.51	9.00	9.29	9.48	9.39	9.00	9.14	9.45	9.12	9.09
	Total	351.04	350.78	351.52	352.31	352.79	353.56	354.36	355.57	356.61	357.55	358.21	358.57	359.45	359.49	358.71	358.12
4A Solid Waste Disposal	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	215.51	215.59	215.59	215.80	216.16	216.60	217.11	217.64	218.20	218.76	219.33	219.89	220.45	221.00	221.38	221.63
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	215.51	215.59	215.59	215.80	216.16	216.60	217.11	217.64	218.20	218.76	219.33	219.89	220.45	221.00	221.38	221.63
4B Biological Treatment of Solid Waste	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	CO_2	8.05	8.01	8.03	8.04	8.05	8.07	8.08	8.09	8.11	8.12	8.13	8.15	8.16	8.14	8.13	8.11
	CH_4	12.00	11.95	11.97	11.99	12.01	12.03	12.05	12.07	12.09	12.10	12.12	12.14	12.16	12.14	12.11	12.09
	N_2O	1.67	1.66	1.66	1.66	1.67	1.67	1.67	1.67	1.68	1.68	1.68	1.69	1.69	1.68	1.68	1.68
	Total	21.72	21.62	21.65	21.69	21.73	21.76	21.80	21.83	21.87	21.90	21.94	21.97	22.01	21.96	21.92	21.88
4D Wastewater Treatment and Discharge	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	108.28	107.79	107.96	108.12	108.29	108.45	108.61	108.77	108.93	109.08	109.24	109.39	109.54	108.76	107.98	107.20
	N_2O	5.54	5.78	6.32	6.70	6.62	6.74	6.84	7.32	7.61	7.80	7.71	7.32	7.45	7.76	7.44	7.41
	Total	113.82	113.57	114.28	114.82	114.90	115.19	115.45	116.09	116.54	116.88	116.94	116.71	116.99	116.52	115.42	114.61

Category	Gas	Annual emissions in Gg CO_2e																
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
4 WASTE	CO_2	8.09	8.08	8.06	8.04	8.03	6.62	6.53	6.45	6.41	6.37	6.33	6.29	6.47	6.87	6.72	6.71	6.62
	CH_4	340.27	339.55	338.78	337.97	337.11	334.15	342.58	350.81	358.89	366.80	374.65	382.52	393.22	404.26	410.93	419.13	427.28
	N_2O	8.61	8.74	8.77	8.74	8.76	8.67	8.97	8.68	9.19	9.90	9.67	9.74	10.50	10.30	10.73	11.02	11.05
	Total	356.98	356.37	355.62	354.75	353.91	349.44	358.08	365.94	374.48	383.06	390.66	398.56	410.19	421.43	428.38	436.86	444.94
4A Solid Waste Disposal	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	221.79	221.88	221.91	221.90	221.84	221.76	231.10	239.35	246.95	254.36	261.68	269.00	276.37	284.98	292.05	299.26	306.98
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	221.79	221.88	221.91	221.90	221.84	221.76	231.10	239.35	246.95	254.36	261.68	269.00	276.37	284.98	292.05	299.26	306.98
4B Biological Treatment of Solid Waste	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Total	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4C Incineration and Open Burning of Waste	CO_2	8.09	8.08	8.06	8.04	8.03	6.62	6.53	6.45	6.41	6.37	6.33	6.29	6.47	6.87	6.72	6.71	6.62
	CH_4	12.06	12.04	12.01	11.99	11.97	9.86	9.73	9.62	9.55	9.49	9.44	9.38	9.65	10.24	10.02	10.01	9.86
	N_2O	1.67	1.67	1.67	1.66	1.66	1.37	1.35	1.33	1.33	1.32	1.31	1.30	1.34	1.42	1.39	1.39	1.37
	Total	21.83	21.79	21.74	21.70	21.65	17.85	17.61	17.40	17.28	17.18	17.08	16.98	17.46	18.52	18.12	18.11	17.85
4D Wastewater Treatment and Discharge	CO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH_4	106.42	105.64	104.86	104.08	103.30	102.53	101.75	101.85	102.38	102.95	103.53	104.13	107.20	109.04	108.87	109.87	110.44
	N_2O	6.94	7.07	7.11	7.08	7.10	7.30	7.62	7.34	7.86	8.58	8.36	8.44	9.16	8.88	9.34	9.63	9.68
	Total	113.36	112.71	111.97	111.16	110.41	109.83	109.37	109.19	110.24	111.53	111.90	112.57	116.37	117.93	118.21	119.50	120.12

6.4.4. Description of Emissions by Category

Solid Waste Disposal (4A)

This category covers the CH_4 emissions from the anaerobic decomposition of degradable fractions of municipal solid waste (MSW) in Guyana´s managed anaerobic solid waste disposal site (SWDS), namely the Haags Bosch Landfill under Category 4A1, as well as all uncategorized SWDS encompassing controlled and open dumps under Category 4A3. Category results are summarized in Figure 2.44 and Table 2.57.

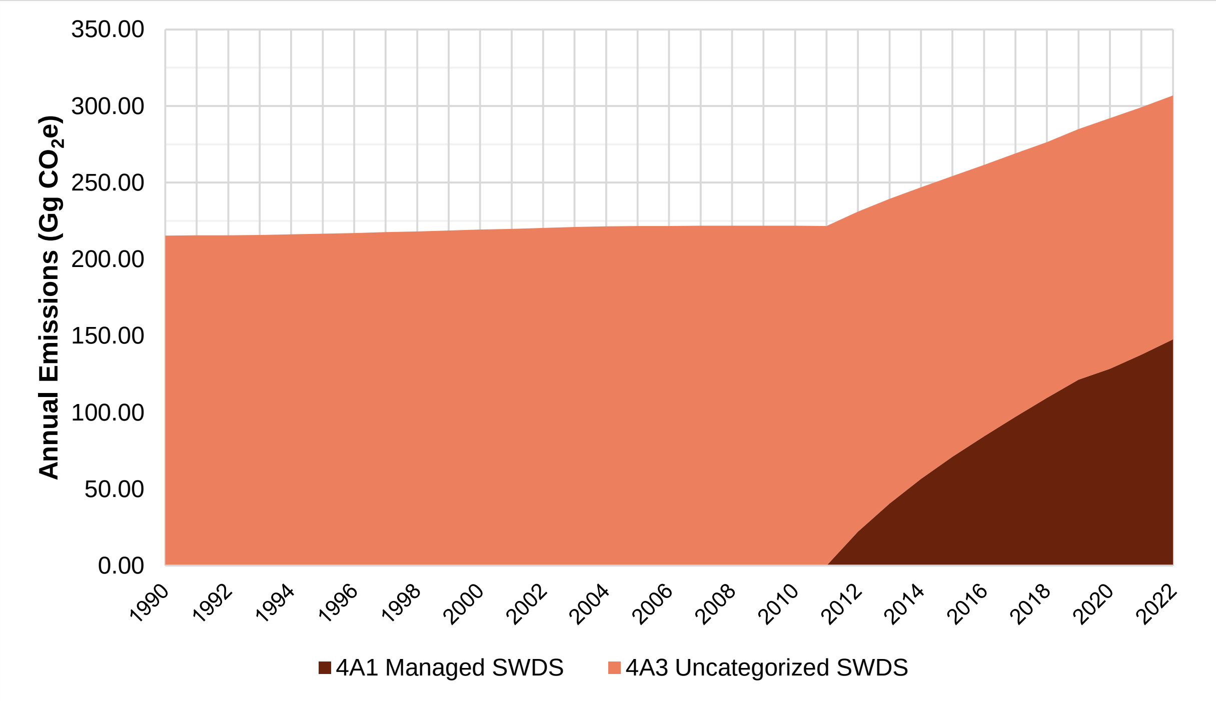

Figure 2.44. Category 4A GHG emissions by SWDS type.

Table 2.57. Summary of GHG emissions from Category 4A – Solid Waste Disposal.

Annual Emissions in Gg CO_2e								
Category	**GHG**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
4A1 Managed SWDS	CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH_4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH_4	215.51	215.59	215.59	215.80	216.16	216.60	217.11
4A SOLID WASTE DISPOSAL	CH_4	215.51	215.59	215.59	215.80	216.16	216.60	217.11
Category	**GHG**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
4A1 Managed SWDS	CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH_4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH_4	217.64	218.20	218.76	219.33	219.89	220.45	221.00
4A SOLID WASTE DISPOSAL	CH_4	217.64	218.20	218.76	219.33	219.89	220.45	221.00
Category	**GHG**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
4A1 Managed SWDS	CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH_4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH_4	221.38	221.63	221.79	221.88	221.91	221.90	221.84
4A SOLID WASTE DISPOSAL	CH_4	221.38	221.63	221.79	221.88	221.91	221.90	221.84

Category	GHG	2011	2012	2013	2014	2015	2016	2017
4A1 Managed SWDS	CH_4	0.00	22.17	40.65	56.69	71.13	84.51	97.22
4A2 Unmanaged SWDS	CH_4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH_4	221.76	208.93	198.69	190.26	183.23	177.17	171.79
4A SOLID WASTE DISPOSAL	CH_4	221.76	231.10	239.35	246.95	254.36	261.68	269.00

Category	GHG	2018	2019	2020	2021	2022
4A1 Managed SWDS	CH_4	109.50	121.52	128.63	137.73	147.73
4A2 Unmanaged SWDS	CH_4	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH_4	166.87	163.47	163.42	161.52	159.25
4A SOLID WASTE DISPOSAL	CH_4	276.37	284.98	292.05	299.26	306.98

Solid waste disposal is the main contributor of GHGs within the waste sector. In 2022, Category 4A accounted for 71.85% of CH_4 emissions and 68.99% of the total emissions from the waste sector. A 42.44% growth in solid waste disposal emissions is observed from 215.51 Gg CO_2e in 1990 to 306.98 Gg CO_2e in 2022. There are three main drivers for this increasing trend:

- Population growth: As the population of Guyana continues to grow, the total quantity of waste generated in the country is increasing accordingly.
- Increased solid waste generation rates: Urbanization and economic development is leading to more elevated per capita MSW generation rates throughout all parts of the country.
- Commissioning of the Haags Bosch landfill: While the landfill is a significant milestone for improved sanitation contributing to both environmental and human health, its anaerobic operating conditions have significantly increased the CH_4 generation potential of waste deposited therein, compared to open and controlled dumps.

Prior to 2011, all sectoral emissions were attributed to Category 4A3, observing a steady 2.9% growth from 215.51 Gg CO_2e in 1990 to 221.76 Gg CO_2e in 2011. Upon commissioning of the Haags Bosch Landfill in 2011, emissions from Category 4A1 began to rise logarithmically as expected under the FOD model to 147.73 Gg CO_2e in 2022. Meanwhile, emissions from Category 4A3 reduced by 28.19% during this period to 159.25 Gg CO_2e in 2022, as newly generated MSW is diverted away from controlled and open dumps for disposal at the Haags Bosch Landfill. By 2022, the Haags Bosch Landfill (Category 4A1) accounted for 48.12% of emissions from solid waste disposal and 33.20% of emissions from the waste sector overall.

The combined uncertainty of emissions from Category 4A has been estimated at 79% for the year 2022. Inherent modelling uncertainties are introduced by the FOD model, as well as the default parameters/emission factors embedded within the IPCC FOD model spreadsheet used to represent the logarithmic decay of degradable waste material and subsequent CH_4 emissions released from solid waste disposal sites. Additional uncertainty is introduced through the waste generation rates, waste composition, and percentage of waste deposited ant each type of SWDS, given that these values were obtained from a single study performed in 2010. Table 2.58 presents the uncertainties for the key parameters used to estimate emissions from Category 4A, consistent with the 2019 IPCC Refinement.

Table 2.58. Uncertainty in GHG Emissions from Category 4A - Solid Waste Disposal.

Parameter	Uncertainty
Total quantity of MSW generated	-30%,+30%
Fraction of MSW sent to SWDS	-30%,+30%
Waste composition	-30%,+30%
Degradable organic carbon	-20%,+20%
Fraction of DOC dissimilated	-20%,+20%
CH_4 generation rate constant – (average for combined waste)	-27%,+27%
Delay time	-33%, +33%
Fraction of CH_4 in developed gas	-5%,+5%
Oxidation factor	0%
Methane correction factor – managed anaerobic SWDS	.10%-0%
Methane correction factor - uncategorized SWDS	-50%,+60%

Biological Treatment of Solid Waste (4B)

While small-scale composting initiatives exist throughout Guyana, associated emissions under this Category 4B were not estimated due to a significant lack of reliable data.

Incineration and Open Burning of Waste (4C)

Category 4C has been included for the first time in the present edition of the Guyana GHG emissions inventory, marking an important milestone in improving the completeness of the inventory. This category covers the CH_4 and N_2O emissions, in addition to non-biogenic CO_2 emissions from the open burning of waste under Category 4C2. While incineration of healthcare waste occurs to a limited degree across Guyana´s healthcare facilities, associated emissions under Category 4C1 were not estimated due to a significant lack of data. Category results are summarized in Figure 2.45 and Table 2.59.

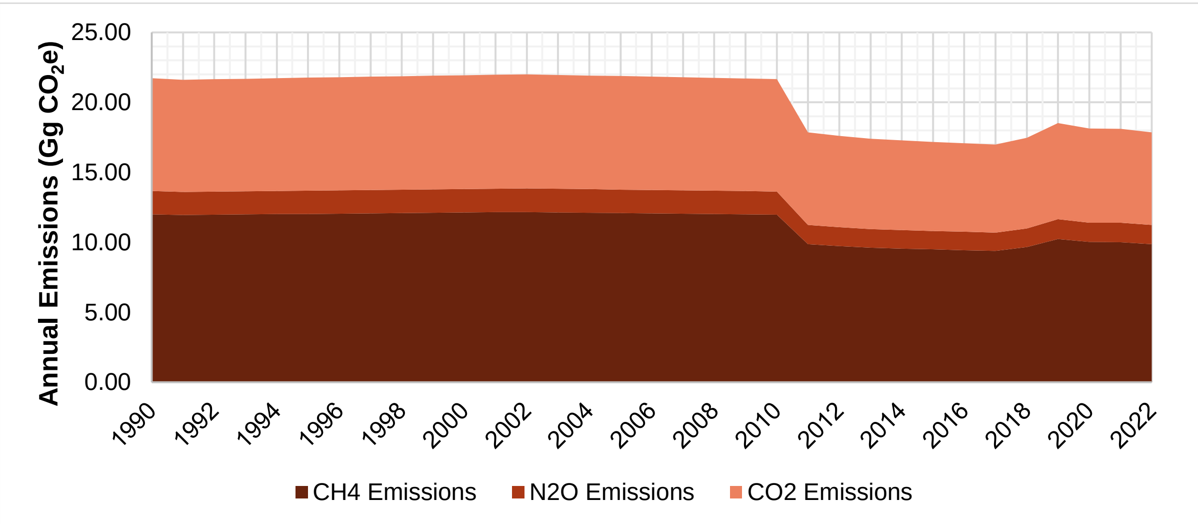

Figure 2.45. Category 4C GHG emissions by gas.

Table 2.59. Summary of GHG emissions of Category 4C – Incineration & Open Burning of Waste.

Annual Emissions in Gg CO_2e								
Category	**GHG**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
4C1 Waste Incineration	CO_2	NE	NE	NE	NE	NE	NE	NE
	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO_2	8.05	8.01	8.03	8.04	8.05	8.07	8.08
	CH_4	12.00	11.95	11.97	11.99	12.01	12.03	12.05
	N_2O	1.67	1.66	1.66	1.66	1.67	1.67	1.67
4C INCINERATIN & OPEN BURNING OF WASTE	Total	21.72	21.62	21.65	21.69	21.73	21.76	21.80
Category	**GHG**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
4C1 Waste Incineration	CO_2	NE	NE	NE	NE	NE	NE	NE
	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO_2	8.09	8.11	8.12	8.13	8.15	8.16	8.14
	CH_4	12.07	12.09	12.10	12.12	12.14	12.16	12.14
	N_2O	1.67	1.68	1.68	1.68	1.69	1.69	1.68
4C INCINERATIN & OPEN BURNING OF WASTE	Total	21.83	21.87	21.90	21.94	21.97	22.01	21.96
Category	**GHG**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
4C1 Waste Incineration	CO_2	NE	NE	NE	NE	NE	NE	NE
	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO_2	8.13	8.11	8.09	8.08	8.06	8.04	8.03
	CH_4	12.11	12.09	12.06	12.04	12.01	11.99	11.97
	N_2O	1.68	1.68	1.67	1.67	1.67	1.66	1.66
4C INCINERATIN & OPEN BURNING OF WASTE	Total	21.92	21.88	21.83	21.79	21.74	21.70	21.65
Category	**GHG**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
4C1 Waste Incineration	CO_2	NE	NE	NE	NE	NE	NE	NE
	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO_2	6.62	6.53	6.45	6.41	6.37	6.33	6.29
	CH_4	9.86	9.73	9.62	9.55	9.49	9.44	9.38
	N_2O	1.37	1.35	1.33	1.33	1.32	1.31	1.30
4C INCINERATIN & OPEN BURNING OF WASTE	Total	17.85	17.61	17.40	17.28	17.18	17.08	16.98
Category	**GHG**	**2018**	**2019**	**2020**	**2021**	**2022**		
4C1 Waste Incineration	CO_2	NE	NE	NE	NE	NE		
	CH_4	NE	NE	NE	NE	NE		
	N_2O	NE	NE	NE	NE	NE		
4C2 Open Burning of Waste	CO_2	6.47	6.87	6.72	6.71	6.62		
	CH_4	9.65	10.24	10.02	10.01	9.86		
	N_2O	1.34	1.42	1.39	1.39	1.37		
4C INCINERATIN & OPEN BURNING OF WASTE	Total	17.46	18.52	18.12	18.11	17.85		

Open burning of waste is the main contributor of non-biogenic CO_2 emissions from the waste sector. In 2022, Category 4C2 accounted for 100% of sectoral CO_2 emissions in 2022 at a value of 6.62 Gg CO_2e, 2.3% of sectoral CH_4 emissions at a value of 9.86 Gg CO_2e, and 12.40% of N_2O emissions at a value of 1.37 Gg CO_2e. Until 2010, Category 4C2 emissions remained relatively constant, oscillating at an average 21.81 Gg CO_2e, equivalent to 6.13% of sectoral total emissions. A notable 17.55% reduction in total emissions from open burning is observed from 21.65 in 2010 (6.12% of sectoral total) to 17.85 Gg CO_2e in 2022 (4.01% of sectoral total) attributed to:

- Primarily the commissioning of the Haags Bosch landfill in 2011 leading to enhanced waste management practices across the country complying with environmental, health, and safety standards; and

- At a lesser extent, then ongoing rehabilitation of open dumps and anti-litter and illegal dumping campaigns reducing the incidence of open burning in the country.

The combined uncertainty of CO_2, CH_4, and N_2O emissions from Category 4C has been respectively estimated at 66%, 113%, and 113% for the year 2022. Default emission factors for N_2O and CH_4 emissions from open burning of waste have a relatively high level of uncertainty, accounting for the greater combined uncertainty of these to gases in comparison with CO_2 emissions. The major uncertainty associated with the CO_2 emissions estimate is related to the estimation of the fossil carbon fraction in the waste. Table 2.60 presents the uncertainties for the key parameters used to estimate emissions from Category 4C, consistent with the 2019 IPCC Refinement.

Table 2.60. Uncertainty in GHG Emissions from Category 4C – Incineration and Open Burning of Waste.

Parameter	Uncertainty
Total quantity of MSW generated	-30%,+30%
Fraction of MSW open-burnt	-30%,+30%
Waste composition	-30%,+30%
Combined CO_2 emission factors for open burning of waste	-40%,+40%
CH_4 emission factor for open burning of waste	-100%,+100%
N_2O emission factor for open burning of waste	-100%,+100%

Wastewater Treatment and Discharge (4D)

This category covers the CH_4 emissions from the treatment and discharge of domestic wastewater in Guyana´s sewerage, septic, and latrine systems, as well as the N_2O emissions from the decomposition of nitrogen compounds in effluent under category 4D1. Category 4D2 was not estimated as no information is currently available on the existence of in-situ industrial wastewater treatment within industrial sites in Guyana. Category results are summarized in Figure 2.46 and Table 2.61.

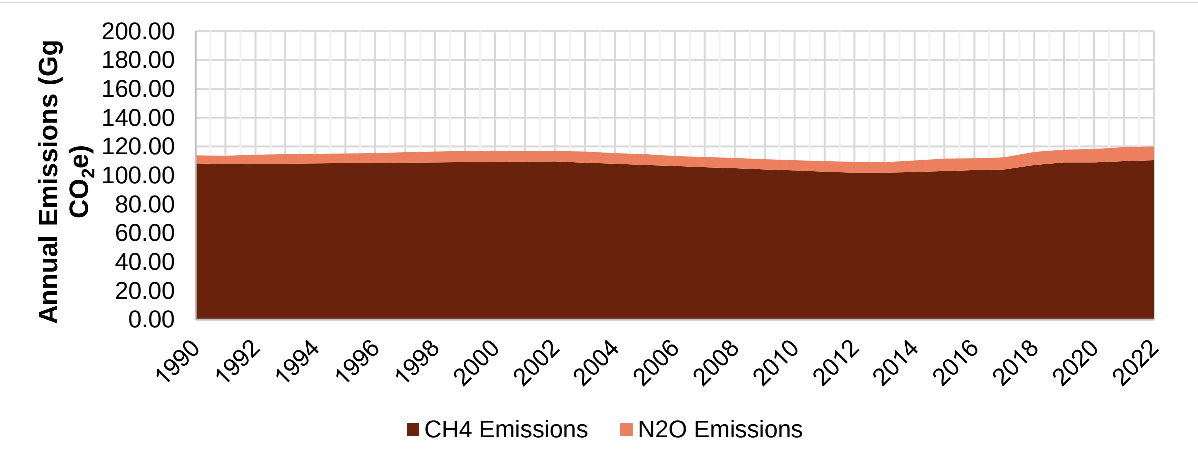

Figure 2.46. Category 4D GHG emissions by gas.

Table 2.61. Summary of GHG emissions from Category 4D – Wastewater Treatment and Discharge.

Annual Emissions in Gg CO_2e								
Category	**GHG**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
4D1 Domestic Wastewater	CH_4	108.28	107.79	107.96	108.12	108.29	108.45	108.61
	N_2O	5.54	5.78	6.32	6.70	6.62	6.74	6.84
4D2 Industrial Wastewater	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4D WASTEWATER TREATMENT AND DISCHARGE	Total	113.82	113.57	114.28	114.82	114.90	115.19	115.45
Category	**GHG**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
4D1 Domestic Wastewater	CH_4	108.77	108.93	109.08	109.24	109.39	109.54	108.76
	N_2O	7.32	7.61	7.80	7.71	7.32	7.45	7.76
4D2 Industrial Wastewater	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4D WASTEWATER TREATMENT AND DISCHARGE	Total	116.09	116.54	116.88	116.94	116.71	116.99	116.52
Category	**GHG**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
4D1 Domestic Wastewater	CH_4	107.98	107.20	106.42	105.64	104.86	104.08	103.30
	N_2O	7.44	7.41	6.94	7.07	7.11	7.08	7.10
4D2 Industrial Wastewater	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4D WASTEWATER TREATMENT AND DISCHARGE	Total	115.42	114.61	113.36	112.71	111.97	111.16	110.41
Category	**GHG**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
4D1 Domestic Wastewater	CH_4	102.53	101.75	101.85	102.38	102.95	103.53	104.13
	N_2O	7.30	7.62	7.34	7.86	8.58	8.36	8.44
4D2 Industrial Wastewater	CH_4	NE	NE	NE	NE	NE	NE	NE
	N_2O	NE	NE	NE	NE	NE	NE	NE
4D WASTEWATER TREATMENT AND DISCHARGE	Total	109.83	109.37	109.19	110.24	111.53	111.90	112.57
Category	**GHG**	**2018**	**2019**	**2020**	**2021**	**2022**		
4D1 Domestic Wastewater	CH_4	107.20	109.04	108.87	109.87	110.44		
	N_2O	9.16	8.88	9.34	9.63	9.68		
4D2 Industrial Wastewater	CH_4	NE	NE	NE	NE	NE		
	N_2O	NE	NE	NE	NE	NE		
4D WASTEWATER TREATMENT AND DISCHARGE	Total	116.37	117.93	118.21	119.50	120.12		

Solid waste disposal is the second largest contributor of CH_4 emissions and the largest contributor or N_2O emissions under the waste sector. In 2022, Category 4D accounted for 25.85% (110.44 Gg CO_2e) of CH_4 emissions, 87.60% (9.68 Gg CO_2e) of N_2O emissions, and 27.00% (120.12 Gg CO_2e) of the total emissions from the waste sector.

Total emissions from Category 4D have remained fairly stable and their contribution share of sectoral totals has actually decreased from 32.42% in 1990 to 27.00% in 2022. CH_4 emissions have observed a mere 1.99% increase in emissions between 1990 and 2022, despite an 11.25% population growth within the same time period. Such trend is attributed to improved sanitation facilities by the replacement of latrines (MCF=0.7) with septic systems (MCF=0.5). N_2O emissions, on the other hand, have observed a 74.73% increase between 1990 and 2022 attributed to population growth and economic development leading to higher protein consumption rates, and thus higher presence of nitrogen in effluent.

The combined uncertainty of CH_4 and N_2O emissions from Category 4D has been respectively estimated at 83% and 500% for the year 2022. As asserted by the 2006 IPCC Guidelines, large uncertainties are associated with the IPCC default emission factors for N_2O from effluent. The main source of uncertainty in CH_4 emissions are both the BOD values and the degree of utilization of each type of wastewater treatment/discharge stream. Table 2.62 presents the uncertainties for the key parameters used to estimate emissions from Category 4D, consistent with the 2006 IPCC Guidelines.

Table 2.62. Uncertainty in GHG Emissions from Category 4D – Wastewater Treatment and Discharge.

Parameter	Uncertainty
Population	-5%,+5%
Per capita protein consumption	-10%, +10%
Nitrogen removed with sludge	0%
Fraction of nitrogen in protein	-6%, +6%
Factor for non-consumed protein added to the wastewater	-9%, +27%
Factor for industrial and commercial co-discharged protein	-20%, +20%
Factor to account for losses of nitrogen prior to discharge	-50%, +50%
N_2O emission factor for effluent	-90%, +1400%
Per capita BOD	-30%, +30%
Correction factor for additional industrial BOD discharged into sewers	-20%, +20%
Degree of utilization of treatment method	-50%, +50%
Organic component removed as sludge	0%
Annual mass of CH_4 recovered and flared	0%
Maximum CH_4 producing capacity	-30%, +30%
Methane correction factors from sewerage and direct disposal	-50%, +50%

7. Data gaps and improvement plans

During the GHG inventory compilation process, specific areas were identified that should be the focus of improvement efforts by Guyana to reduce uncertainties to the extent possible and enable continuous improvement of inventory estimates. Tables 2.63, 2.64, 2.65, and 2.66 presents the findings and recommendations for improvement under each sector, including the relevant timeframes and responsible institutions.

7.1. Energy

Table 2.63. Improvement plan for the energy sector.

Energy Sector – Energy Industries (1A1)				
Identified gaps	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Sectoral consumption is estimated based on the growth rate of the supply data.	1	Collect data on fuel consumption from the main activity producers of electricity generation, combined heat and power generation, and heat plants for the entire time series.	2024-2026	GPL
Energy Sector – Manufacturing Industries and Construction (1A2)				
Identified gaps	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Sectoral consumption is estimated based on the growth rate of the supply data.	1	Collect data on fuel consumption from the manufacturing industries by sub-categories that correspond to the ISIC for the entire time series.	2024-2026	GRA
Energy Sector – Transport (1A3)				
Identified gaps	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
No information is available on domestic navigation and the sectoral consumption is estimated based on the growth rate of the supply data.	1	Collect data on fuel consumption for all transport activities specified by sub-categories for the entire time series.	2024-2026	GRA
Energy Sector – Other Sectors (1A4)				
Identified gaps	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Sectoral consumption is estimated based on the growth rate of the supply data.	1	Collect data on fuel consumption for activities in commercial and institutional buildings, households, and in agriculture, forestry, fishing and fishing industries for the entire time series.	2024-2026	GRA
Energy Sector – Other (1A5)				

Identified gaps		Improvement actions	Proposed timeframe	Responsible institution
Sectoral consumption is estimated based on the growth rate of the supply data.	1	Collect data on any remaining fuel combustion for the entire time series.	2024-2026	GRA
Energy Sector – Oil and Natural Gas (1B2)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Data on oil and natural gas production is available, however, activity data is not clearly split by oil and gas segment.	1	Implement an MRV system to continuously collect data from producers on activity data.	2024-2026	EPA

7.2. Industrial processes and product use

Table 2.64. Improvement plan for the IPPU sector.

IPPU Sector – Non-Energy Products from Fuels and Solvent Use (2D)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Emissions from lubricant use for their lubricant properties are not estimated.	1	Collect data on total lubricant consumption for lubrication purposes for the entire time series.	2024-2026	GRA
	2	Collect data on lubricant consumption for lubrication purposes split by the quantities of different types of lubricants for the entire time series.	2026-2028	GRA
Emissions from the use of paraffin waxes are not estimated.	1	Collect data on total paraffin wax consumption for the entire time series.	2024-2026	GRA
	2	Collect data on paraffin wax consumption split by quantities and type of paraffin waxes and their respective use for the entire time series.	2026-2028	GRA
IPPU Sector – Product Uses as Substitutes for Ozone Depleting Substances (2F)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Emissions from the use of HFC and PFC gases are not estimated.	1	Collect data on total HFC and PFC imports and split between application area such as refrigeration and air conditioning, foam blowing and fire protection for the entire timeseries.	2024-2026	GRA/NOAU
	2	Collaborate with the Ozone Secretariat in the framework of the Kigali Amendment to assess whether the data they collect can be used for the estimates of the GHG inventory.	2024-2026	GRA/NOAU
IPPU Sector – Other Product Manufacture and Use (2G)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Emissions from the use of electrical equipment in the transmission and	1	Collect data on SF_6 consumption for electrical insulation and interruption in equipment	2024-2026	GPL

distribution of electricity are not estimated.		utilised in electricity transmission and distribution for the entire timeseries.		
Emissions from the medical use of N_2O as anaesthesia are not estimated.	1	Collect the data on supply from companies that commercialize N_2O for medical applications (anaesthetic use, analgesic use and veterinary use) or data on N_2O consumption from the hospitals for the entire timeseries.	2024-2026	GRA/ Hospitals
	2	Collect data on N_2O consumption for other type of product use such as use as a propellant in aerosol products, primarily in food industry for the entire timeseries.	2026-2028	GRA

IPPU Sector – Other (2H)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Emissions for the pulp and paper industry are not estimated.	1	Collect data on pulp and paper production split by sub-processes in the pulp and paper industry for the entire timeseries.	2024-2026	GRA
Emissions for the food and beverages industry are not estimated.	1	Collect data on food and beverages production split by production sub-processes in the food and beverages industry for the entire timeseries.	2024-2026	GRA

7.3. Agriculture, forestry, and other land use (AFOLU)

Table 2.65. Improvement plan for the AFOLU sector.

AFOLU Sector – Livestock (3A)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Livestock data for total cattle is not disaggregated by dairy and other cattle for the periods: 1990-1992 and 2019-2022.	1	Disaggregate total cattle by dairy and other cattle for those years.	2024-2026	GLDA
	2	Collect data for those both categories in the future.	2024-2026	GLDA
AFOLU Sector – Land (3B)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
No data was identified for afforestation or reforestation activities	1	Collect data on hectares of land reforested or afforested if they occur.	2026-2028	GFC
AFOLU Sector – Aggregate Sources and Non-CO2 Emission Sources on Land (3C)				
Identified gaps		**Improvement actions**	**Proposed timeframe**	**Responsible institution**
Inconsistencies between the area burnt of sugarcane and the harvested area for this crop.	1	Maintain accurate records of totals of harvested area and area burnt for the sugarcane crop.	2024-2026	GUYSUCO

No national data for limestone and synthetic fertilizer applied or burnt area for sugarcane crops after 2016.	1	Collect data for limestone and synthetic fertilizer applied on sugarcane crops, and for area of sugarcane burnt.	2024-2026	GUYSUCO
No national data for limestone application for other crops except sugarcane	1	Collect data on lime application on crops	2024-2026	NAREI
No national data on annual harvested area before 2014 and no data on crop production before 2016 (except for rice and sugar)	1	Keep collecting data regularly on harvested area and crop production	2024-2026	NAREI
Inconsistencies exist between two national sources for harvested area and synthetic fertilizers data on sugarcane crops	1	Maintain accurate records of the synthetic fertilizer use and on harvested area	2024-2026	GUYSUCO
No national data on synthetic fertilizer imports before 2020. Data from 2020 to 2023 has no detail of the nitrogen content per product	1	Maintain accurate records of the synthetic fertilizer and classify the imports by content of nitrogen	2024-2026	GRA
No national data on urea imports before 2020 and some products only appear one of the years for the period 2020-2023. Inconsistencies exist between national and FAO data for the years 2020 and 2021.	1	Maintain accurate records of the urea imports	2024-2026	GRA

7.4. Waste

Table 2.66. Improvement plan for the waste sector.

Waste Sector – Solid Waste Disposal (4A)				
Identified gaps and barriers	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Elevated uncertainty in emission estimated from MSW disposal.	1	Establish and operate a system for conducting recurring waste characterization studies using standardized nomenclature throughout the different regions of Guyana.	2024-2026	MLGRD
	2	Maintain accurate records of the quantity of waste deposited at all of Guyana´s landfills and controlled dumps either through weighbridges or accounting for number of truckloads received at each site.	2024-2030	MLGRD
Controlled and open dumps could not be classified under IPCC definitions.	1	Launch studies and maintain updated records of operating conditions throughout all of Guyana´s controlled and open dumpsites to enable classification as "managed aerobic", "managed	2024-2026	MLGRD

		anaerobic", "unmanaged deep" or "unmanaged shallow" as per IPCC definitions.		
Emissions from industrial solid waste were not estimated.	1	Launch detailed studies and begin data collection on industrial waste generation rates, composition, and management practices.	2026-2028	MLGRD
Waste Sector – Biological Treatment of Solid Waste (4B)				
Identified gaps and barriers	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Emissions from composting are not estimated.	1	Begin collecting data on composting rates using standardized templates.	2028-2030	MLGRD
Waste Sector – Incineration and Open Burning of Waste (4C)				
Identified gaps and barriers	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Emissions for healthcare waste incineration are not estimated.	1	Establish regular, standardized, and mandatory record-keeping and reporting of healthcare waste generation and treatment practices, including incineration.	2024-2026	Ministry of Health´s Food and Drug Department, Materials Management Unit, and Hospitals
Waste Sector – Wastewater Treatment and Discharge (4D)				
Identified gaps and barriers	**Improvement actions**		**Proposed timeframe**	**Responsible institution**
Elevated uncertainty in emission estimated from domestic wastewater treatment and discharge systems.	1	Establish a system for frequent and standardized BOD measurements specific to each wastewater treatment and discharge stream, including sewerage, septic systems, and latrines.	2024-2026	GWI
Sludge removal and treatment is not accounted for.	1	Regularly collect data on sludge removal and treatment methods.	2026-2028	GWI and Puran Brothers
Emissions from industrial wastewater treatment and discharge are not estimated.	1	Develop an inventory of industrial facilities with on-site wastewater treatment systems in Guyana.	2026-2028	GWI
	2	Regularly collect data on the quantity and characteristics of industrial wastewater generated and treated on-site, including treatment systems implemented.	2028-2030	GWI

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3 Adaptation to Climate Change

1. Introduction and conceptual frameworks

Climate change poses a significant constraint on the ability of Guyana to address climate impacts. With over 90% of its inhabitants and economic activity located along the exposed coastal plain region, the country is extremely vulnerable to the threats posed by increasing sea levels, intensifying storms, shifting rainfall patterns (timing and magnitude), and resulting land and water (surface and ground) degradation from clearing, erosion, and saltwater intrusion. Occurrences of hydro-meteorological events such as flooding and storms have been increasing in frequency over the last few decades. Guyana has also begun to suffer from increasing temperatures, heatwaves, and droughts. All these events pose associated risks to infrastructure, internal migration, health and well-being, food security, and energy security, as well as climate impacts on biodiversity and traditional livelihoods of Amerindian communities.

Thus, incorporating climate change projections and vulnerability assessments into national policy planning is crucial to build adaptive capacities and advance resilient development in light of the expected impacts climate change poses. Despite significant progress made by Guyana in developing a robust adaptation policy framework and advancing adaptation measures over the past two decades, the country faces persistent challenges and barriers hindering further advances in adaptation action to the required levels. This calls for collective action leveraging international support mechanisms to build the nation´s informational, institutional, human, financial, technological, and regulatory capacities for effective adaptation.

This chapter explores projected climate scenarios and the subsequent impacts and vulnerabilities at the national and sectoral level. An overview of the national and sectoral adaptation policy frameworks of the Government of the Cooperative Republic of Guyana (GoG) is provided, coupled with the recent adaptation actions completed, ongoing, and envisioned. Finally, the chapter concludes with an analysis of the persisting national and sectorial barriers and support mechanisms required for effective adaptation. Figure 3.1 illustrates the adopted conceptual methodological framework.

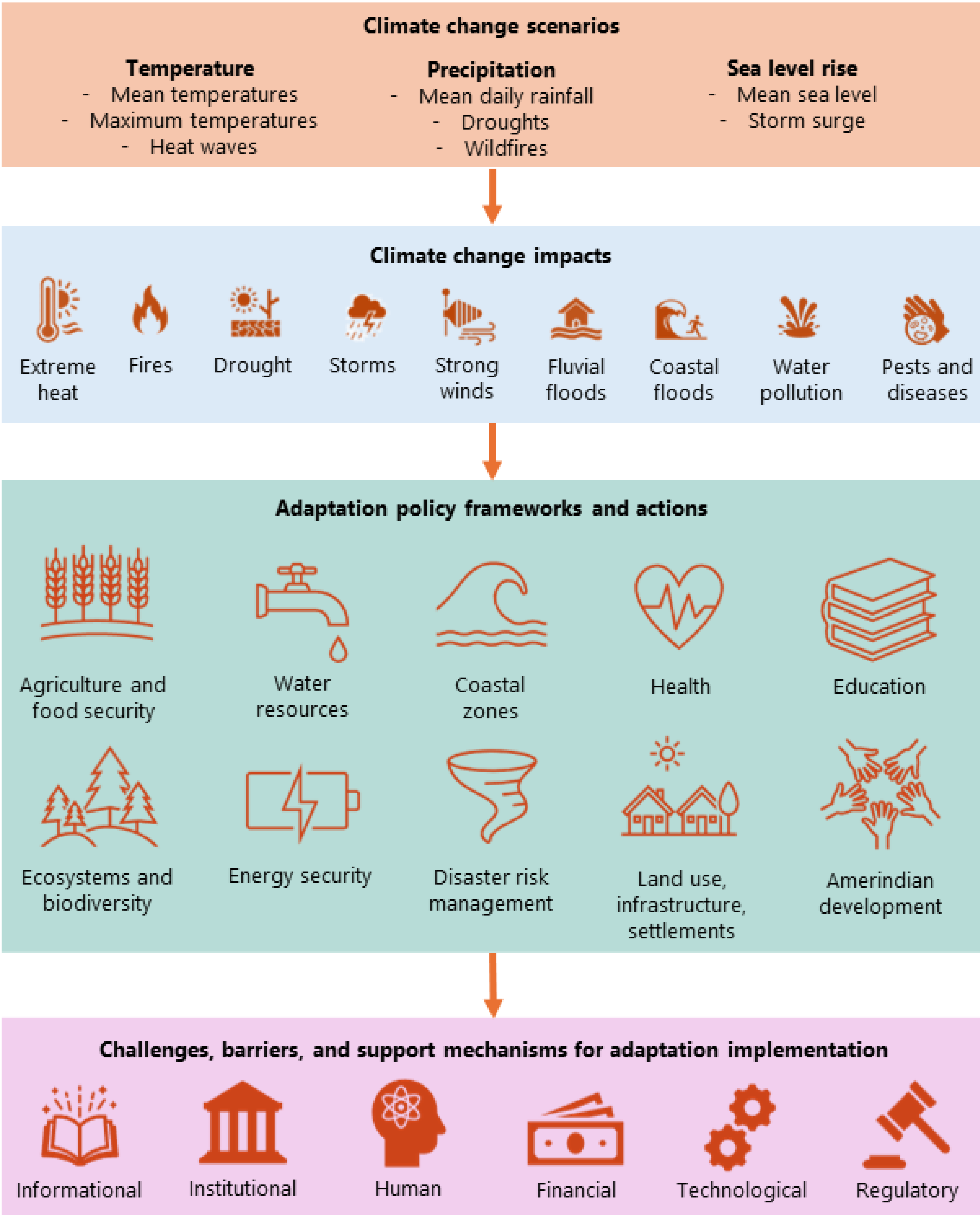

Figure 3.1. Conceptual methodological framework of the adaptation chapter.

2. Climate scenarios

2.1. Methodology

Guyana has prepared a total of nine climate change scenarios based on three principal climate impacts as follows:

- **Temperature:** mean temperatures, mean maximum temperatures, and heat waves.
- **Precipitation:** mean daily rainfall, droughts and wildfires.
- **Sea level rise:** mean sea level rise, minimum storm surge, and maximum storm surge.

Projections for all scenarios under the temperature and precipitation variables were developed explicitly for the preparation of this Third National Communication (TNC) according to three representative concentration pathways (RCPs), namely RCP 2.6, RCP 4.5, and RCP 8.5 for every year until 2090, with visual maps developed for 2030, 2040, and 2050.

Historical and projected georeferenced data on mean temperatures, maximum temperatures, humidity, and precipitation quantities for Central America were obtained from the Coordinated Regional Climate Downscaling Experiment (CORDEX) according to the Sixth Coupled Model Intercomparison Project (CMIP6), whereby the georeferenced data was available based on grids of 0.22x0.22 resolution. The data was available in terms of daily values, for which temperature data was averaged on a monthly and annual basis, whereas precipitation data was added and subsequently averaged over a monthly and annual basis.

A historical reference base for the mean temperatures, maximum temperatures, humidity, and precipitation quantities was developed taking the average values for these variables between the 1981-2010 period according to good practices stipulated by the Intergovernmental Panel on Climate Change (IPCC). Then, a gradient was prepared for each of these three variables to determine the expected changes over time compared to the historical reference base for the 0.22x0.22 gird resolutions. The gradient was then mapped and scaled in resolution until the density of change (measured using differential variability rate dispersion theory) was no longer differentiable.

Maximum temperatures were used to project heat waves, defined as the periods occurring over at least three consecutive days in which daily maximum temperatures exceed 5% of the warmest days recorded in July and August in the period 1971-2000.

Droughts were projected based on the Palmer Hydrological Drought Index (PHDI), measuring the difference in the balance of rainfall, temperature, and evaporation between the historical baseline and future predictions.

On the other hand, historic wildfire data between 2014 and 2024 was collected from satellite images based on NASA´s LANCE satellite and compiled to identify current fire hazard zones, extended over time based on drought projection results.

Concerning sea level rise, the latest analysis was conducted in 2012 under Guyana´s Second National Communication, whereupon the results have been continuously used under the country´s ongoing adaptation planning framework. As such, the present TNC restates the results conducted from the afore-mentioned study.

The analysis was based on historical tide gauge records from 1951 to 1979 from which sea level rise was modelled for Guyana for 2031, 2051, and 2071 according to two ocean general circulation models, namely the Hadley Circulation Model 3 (HadCM3) and the Canadian General Circulation Model 2 (CGCM2). For each, three different scenarios were considered as follows: average sea level rise, sea level rise with a minimum storm surge of approximately 2m, and sea level rise with a maximum storm surge of approximately 5m.

The impact analysis of the coastal zone was then done by estimating how many hectares of different land uses (residential, various crops, grazing land, and uncultivated lands) would be inundated due to sea-level rise, using the digital elevation model available for Region 3 at the time Guyana´s Second National Communication was prepared.

2.2. Results

2.2.1. Temperature

The temperature in Guyana has been steadily increasing over the last few decades in response to the general global warming trend. The current mean annual temperature is already 0.34°C higher than the 1950-2000 average. Modelling results indicate that, in all cases, temperature will continue to increase as illustrated in Figure 3.2 and Table 3.1 below.

Compared to the 1950-2000 average, under RCP 2.6, annual average temperatures will increase by 0.56°C, 0.80°C, and 0.89°C by 2030, 2040, and 2050, respectively. Under RCP 4.5, temperatures will respectively increase by 0.39°C, 0.69°C, and 1.29°C by 2030, 2040, and 2050 compared to the 1950-2000 average, while under RCP 8.5, temperature increases will respectively reach 1.49°C, 1.97°C, and 2.63°C.

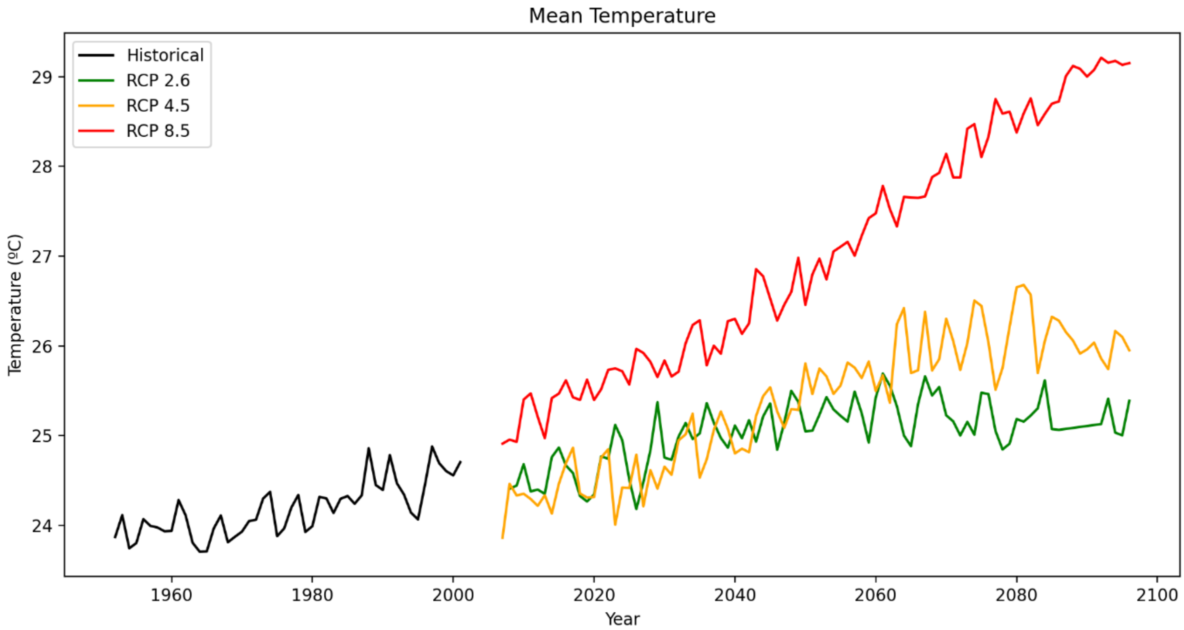

Figure 3.2. Historical and projected mean annual temperatures (°C).

Table 3.1. Historical and projected mean annual temperatures (°C).

Year	Historical	RCP 2.8	RCP 4.5	RCP 8.5
1950-2000	24.17			
2010		24.38	24.29	25.47
2020		24.77	24.76	25.52
2030		24.73	24.56	25.66
2040		24.97	24.86	26.14
2050		25.06	25.46	26.80
2060		25.69	25.67	27.78
2070		25.16	26.05	27.88
2080		25.16	26.68	28.59
2090		25.12	26.04	29.08

Despite this increasing trend, there will be significant variability in terms of spatial distribution in temperature changes throughout the different months of the years, as can be observed in Figures 3.3, 3.4, and 3.5, below.

January temperatures will decrease significantly across the coast and throughout Northern Guyana, while the Southern portion will observe a substantial increase. This pattern will be reversed by April, where nearly all of Guyana will have temperature increases with the highest temperate increments observed across the coast, while temperatures in the Southern tips of Regions 9 and 6 will fall. By July, on the contrary, substantial nation-wide temperature decreases are projected, expect in the coastal zone. This pattern is reversed once again by October, whereby nation-wide increments in temperature are expected, except for the coastal zone which will observe a decrease in temperatures.

Such heating and cooling effects throughout the different geographical regions of Guyana will further contribute to torrential rain patterns as hot humid air in “heat zones” clash with cooler temperatures in “cooled zones”. The above-mentioned patterns will be intensified under RCP 4.5 and 8.5.

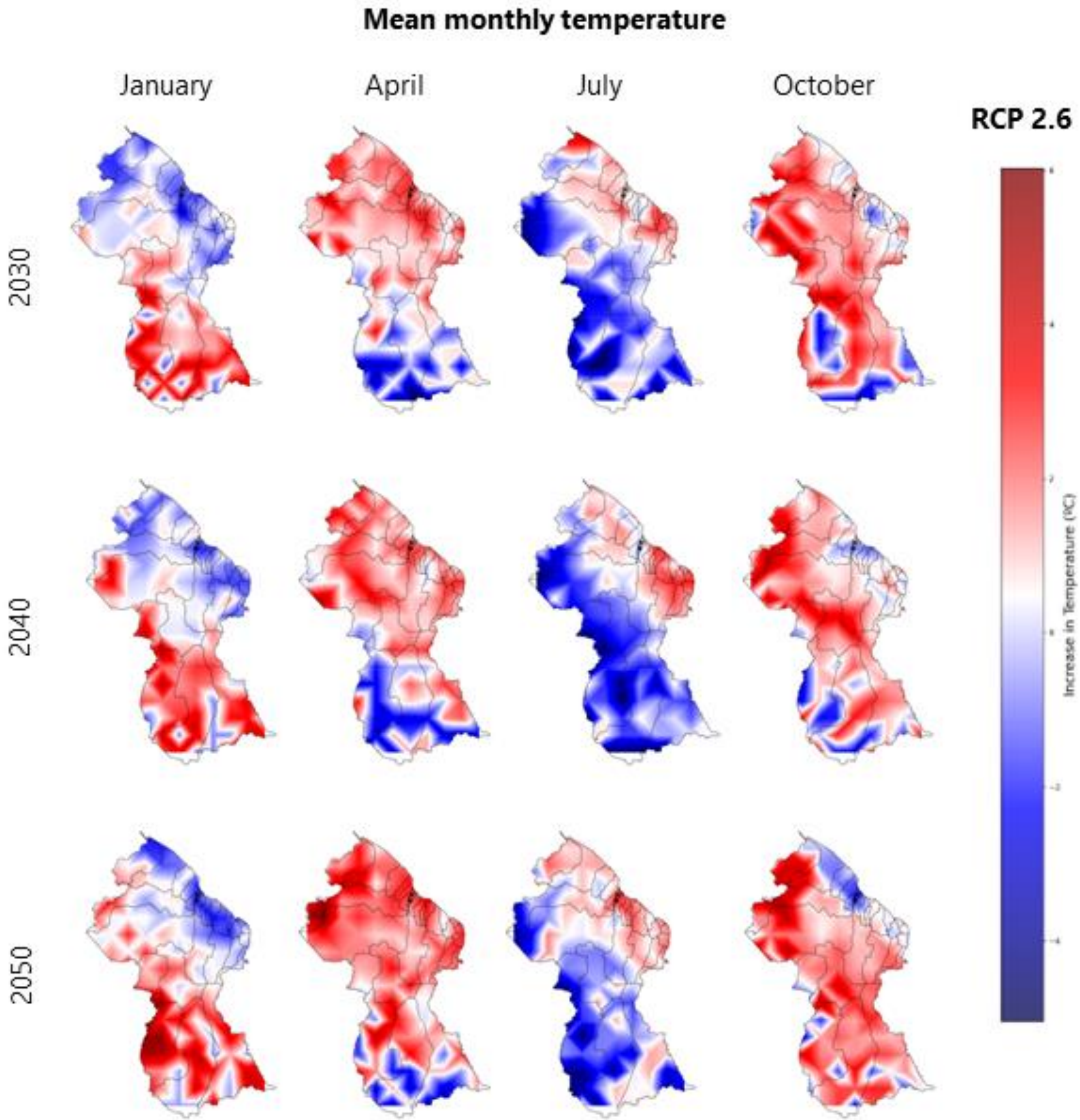

Figure 3.3. Projected mean monthly temperature increases (°C) under RCP 2.6.

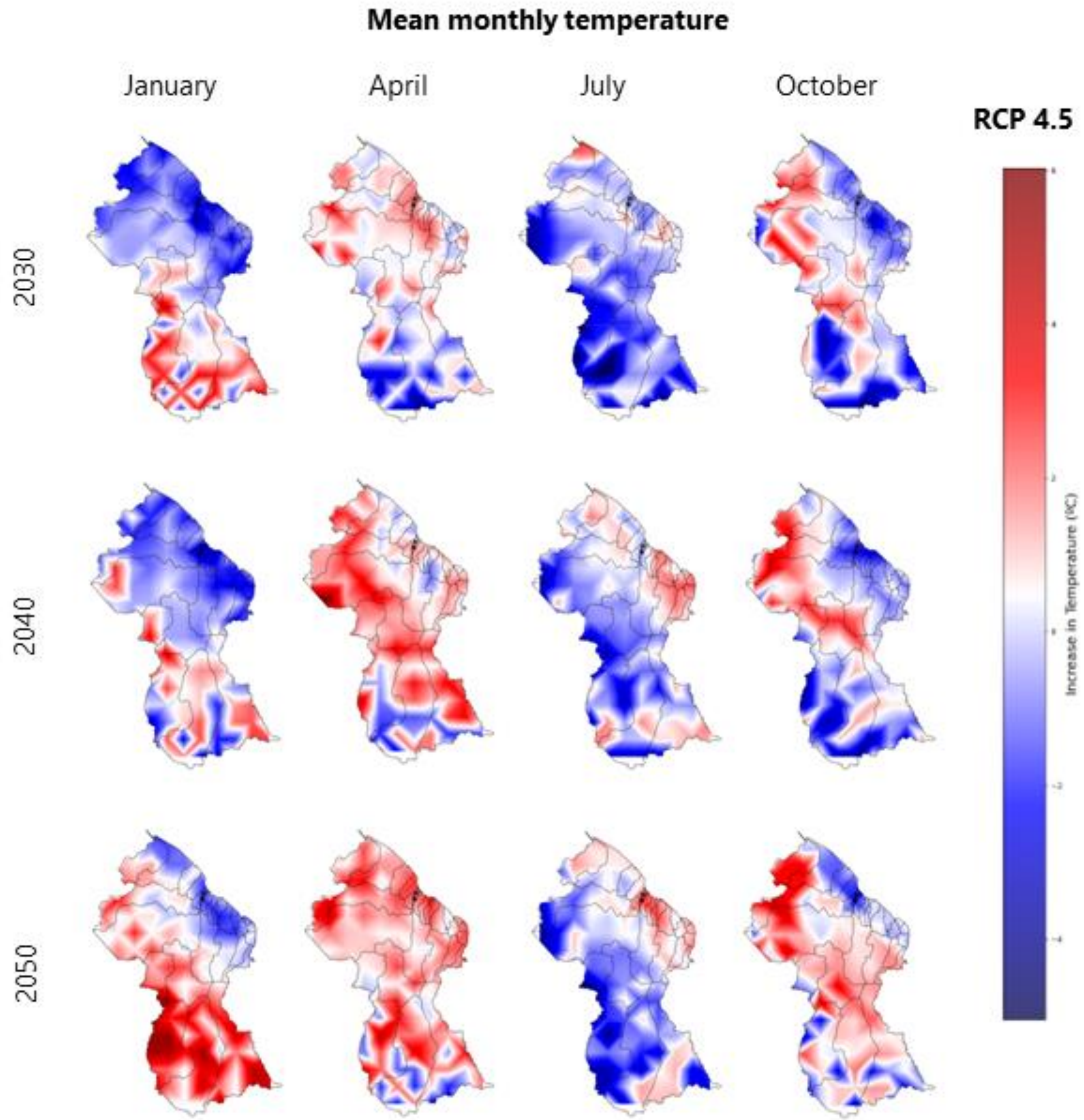

Figure 3.4. Projected mean monthly temperature increases (°C) under RCP 4.5.

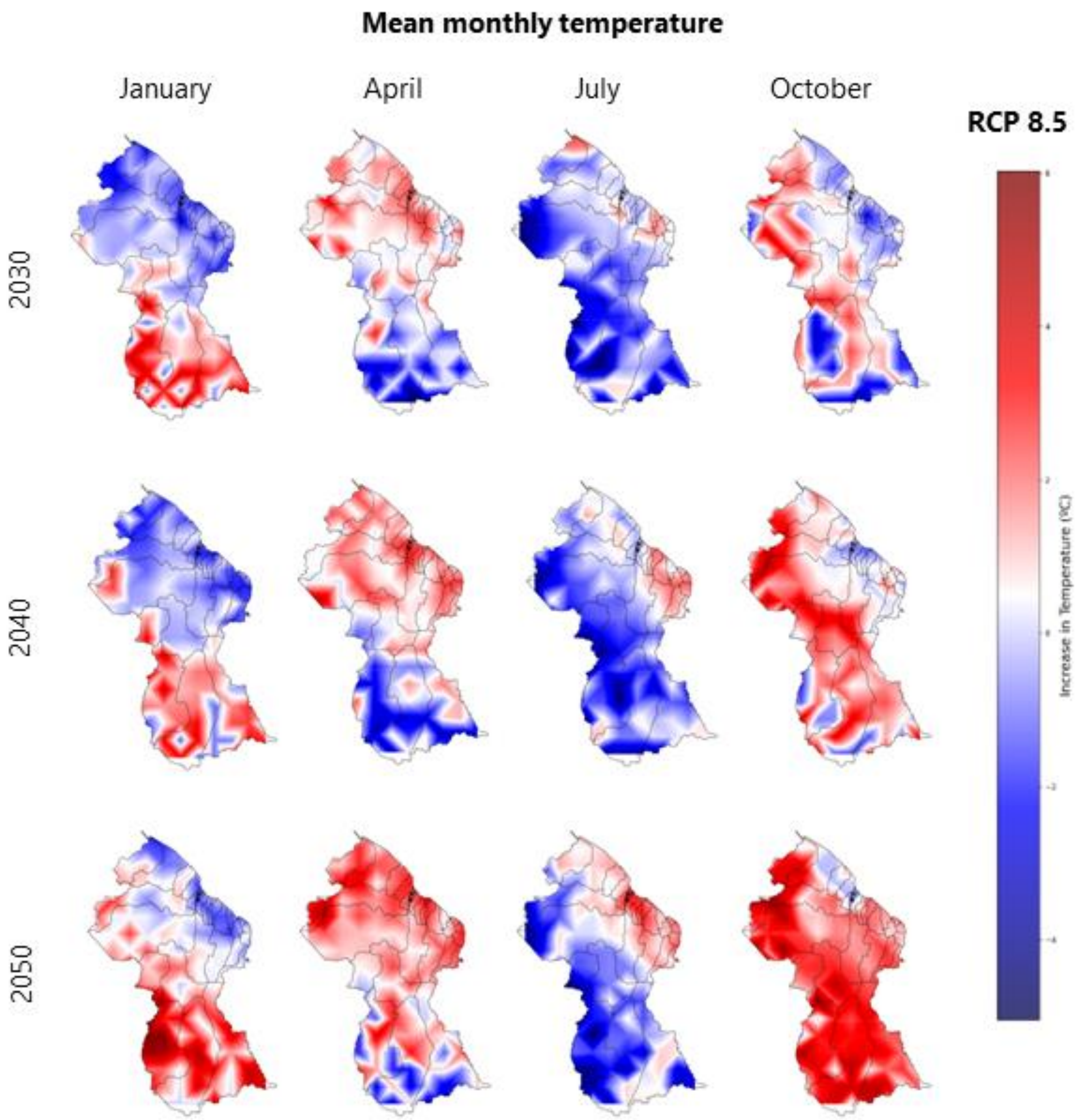

Figure 3.5. Projected mean monthly temperature increases (°C) under RCP 8.5.

The daily maximum temperatures in Guyana have also been steadily increasing over the last few decades, noting that the current maximum annual temperature is already 0.14°C higher than the 1950-2000 average. Modelling results indicate that, in all cases, temperature will continue to increase as illustrated in Figure 3.6 and Table 3.2 below.

Compared to the 1950-2000 average, under RCP 2.6, annual average maximum temperatures will increase by 0.37°C, 0.56°C, and 0.76°C by 2030, 2040, and 2050, respectively. Under RCP 4.5, average maximum temperatures will respectively increase by 0.34°C, 0.50°C, and 1.17°C by 2030, 2040, and 2050 compared to the 1950-2000 average, while under RCP 8.5, average maximum temperature increases will respectively reach 1.43°C, 1.87°C and 2.44°C.

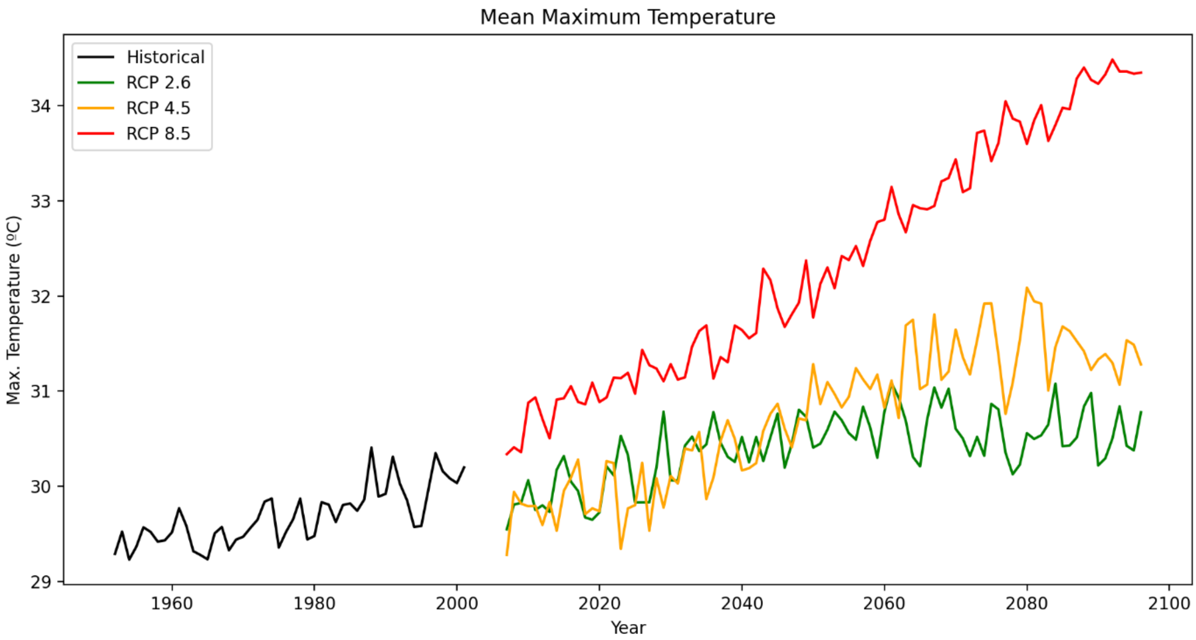

Figure 3.6. Historical and projected maximum annual temperatures (°C).

Table 3.2. Historical and projected maximum annual temperatures (°C).

Year	Historical	RCP 2.8	RCP 4.5	RCP 8.5
1950-2000	29.69			
2010		29.75	29.79	30.93
2020		30.21	30.27	30.93
2030		30.06	30.03	31.12
2040		30.25	30.19	31.56
2050		30.45	30.86	32.13
2060		31.08	31.11	33.15
2070		30.50	31.36	33.09
2080		30.50	31.95	33.84
2090		30.29	31.39	34.33

Once again, despite this heating trend, there will be significant variability in terms of spatial distribution in temperature changes throughout the different months of the years. As can be observed in Figure 3.7, monthly maximum temperatures in July will actually decrease across the country except for the coastal zone, which will observe a slight increase. The pattern is reversed by October, in which a severe increase in daily maximum temperatures is expected throughout the country, except for the coastal zone, which will be subject to lower maximum temperatures.

As sated above, such patterns will contribute to increased intensity and frequency of torrential rains due to increased evaporation rates followed by rapid cooling and downpours.

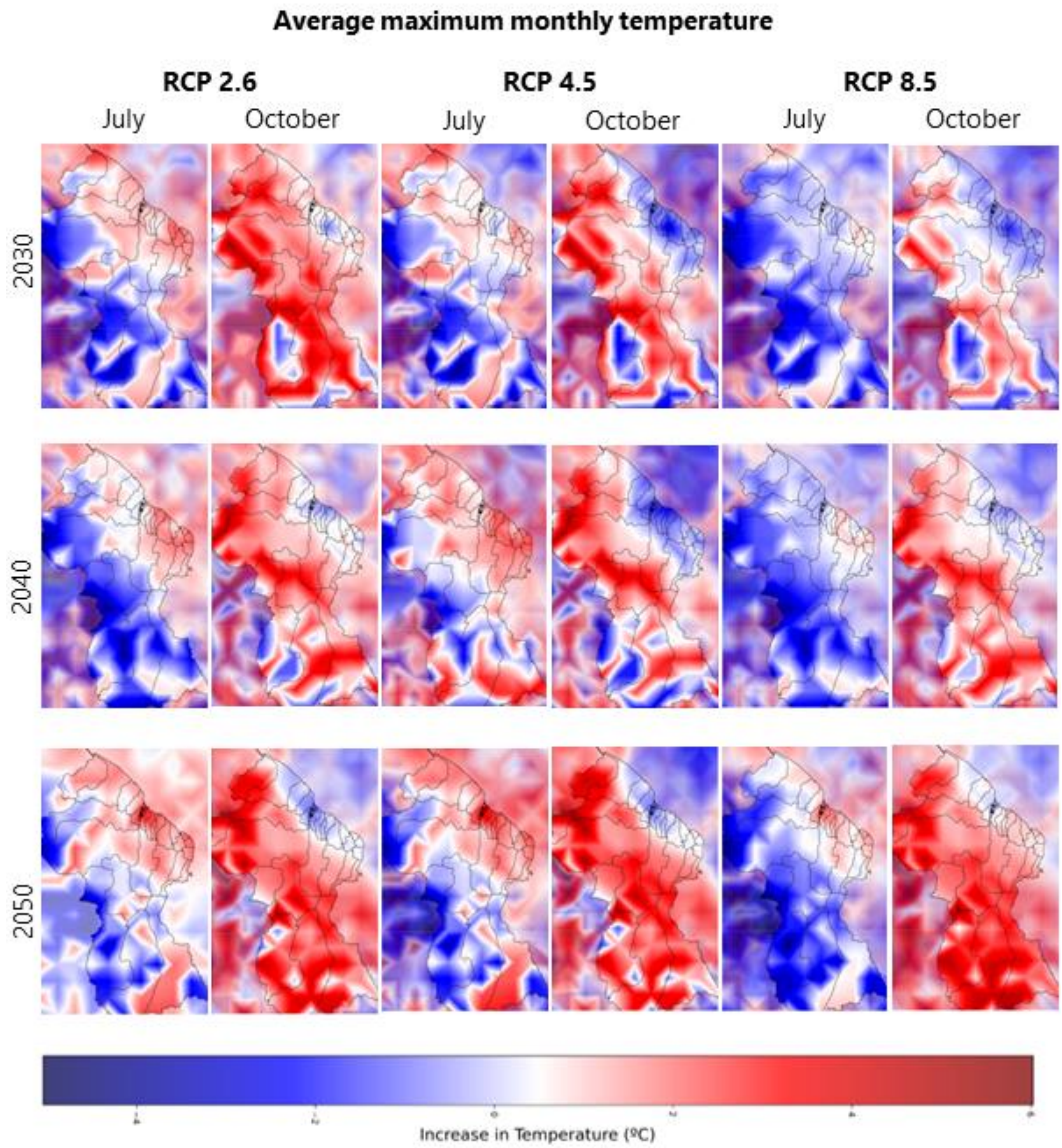

Figure 3.7. Projected average maximum monthly temperature increases (°C).

Similar trends can be observed for heat waves. Over the past two decades, Guyana has observed an average of 3 heat waves per month. According to modelled results, Guyana is expected to observe between 5 to 8 heat waves on a monthly basis by 2050 and up to 10 heat waves monthly by 2070.

However, the spatial distribution of such episodes is projected to observe high variability, as illustrated in Figures 3.8, 3.9, and 3.10. The middle strip of Guyana (Regions 7, 8, and 10) will be most impacted, with severe risk of heat waves in January, April, and October. Southern Guyana (Regions 9 and 10) will be particularly impacted in January. On the other hand, the coastal strip will not be as prone to heat events in this period, observing a mild probability to heat events in July.

Modelled results show that the number, intensity, and spatial reach of heat waves will subsequently increase between RCP 2.6, 4.5, and 8.5, with the impact on the coastal zone subsequently augmenting.

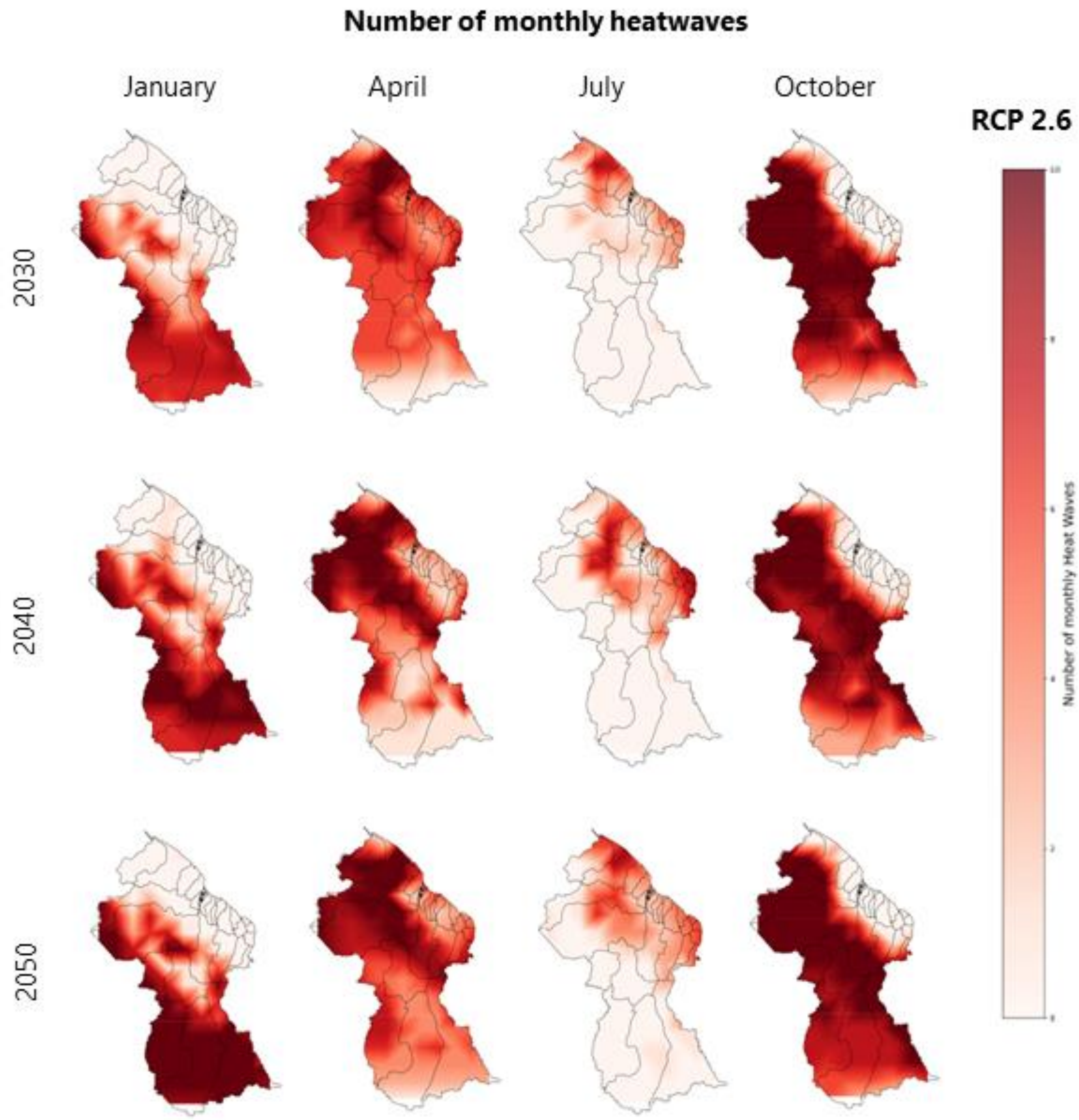

Figure 3.8. Projected monthly number of heat waves under RCP 2.6.

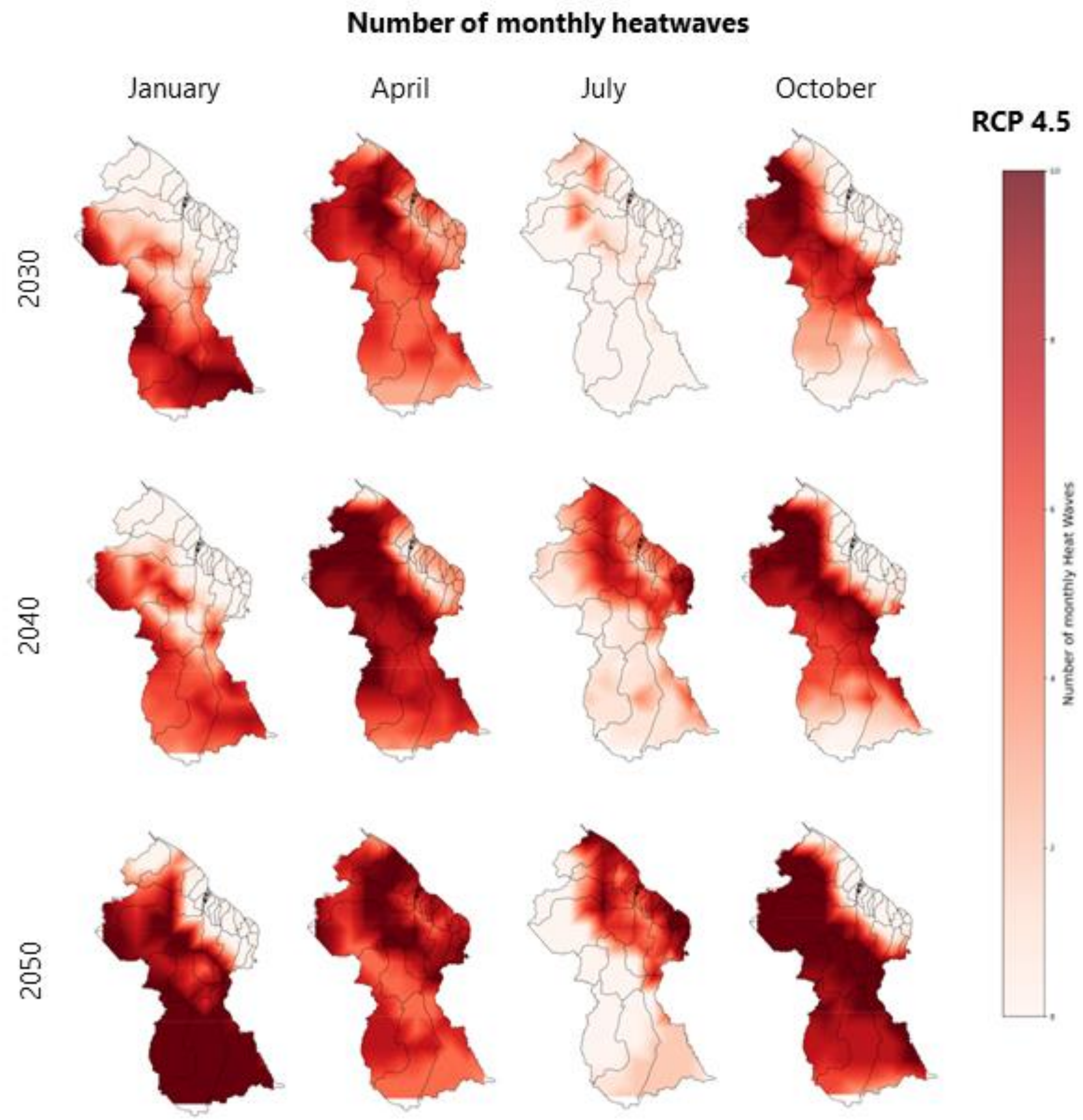

Figure 3.9. Projected monthly number of heat waves under RCP 4.5.

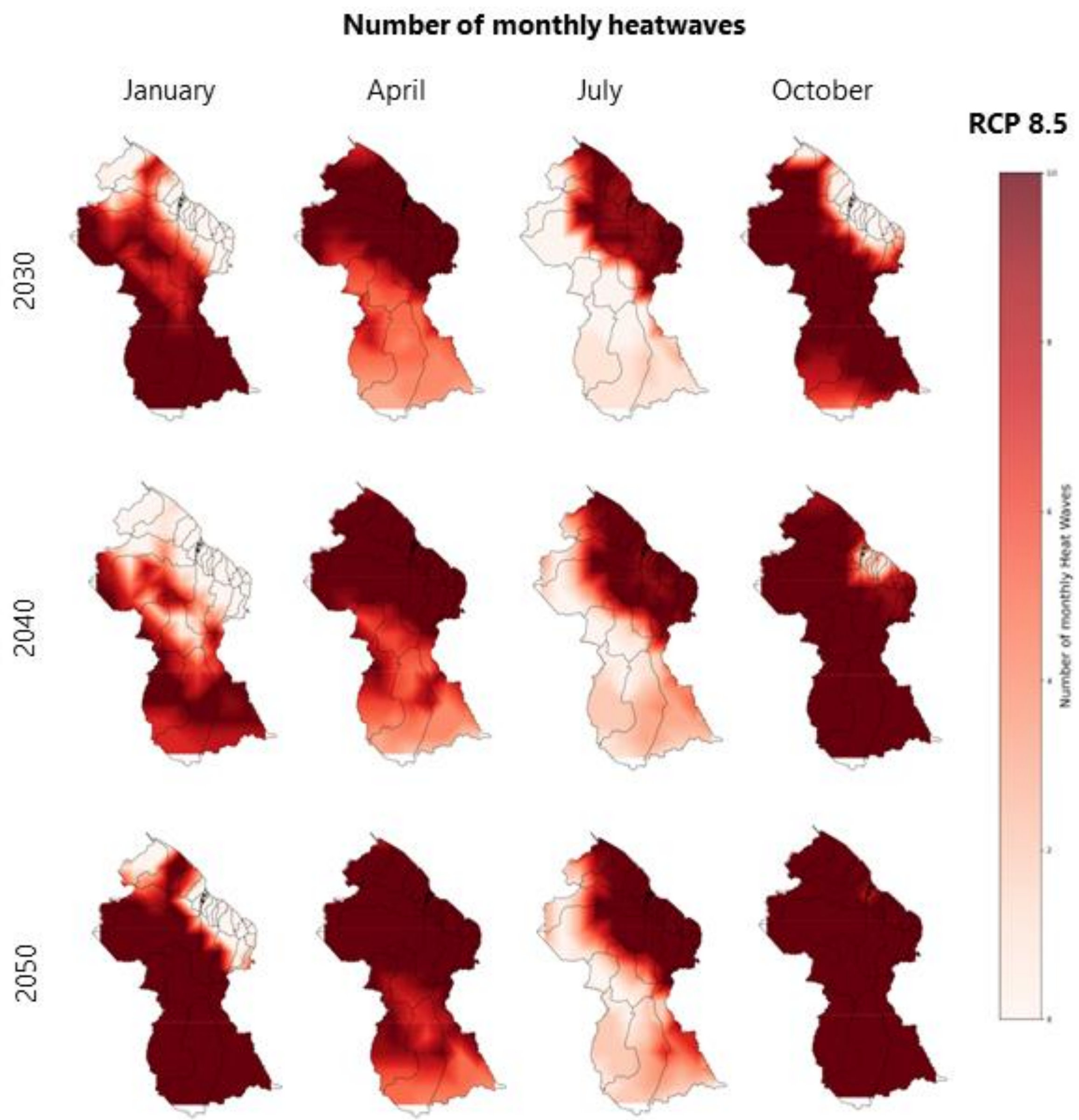

Figure 3.10. Projected monthly number of heat waves under RCP 8.5.

2.2.2. Precipitation

Guyana is influenced by climate events originating from other parts of the world. One of the more frequent influencing climate modes is the El Niño Southern Oscillation (ENSO) (National Oceanic & Atmospheric Administration 2018). Influences of the ENSO generally manifest themselves as lower amounts of rainfall during El Niño (warmer) phases and greater amounts during the La Niña (cooler) phases. The ENSO has a return period that varies from 2 to 7 years, with the effects lasting anywhere from 6 to 18 months depending on the strength of the event. A major uncertainty in the climate science community is the effect that global warming may have on the intensity, duration, and frequency of future ENSO events, including the related changes to precipitation patterns and the overall water balance of the country.

During El Niño episodes, drier conditions are experienced on the north coast of South America from December to February. During La Niña episodes, the opposite occurs with wetter conditions along the North coast of South America from December to February.

Having a historical average of 3.91mm/day over the 1950-2000 period, precipitation in Guyana has been quite variable, demonstrating a somewhat cyclical increase-decrease pattern of every five years. Since the great floods of 2005, there has been a dramatic jump in the average amount of rainfall in the country, increasing to a mean 4.82mm/day over the past two decades. As shown in Figure 3.11 and Table 3.3, modelling results indicate that, in all cases, precipitation will continue to increase within its five-year cyclical nature to peak around 2040, then subsequently decreasing back to 2005 levels. Under RCP 2.6, 4.5, and 8.5, peak average daily rainfall in 2040 could respectively reach an average of 4.58mm/day, 5.18mm/day, and 5.69mm/day.

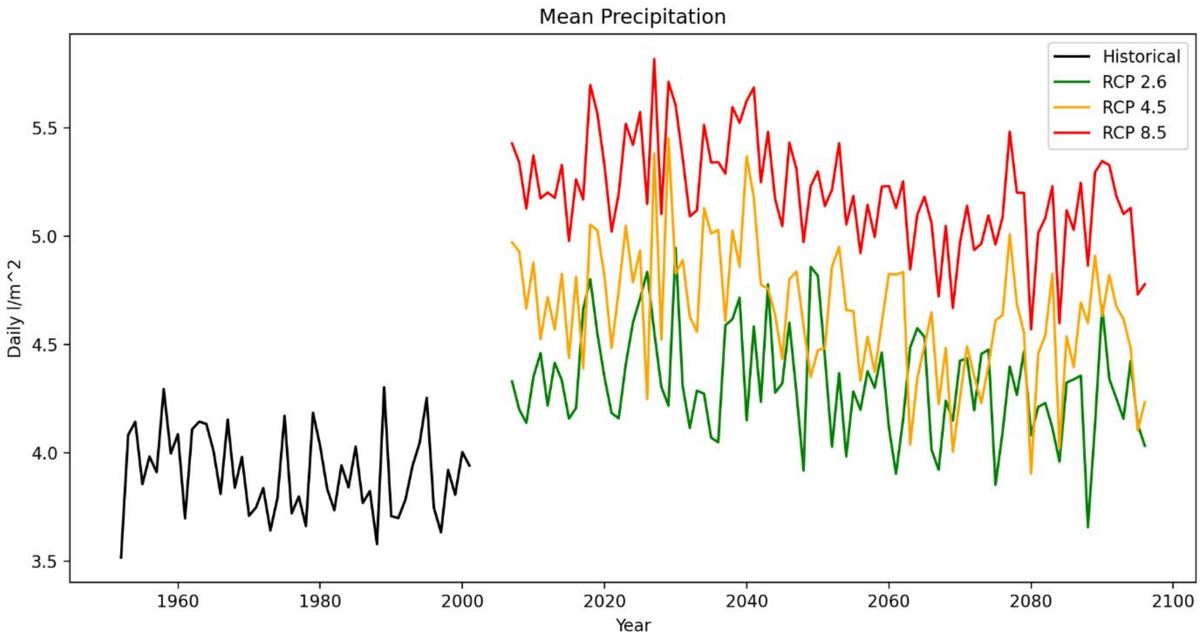

Figure 3.11. Historical and projected mean daily precipitation (mm/day).

More noteworthy are the expected changes in the spatial distribution of rainfall as well as the intensity of precipitation. Rainfall is expected to concentrate both geographically and temporally, leading to both severe drought-like conditions as well as severe torrential rains with elevated flooding risks throughout various Regions of Guyana at different times of the year. These patterns will intensify as the years progress, subsequently more concerning under RCP 2.6, 4.5, and 8.5, as can be observed in Figures 3.12, 3.13, and 3.14, below.

Table 3.3. Historical and projected mean daily precipitation (mm/day).

Year	Historical	RCP 2.8	RCP 4.5	RCP 8.5
1950-2000	3.91			
2010		4.46	4.52	5.17
2020		4.18	4.48	5.02
2030		4.31	4.89	5.36
2040		4.58	5.18	5.69
2050		4.44	4.48	5.14
2060		3.90	4.82	5.13
2070		4.44	4.49	5.14
2080		4.21	4.46	5.01
2090		4.34	4.82	5.33

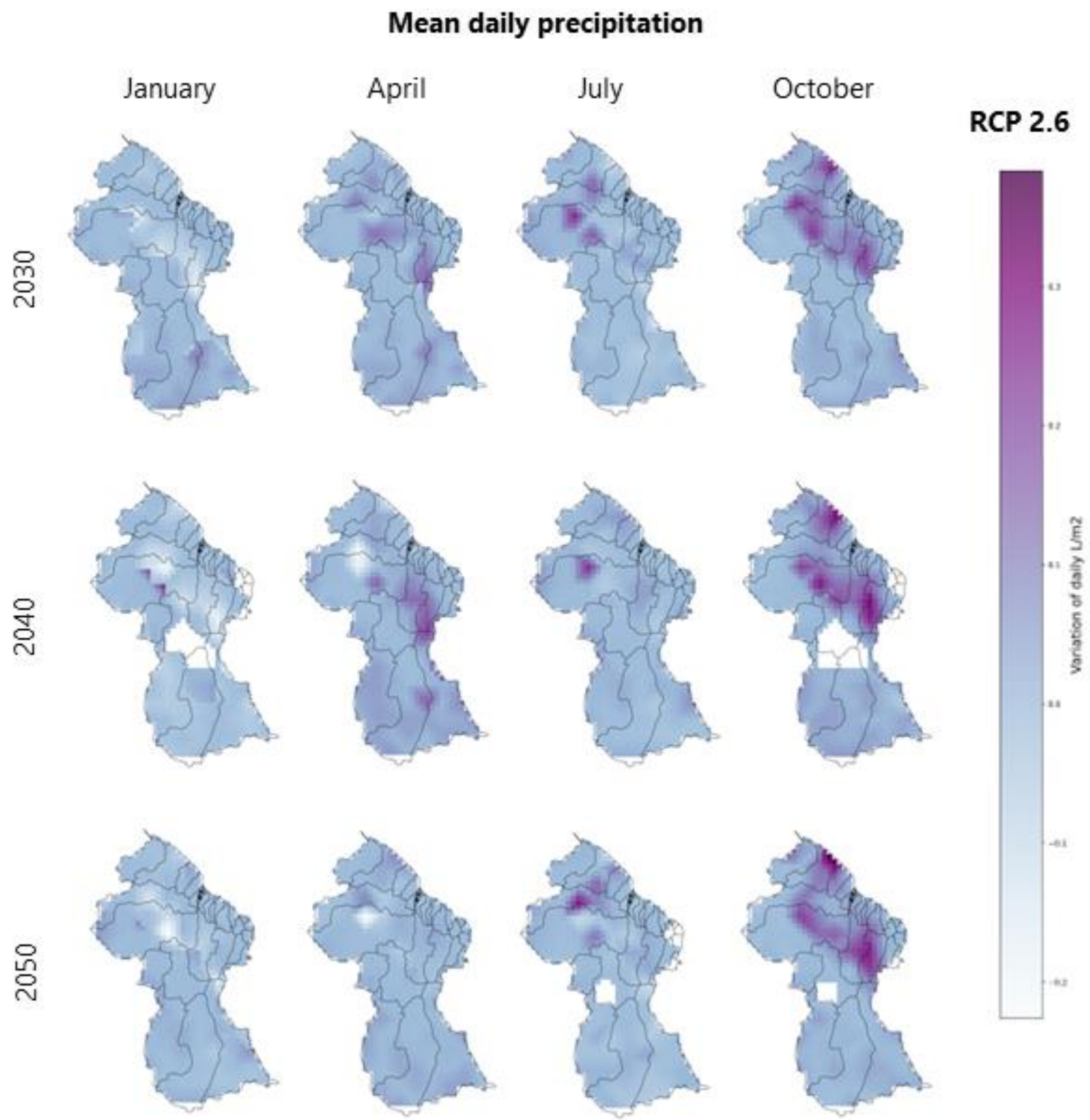

Figure 3.12. Projected increase in daily rainfall (mm) under RCP 2.6.

Under RCP 2.6 and 4.5, nation-wide decreases in precipitation are expected. However, Regions 2, 7, and 10 will be impacted by torrential rains particularly in July through October, while Region 10 is projected most at risk of drought in the period between October through January. Under RCP 8.5, however, torrential rains are expected nationwide, maintaining Region 10 at high risk of drought-like conditions throughout the October-January period.

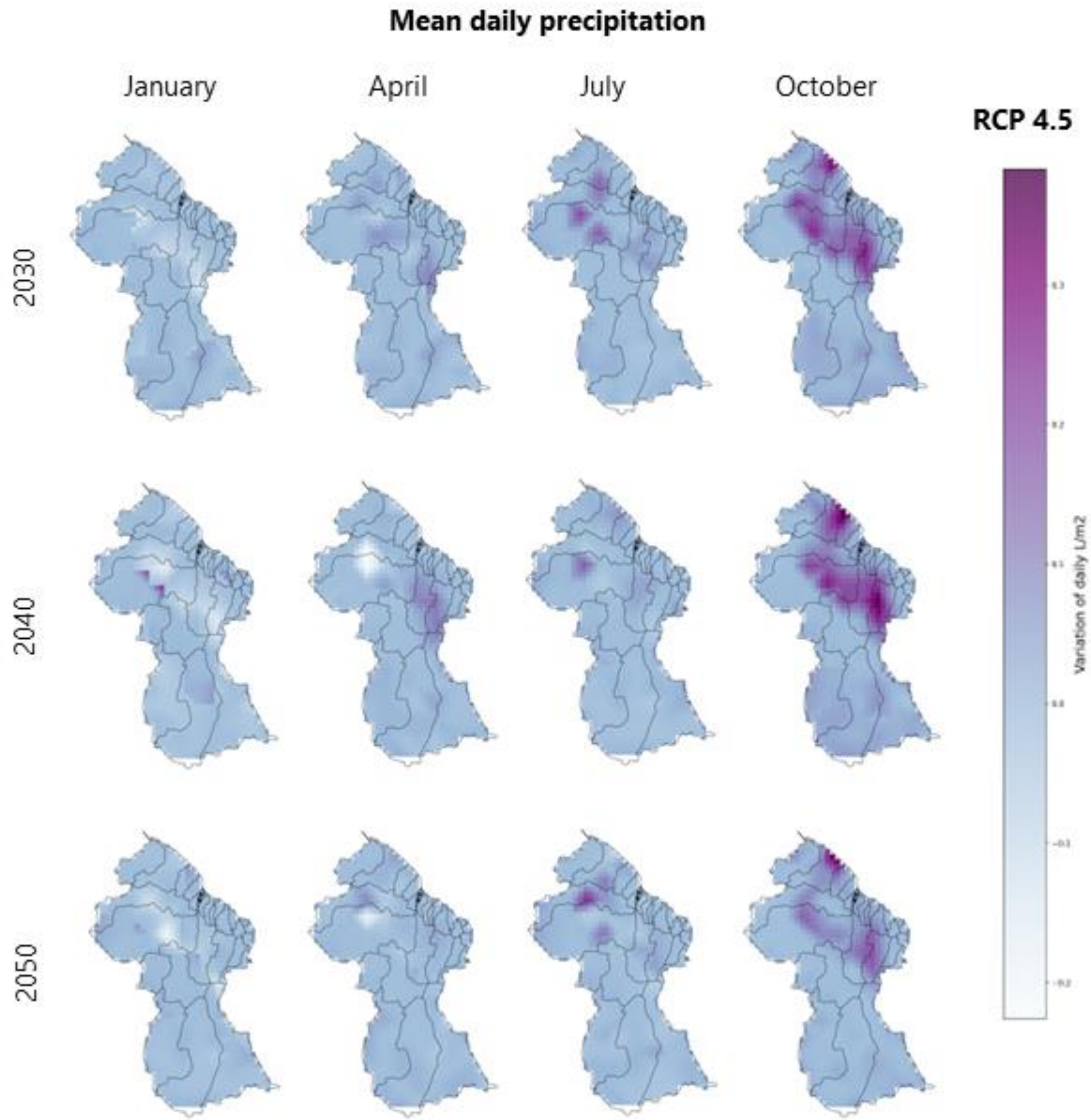

Figure 3.13. Projected increase in daily rainfall (mm) under RCP 4.5.

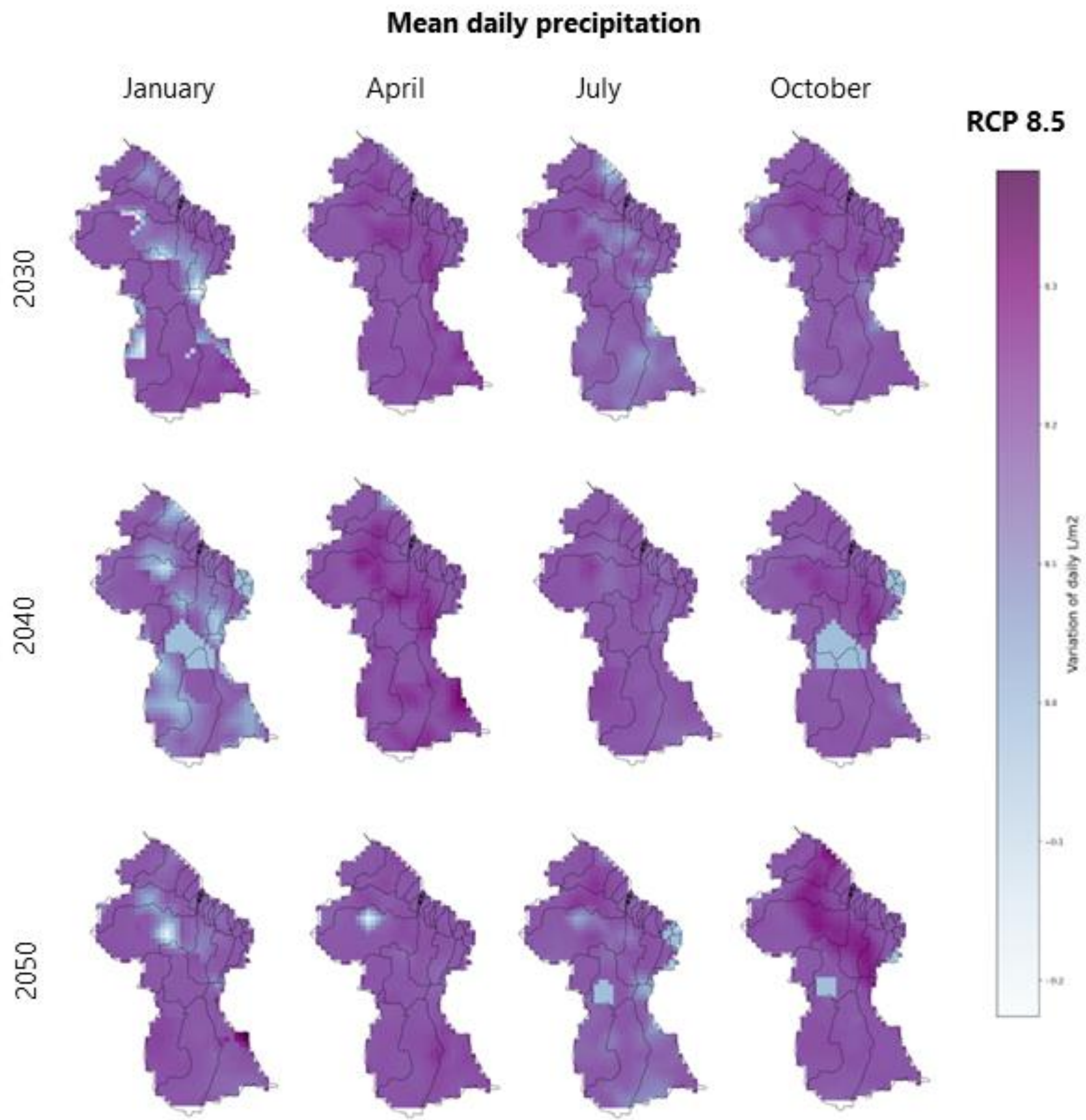

Figure 3.14. Projected increase in daily rainfall (mm) under RCP 8.5.

Figures 3.15, 3.16 and 3.17 below, showcase the Palmer Hydrological Drought Index (PHDI) calculated under RCP 2.6, 4.5, and 8.5, respectively. An index value below zero indicates a risk of drought-like conditions, while the larger the index value above zero, the higher the quantity of water abundance.

Projections indicate that Guyana will experience an increase in hydrological drought towards 2050. The most affected regions will be the Central and Southern parts of the country (Regions 8, 9, 10, and South of 6), all at risk of drought-like conditions throughout all stages of the year, with worsening conditions in October. Region 1 will also experience slight droughts in October, while the rest of the Northern portion of Guyana (Regions 2, 4, 5, 7, and North of 6) will observe an increase in water abundance.

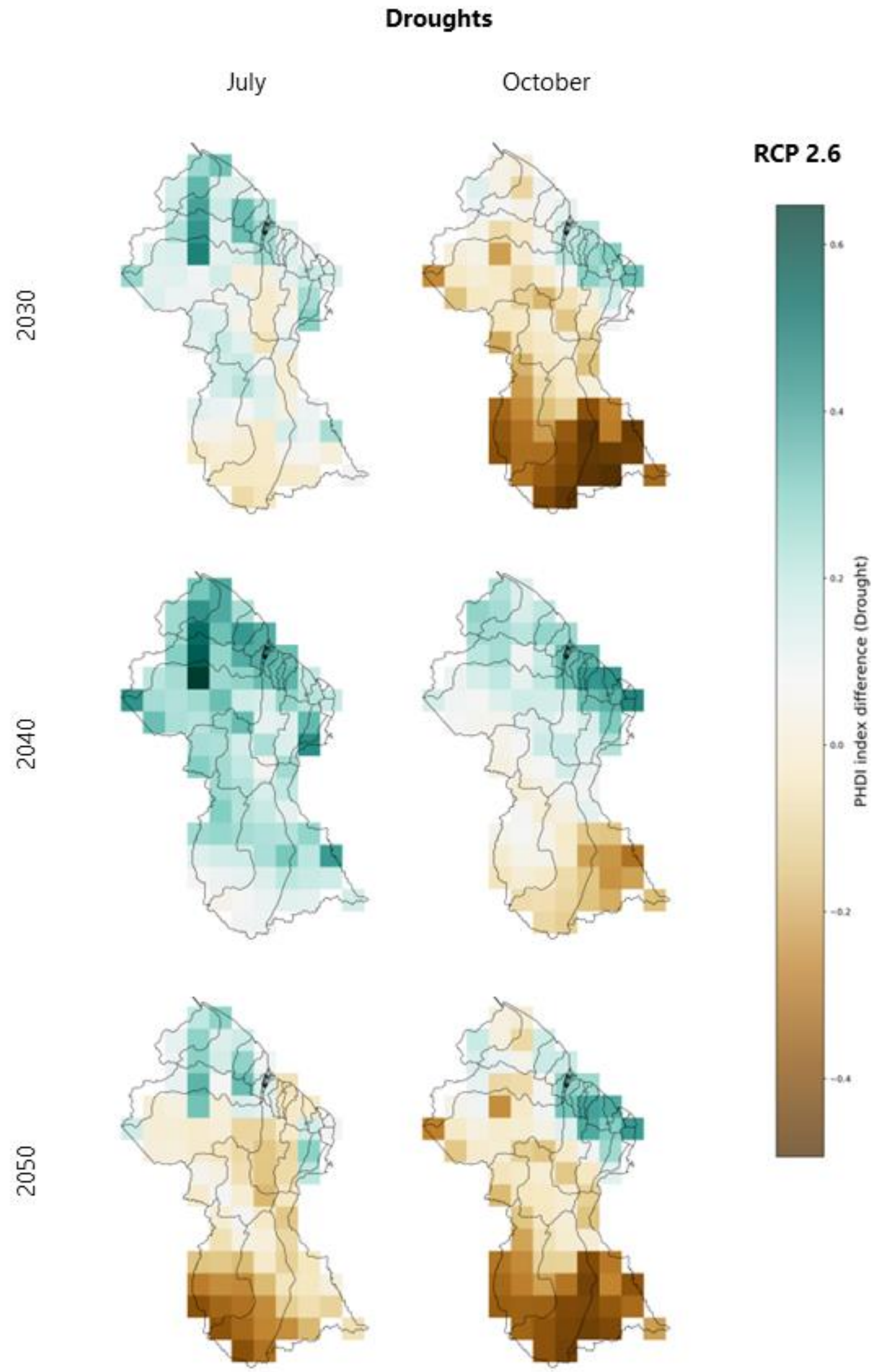

Figure 3.15. Projected drought variation using the PHDI index under RCP 2.6.

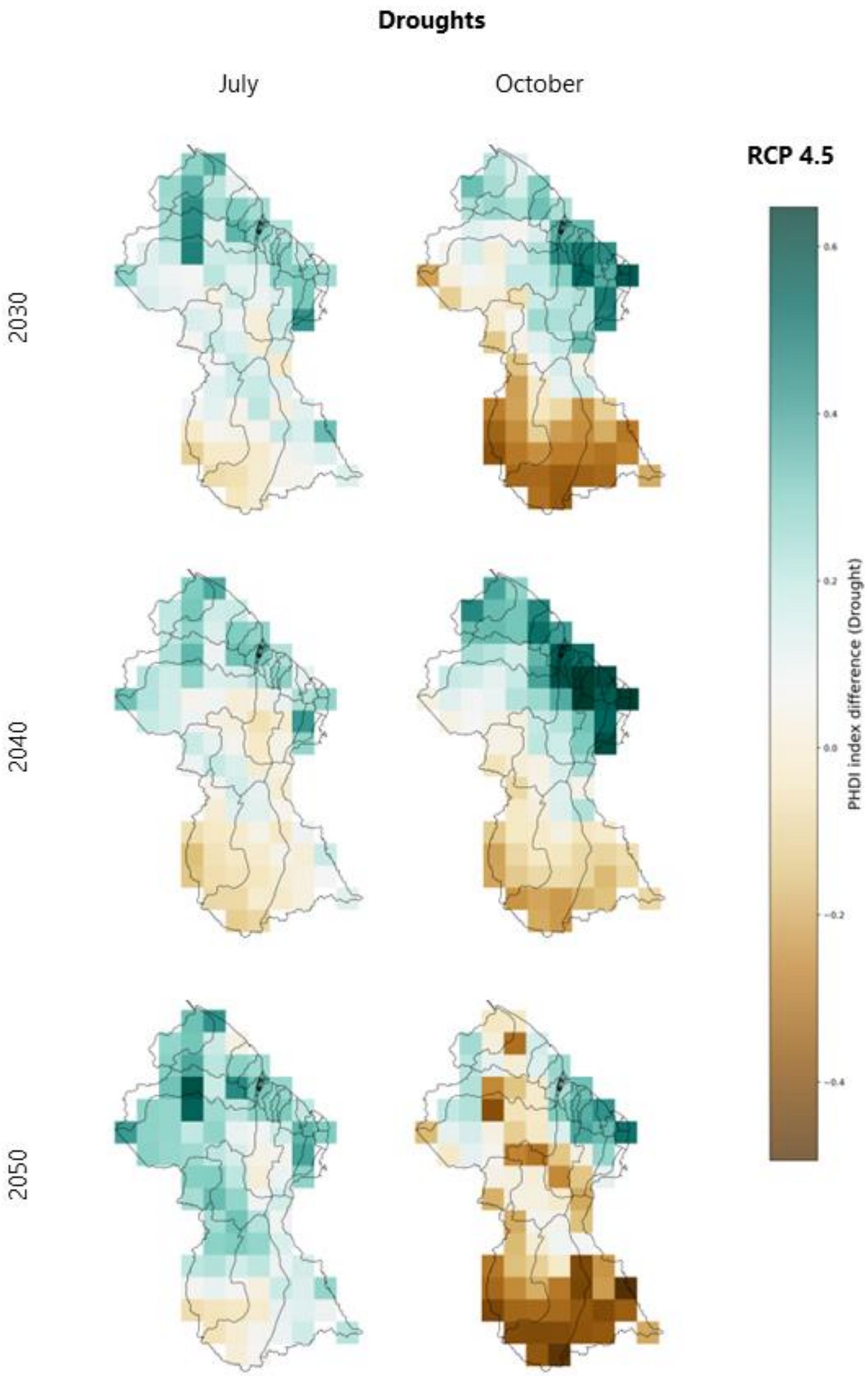

Figure 3.16. Projected drought variation using the PHDI index under RCP 4.5.

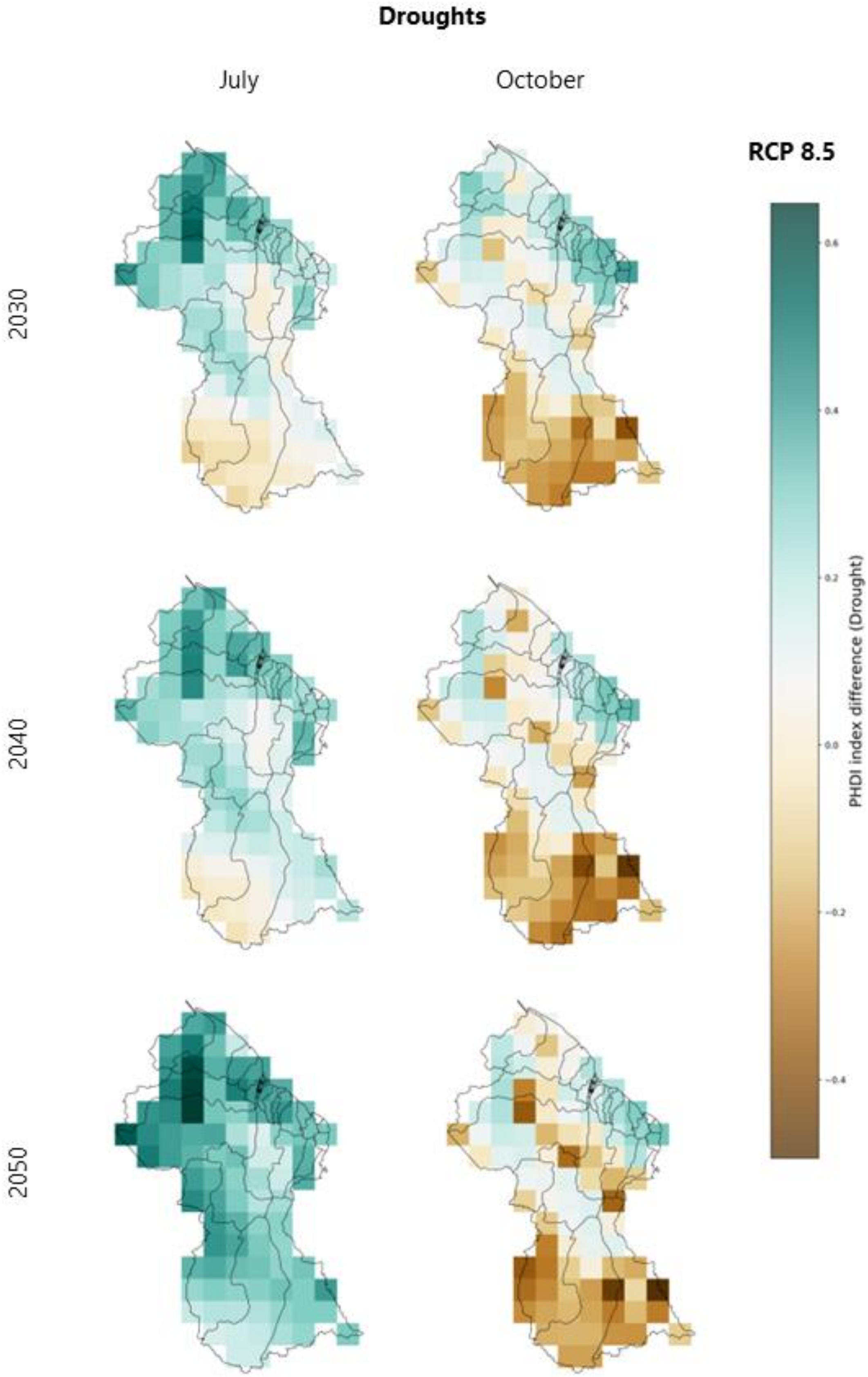

Figure 3.17. Projected drought variation using the PHDI index under RCP 8.5.

The PHDI index, combined by the type of ecosystems present in Guyana translate into fire risk, notable in two key areas of the country as follows:

- **Savannah fires:** The Rupununi savannahs in Region 9 are at a high risk of wildfires. These fires take place mainly during the long dry season from July to December, and can play an important role in the maintenance and evolution of certain habitats of these ecosystems.
- **Urban fires:** Urban areas along the thin coastal strip stretching across Regions 2, 3, 4, 5, and North of 6 have historically shown in important incidence of fires.

The following Figure 3.18 illustrates the historical locations and spread of wildfires in Guyana. Under RCP 2.6, 4.5, and 8.5, both the expected location and spread of these fires in the future remain constant, rather increasing in frequency and timing throughout the year corresponding to drought-like periods identified by the PHDI index.

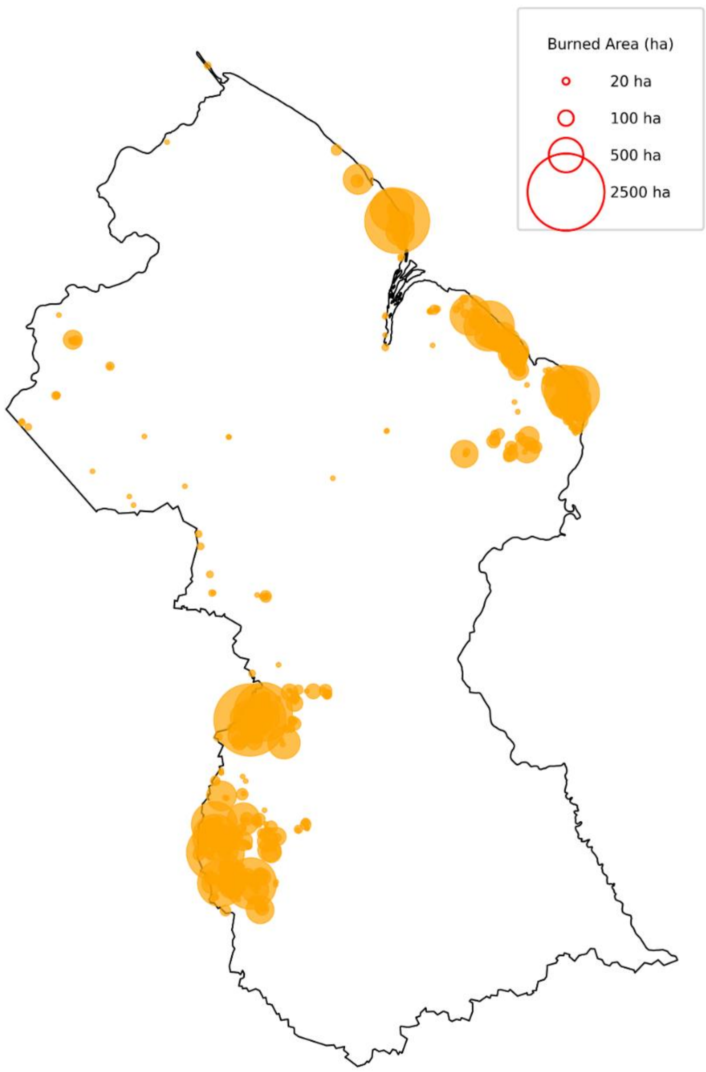

Figure 3.18. Historic wildfire locations and extents in Guyana.

2.2.3. Sea Level Rise

Analysis of tide gauge records from 1951 to 1979 shows the trend in sea level rise for Guyana to be in excess of 10mm per year, which is 2 to 5 times faster than the global estimate. As presented in the following Table 3.4, sea level rise has been modelled for Guyana for 2031, 2051, and 2071 according to the Hadley Circulation Model 3 (HadCM3) and the Canadian General Circulation Model 2 (CGCM2). For each, three different scenarios were considered as follows:

- Average sea level rise.
- Sea level rise with a minimum storm surge of approximately 2m.
- Sea level rise with a maximum storm surge of approximately 5m.

In the worst-case scenario, sea level rise will range from 5.93m to 6.19m by the year 2071, including the effect of storm surge. With Guyana's coastland already up to 1.4m below mean high-tide level, this significant sea level rise can have devastating impacts for Regions 2, 3, 4, 5, and 6.

Table 3.4. Projected sea-level rise in Guyana for 2031, 2051 and 2071 according to HadCM3 and CGCM2 models under three storm surge scenarios.

Year	Scenario	HadCM3	CGCM2
2031	Average sea level rise	0.14	0.26
	Sea level rise with a minimum storm surge	2.82	2.94
	Sea level rise with a maximum storm surge	5.82	5.94
2051	Average sea level rise	0.21	0.34
	Sea level rise with a minimum storm surge	2.89	3.02
	Sea level rise with a maximum storm surge	5.89	6.02
2071	Average sea level rise	0.25	0.51
	Sea level rise with a minimum storm surge	2.93	3.19
	Sea level rise with a maximum storm surge	5.93	6.19

Source: (GoG, 2019)

About 45% of the coastline is currently subject to erosion (Ahmad et al., 2012), mainly caused by natural forces, such as the 30-year erosion-accretion cycle, and also by mangrove depletion, fluvial flooding caused by ineffective outflow of water from drainage and irrigation systems on the coastal zone, as well as beach materials. Climate change is increasing the levels of coastal erosion, leading to loss of arable lands in Guyana's coastal zone. As can be observed in Figure 3.19 and Table 3.5 below, coastal erosion over the past 50 years is most prominent for Regions 2, 3 and 4.

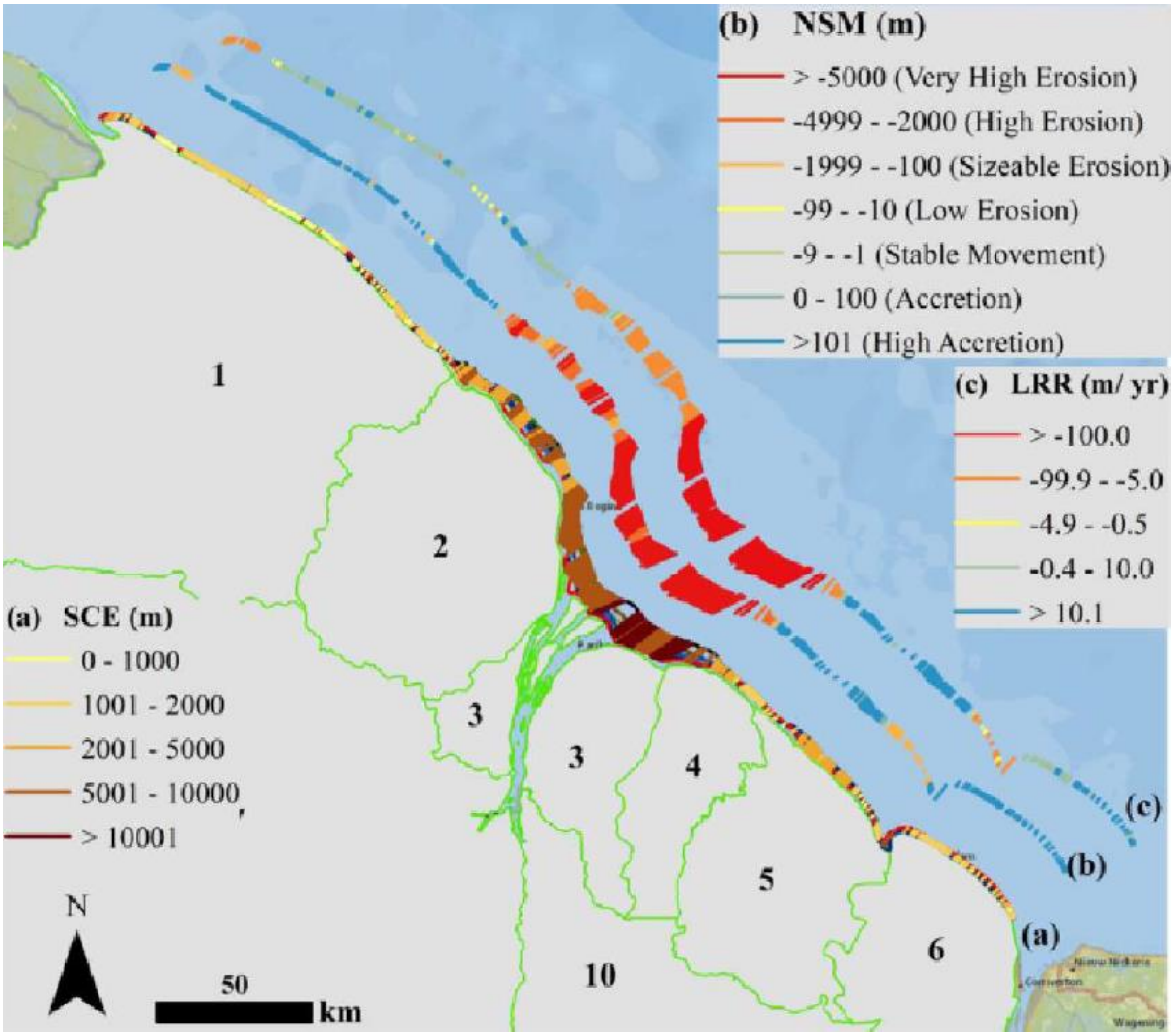

Figure 3.19. Yearly shoreline coastal erosion metrics over the past 50 years (1969-2018). Source: (Oyetudun et al., 2019)

Table 3.5. Coastal erosion risk in urban coastal centres.

Region	Coastal urban centre	Erosion rate	Erosion risk
2	Annandale	-2.4 to -4.9 m per year (erosion)	Very high
4	Mon Repos	-2.4 to -4.9 m per year (erosion)	Very high
4	Kensington	-2.4 to -4.9 m per year (erosion)	Very high
4	Columbia	-2.4 to -4.9 m per year (erosion)	Very high
4	Dekinderen	-2.4 to -4.9 m per year (erosion)	Very high
4	Mahaicony	-2.4 to -4.9 m per year (erosion)	Very high
2	Coastline of Aberdeen	-1.0 to -2.0 m per year(erosion)	High
3	Anna Catherina	-1.0 to -2.0 m per year (erosion)	High
4	Enterprise	-1.0 to -2.0 m per year (erosion)	High
2	Dartmouth	-0.8 to -1.0 m per year (erosion)	Moderate
2	Windsor Castle	-0.8 to -1.0 m per year (erosion)	Moderate
2	Anna Regina	-0.8 to -1.0 m per year (erosion)	Moderate

Region	Coastal urban centre	Erosion rate	Erosion risk
2	Zorg	-0.8 to -1.0 m per year (erosion)	Moderate
3	Parika	-0.8 to -1.0 m per year (erosion)	Moderate
3	Ruby	-0.8 to -1.0 m per year (erosion)	Moderate
3	Zeelugt	-0.8 to -1.0 m per year (erosion)	Moderate
3	Windsor Forest	-0.8 to -1.0 m per year (erosion)	Moderate
3	Vreed-en-Hoop	-0.8 to -1.0 m per year (erosion)	Moderate
4	Georgetown	-0.8 to -1.0 m per year (erosion)	Moderate
4	Better Hope	-0.8 to -1.0 m per year (erosion)	Moderate
4	Golden Grove	-0.8 to -1.0 m per year (erosion)	Moderate
4	Grove	-0.8 to -1.0 m per year (erosion)	Moderate
2	Ondemeeming	+1.1 to +1.3 m per year (accretion)	Low
2	Vilvoorden	+1.1 to +1.3 m per year (accretion)	Low
2	Good Hope	+1.1 to +1.3 m per year (accretion)	Low

Source: (Ali Ayat, 2016)

3. Climate change impacts and vulnerability assessment

The ongoing and projected changes in climate is already inflicting a series of slow onset extreme acute impacts for Guyana including extreme heat, fires, drought, storm, strong winds, fluvial flooding, coastal flooding, water pollution, and pests and diseases, all of which will increase in frequency, intensity, and extent in the future. Just as projected changes in climatic variables will vary geographically in Guyana, so too will these impacts vary across the various administrative regions.

The effects of extreme weather events, particularly increased frequency and intensity of precipitation and storm surges coupled with sea level rise, will significantly impact Guyana's coastal zone. This area, where the majority of the population, settlements, main infrastructure and economic centres are located, is highly vulnerable to frequent flooding. Flooding poses the greatest threat among hydro-meteorological events, with Regions 1 to 6 along the coastline being the most exposed and vulnerable (GoG, 2019).

In 2021, the Civil Defence Commission completed a series of risk assessments at the regional level. Through a participatory approach, these assessments identified and ranked the most concerning climate-induced risk across each region in Guyana, with results summarized in Table 3.6 below.

Such impacts will inflict a series of environmental and socioeconomic consequences for all economic sectors in Guyana at varying magnitudes and extents considering the sectoral exposures, sensitivities, and adaptive capacities which collectively dictate the country´s sectoral vulnerabilities to these climate impacts.

Table 3.6. Identification and ranking of current climate risks across Guyana, 1 being the top concern for each region.

	Crop pests and diseases	Drought	Water pollution	Fluvial flooding	Health epidemics	Fires	Erosion	Saltwater intrusion	Coastal flooding	Strond winds	Elevated temperatures
Region 1	1	2	3	4	6	7		8	5		
Region 2	4	5		1	6	8	3	7	2	9	
Region 3	5	3		1	6	8			2	4	7
Region 4	5	3		1	6	8			2	4	7
Region 5	5	4		1	2	3			6		
Region 6			5	2	4	3				1	
Region 7	2		3	4	1	5	6				
Region 8	5	3	2	1	6	4	7				
Region 9	4	3	6	1	5	7	2			8	
Region 10	5	1	4	6	3	7	2			8	

Source: (Civil Defence Commission, 2021)

3.1. Observed climate change impacts

Guyana is already experiencing the adverse, and potentially catastrophic, socioeconomic and environmental impacts of climate change, including marked increases in temperatures, sea levels, and the frequency and intensity of extreme rainfall events.

According to Germanwatch (2021), Guyana Ranks 119th in terms of climate risk index for the 2000-2019 period, being 49th in average losses per unit GDP related to climate-induced extreme weather events.

Guyana normally experiences heavy rainfall events during La Niña events which exacerbates flooding in areas of the country prone to such events. Guyana has already suffered from flooding events in 2005, 2006, 2008, 2010, 2011, 2013, 2014, 2015 and 2021, all inflicting negative effects on the people of Guyana and have cost the country millions of dollars. For example, the great flood of 2005 caused damage estimated at US $465 million, equivalent to 60% of the country’s gross domestic product (GDP). This event was reported to have affected close to 275,000 people (37% of the population at the time of the disasters). Considerable losses were recorded in the agriculture sector, associated with damage and production shortfalls in sugar, rice, livestock and other crops (fruits, vegetables, roots and tubers, and herbs and spices). Region 4 was most severely affected, experiencing close to 55% of the total damage, followed by Regions 2 (23%) and 5 (19%) (Office of Climate Change, 2016a).

Guyana’s most recent water-related disaster was the 2021 floods, which resulted from heavy rains and were declared a national disaster in June 2021. The economic losses were estimated at 12% of national GDP. While no direct deaths or missing persons were recorded, the severe impact on the agriculture sector led the government to distribute flood relief grants to 55,667 farmers, at total cost of US $7.8 billion (Red Cross, 2021).

Guyana normally experiences droughts during El Niño events, which cause significant socioeconomic and environmental losses and damages. In fact, the country has also observed severe droughts in 1997-1998, 2009-2010 and 2015. The drought of 1997 affected the greatest number of people (607,200). The drought of 2009-2010 affected the entire Caribbean region, leading to water rationing and major crop losses. The cost of delivering water through pumping and creating canals in Guyana reached US $16,000 per day, pumping saline water to about 150 acres of rice lands. During the drought in April 2015, potable water had to be trucked into communities in Regions 9 and 1 (Office of Climate Change, 2016a). In Region 9, all the water wells dried up and frequent bush fires broke out, and residents lacked access to potable water for domestic and agricultural use. The drought also caused a resurgence of pests that attacked the few crops that survived. In response, authorities spent US $1.2 million to improve irrigation and pump water into farmlands affected by absent of year-end rains (Guyana Lands and Surveys Commission, 2020).

The frequency, intensity, and spread of these already-observed impacts in Guyana will further increase in the future due to climate change, affecting various sectors differently according to their expected vulnerability to climate change.

3.2. Sectoral vulnerability and impact assessment

The analysis of the impacts and vulnerabilities from climate change hazards in Guyana for each sector highlights the multifaceted challenges faced by the country. The following sections present a summary of the detrimental effects these climate change impacts will inflict on each of Guyana´s ten priority adaptation sectors, as well as a summary of the conditions that make each sector vulnerable to climate change. These ten priority adaptation sectors are: agriculture and food security; water resources; coastal zones; health; education; ecosystems and biodiversity; energy security; disaster risk management; land use, infrastructure, settlements, and services; and Amerindian and Hinterland development.

3.2.1. Agriculture and food security

Agriculture is crucial to Guyana's food security, sustainable livelihood development, employment generation, and foreign exchange earnings. However, the sector is highly vulnerable to the observed and predicted changes in climate, posing significant impacts on agriculture as follows:

- **Decreased precipitation and drought-like conditions**: The agriculture sector's heavy dependence on water, a critical input for plant and animal growth, underscores its exposure to climate change impacts. Water scarcity for irrigation and livestock presents a significant risk for food security, employment, and export revenues. Most of Guyana´s agriculture is dependent of the extensive coastal irrigation network supported by the nation´s water conservancies, whereupon irrigation restrictions due to water shortages in conservancy areas impacting agricultural activities. This change will severely reduce crop productivity for staples such as dasheens, cassavas, eddoes, and cash crops like sugarcane and rice, with greater impacts in Regions 3 and 4 (GoG, 2021). On the other hand, inland farming among Amerindian and Hinterland communities tend to depend on groundwater resources. The North and South Rupununi villages in Region 9 have traditionally suffered from inadequate water supply for their crops and livestock during dry months of the year. (Guyana Lands and Surveys Commission, 2020). These changes also exacerbate soil erosion, reducing agricultural yields and affecting local food security and employment.
- **Increased temperature and humidity facilitating spread of pests and diseases**: Increased spread of pests and diseases among crops and livestock reduce agricultural yields and threatening food security, exports, and employment.
- **Spread of wildfires**: Increased frequency of wildfires destroy agricultural lands, particularly smallholder farms in the Hinterland. The regions with areas that are at high and extreme danger of a vegetation fire are Regions 4 (45%), 10 (44%), 9 (23%), 8 (19%), and 3 (18%) (GoG, 2021).
- **Increased precipitation intensity and storms result in flooding events**: The inadequacy of drainage systems to handle increased rainfall causes significant damage to crops and annual yields. Flooding also threatens livestock and rural livelihoods. Coastal flooding reduces discharge windows for drainage, damaging agricultural lands, particularly rice paddies and sugarcane crops, with severe consequences for local food security, employment, and coastal rural livelihoods.
- **Sea level rise and saltwater intrusion**: Estimates of the impacts to agricultural GDP under various seawater inundation scenarios range from 1% with a 1m impact to 7% with a 6m impact (storm surge inundation). Modelled impacts to crop productivity have equally indicated declines as much as 47% for sugarcane, 4% and 8% for rice (rainfed and irrigated, respectively), and 7-8% for maize and cowpea (GoG, 2019). The encroachment of saline water damages agricultural lands, reducing productivity and threatening local food security and employment.

The agriculture sector's vulnerability to climate change is due to its inherent dependencies on climatic conditions for water resources, plant development, and animal health. Agriculture is a major contributor to Guyana's GDP and a significant source of cash crop and non-traditional crop exports, making any negative impact on this sector significant for the national economy. However, the sector is primarily comprised of community-based subsidence farming and small to medium scale commercial operations farming less than 15ha of land. Apart from rice and sugar other key crops include coconuts, vegetables (tomatoes, cabbage, pumpkin, bora, ochro, boulanger, squash, cucumber) herbs, spices and seasonings, fruits (banana, pineapple, pear, carambola, and watermelon) and to a lesser extent, coffee, cocoa, and cotton. Small-scale farmers, in some cases, lack access to finance, technology, and technical knowledge on climate resilience practices.

Much of the Lowland Coastal Plain has been reclaimed to become agricultural fields in order to take advantage of the rich alluvial soil deposited by currents from the Amazon. The concentration of agricultural activity in the Low Coastal Plain in a narrow strip mostly below mean high tide level, increases the sector's exposure to sea level rise and storm surge-related flood damage, which are exacerbated by combined fluvial flooding events and poor drainage capacity. Challenges to drainage and irrigation systems exacerbate the sector's vulnerability to climate impacts, restricting the ability to manage these impacts effectively.

3.2.2. Water resources

Adequate availability and quality of water resources is critical for Guyana’s socioeconomic development as key sectors in Guyana such as agriculture, forestry, mining, manufacturing, infrastructure, and settlements are highly dependent on water resources, which provide a range of services including, irrigation for its vast agriculture sector, domestic and commercial water supply, ecotourism, flooding control, and hydropower. As such, projected climate change impacts in the water resources sector will inflict knock-on effects to all other environmental and socioeconomic activities in the country.

The water resources sector is impacted two climate-induced threats namely (1) increased precipitation intensity, where the excess leads to flooding, and (2) a lack of rainfall, resulting in water deficit and drought. These hazards lead to a range of socioeconomic impacts and reveal numerous vulnerabilities due to existing unsustainable water resource management practices and infrastructural challenges as outlined below:

- **Decreased precipitation and drought-like conditions**: Periods of decreased precipitation, leading to droughts, create significant water deficits for domestic, industrial, and commercial purposes, particularly in Southern Guyana (Regions 5, 7, 8, 9, and 10). While Central and Coastal Guyana rely on a complex system of water conservancies to maintain year-round water balance, Southern Guyana's lack of water conservancies makes water regulation between dry and wet seasons difficult, often resulting in flooding during rainy periods and water shortages during dry periods due to overflows and drying of surface water resources. The underlying sandy soils in these regions exacerbate surface drainage issues, complicating crop irrigation. Most recently, groundwater wells have increased in importance in Southern Guyana to overcome the above-mentioned challenge. However, reduced groundwater recharge during droughts leads to water shortages in areas with limited aquifer potential, especially in severely drought-hit regions. Limited hydrological data hampers the understanding of groundwater resources, putting Hinterland communities at high risk of over-drawing groundwater during droughts due to insufficient information on groundwater characteristics and pumping rates.

- **Severe flooding including fluvial flooding from increased precipitation and coastal flooding from sea level rise, whose combined effect is particularly severe for the low-lying coastal area**: Most of Guyana´s socioeconomic activity is located in the low-lying coastal strip which extends several meters below sea level and concentrates around the delta of several mayor watersheds, including the Essequibo River. Furthermore, the region´s low-lying topography already undergoes seasonal flooding, whereupon floodwaters remain stagnated for weeks on end. As such, Guyana´s socioeconomic activity is highly vulnerable to both fluvial and coastal flooding, whose impacts are duplicated with their combined effect. Moreover, while Guyana´s water conservancies play a crucial role in managing the intraseasonal water balance, their respective dams are aging and pose an additional severe flood risk to downstream urban centres and agricultural lands from overtopping or breaching. Guyana's lowland areas therefore rely on a complex drainage network and riverine and seawall defence system for flooding control, both of which are aging and in need of maintenance and repair. Additionally, increased precipitation intensities overwork sluices and pumps essential for drainage, risking damage and necessitating upgrades to withstand more extreme conditions. Sea level rise further aggravates the situation by reducing the "discharge window" from low tide to mean tide. Flood-prone areas without adequate drainage systems face significant annual economic losses, projected to reach US $150 million by 2030 due to damage to infrastructure, human loss, and disruption to socioeconomic activities.
- **Water contamination from increased runoff**: Increased precipitation events pose a risk to water contamination from overtopping of sewerage, spread of wastes, wash-out of agricultural chemicals, and wash-out of mining chemicals and tailings. This is particularly concerning as 75% of the Hinterland population has access to safe water supply and just over half of the costal urban hubs have treated water coverage. While sanitation methods in Guyana have substantially improved over the past three decades,. the country relies of septic tanks which are prone to overtopping during flooding events. Uncontrolled use of pesticides and fertiliser for agricultural purposes, as well as the use of chemicals and mercury in mining operations pose a severe risk to

water contamination, which, under flooding conditions, are elevated due to increased run-off and wash-out of these substances. Within this context, improving the efficacy of assessing water quality remains a high priority for Guyana, in addition to enhanced regulation and enforcement of water pollution control.

- **Saltwater intrusion**: Saltwater intrusion threatens the groundwater and surface aquifers, reducing the availability of fresh and potable water. This issue is especially critical as the coastal groundwater aquifer system supports 90% of the national population residing on the coastal lowlands. Additionally, saline and brackish water spreads into the lower reaches of rivers, particularly during extreme dry conditions, affecting freshwater availability up to 200km inland.
- **Rising temperatures increasing water demands**: Rising temperatures in Guyana increase freshwater demands, straining the existing water supply infrastructure already in need of expansion, maintenance, and repair. Population growth and urbanization, driven by economic developments, exacerbate these challenges. Rising temperatures and heatwaves further increase domestic and commercial water demand, compounding supply challenges and stressing the overall water supply system.

The following maps in Figures 3.20, 3.21, and 3.22 illustrate the impact of precipitation on Guyana´s main rivers for RCP 2.6, 4.5, and 8.5 scenarios, respectively. These maps highlight the critical regions and times of the year where water resources in Guyana are expected to be most affected by changes in precipitation due to climate change.

In summary, RCP 2.6 and 4.5 scenarios highlight significant decreases in precipitation in most of the country, showing a peak in low precipitation rates in 2040. January is projected as the month that will most suffer from reduced rainfalls, particularly impacting water availability in Central Guyana (Regions 7, 8, and 10). The maps indicate, however, that a water surplus for a particular area of Guyana is expected in October, impacting major river systems and water bodies in Regions 2, 3, 10 and Northern 6.

The high emission scenario, RCP 8.5, on the contrary, shows a nation-wide dramatic increase in precipitation across all regions and months, indicating severe fluvial flooding risk for Guyana's water resources sector, except in the coastal line and some central areas of the country, where precipitations will be reduced or will remain invariable.

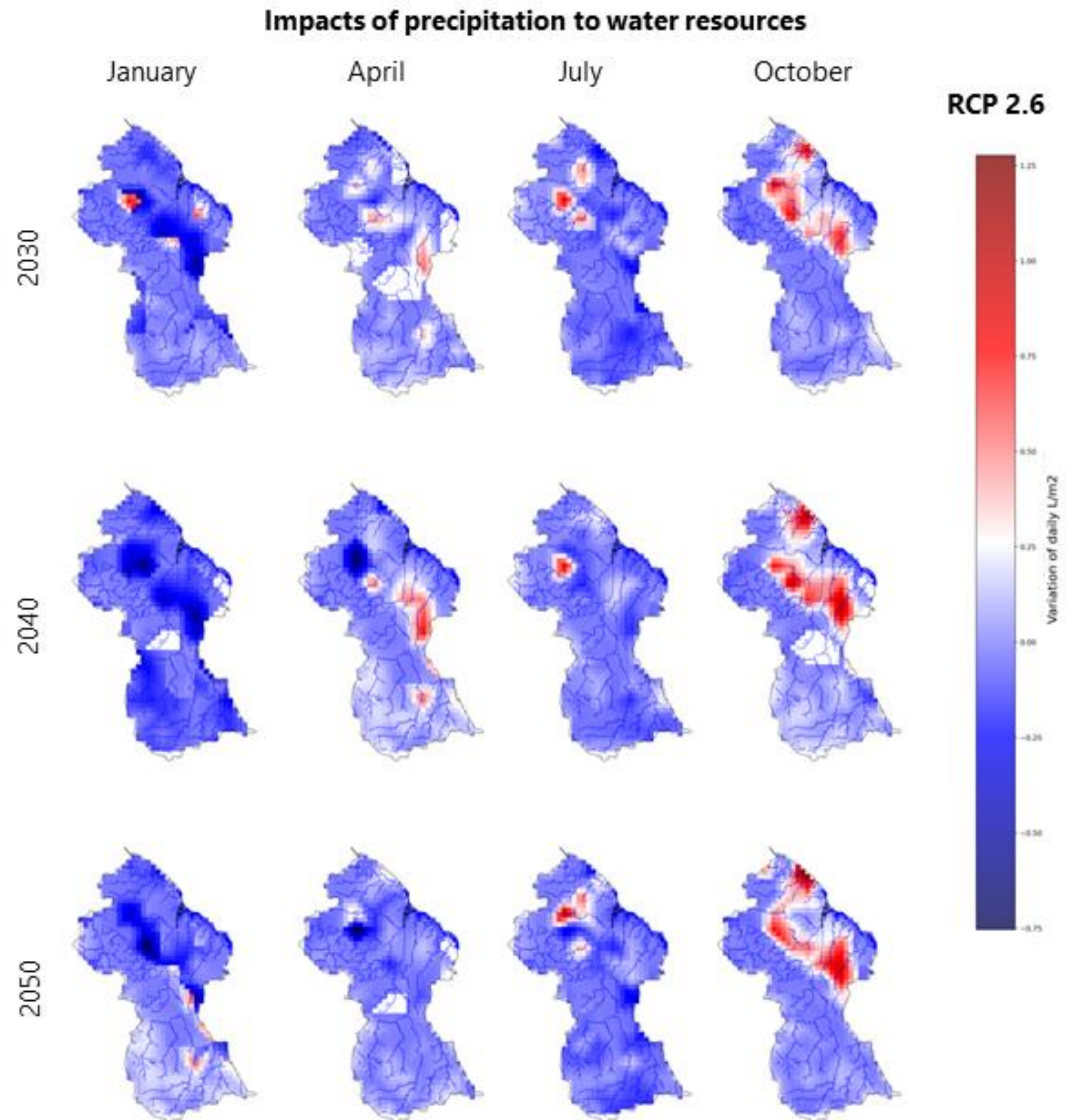

Figure 3.20. Changes in daily precipitation (mm) under RCP 2.6 and its impact on water bodies.

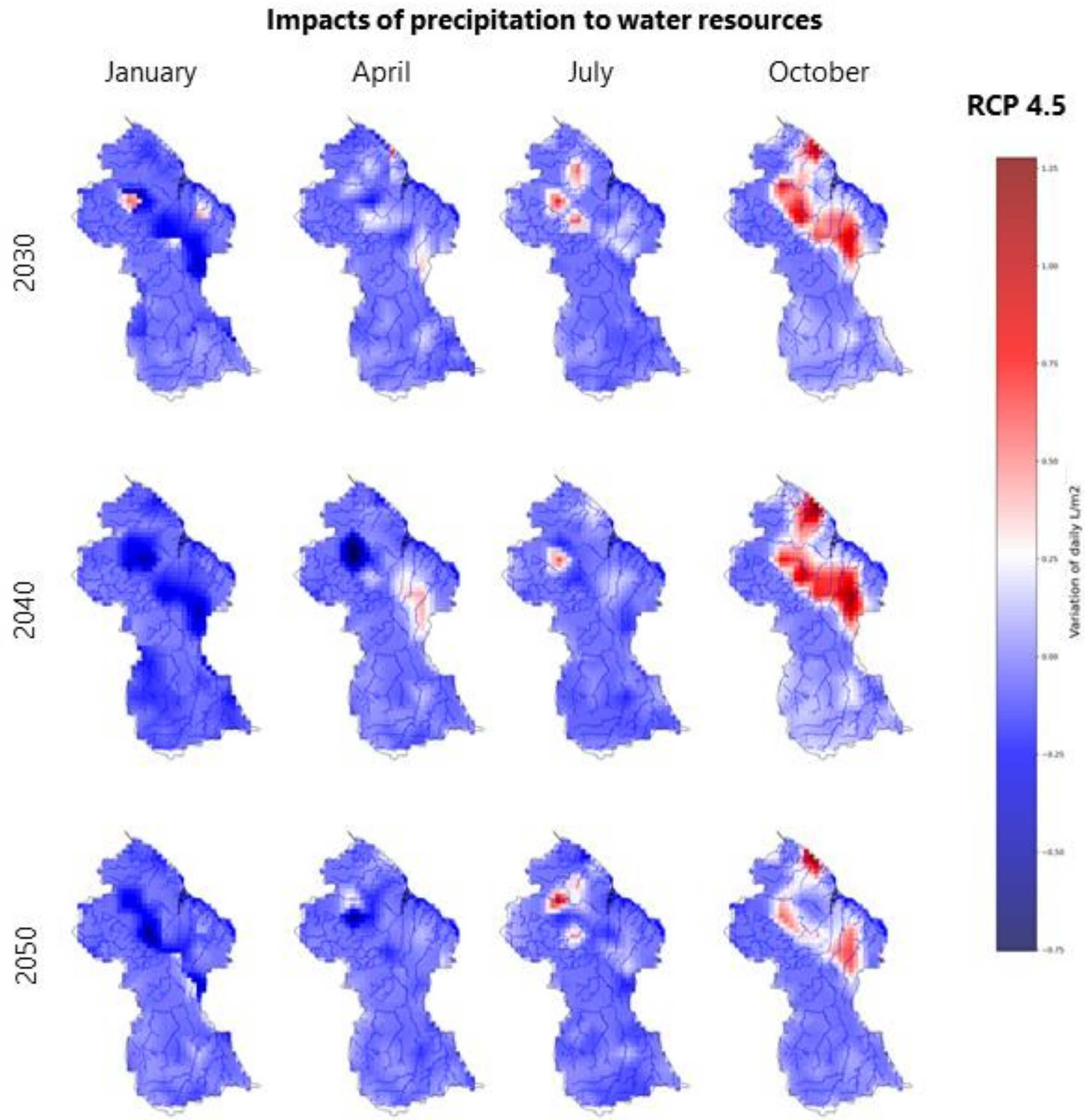

Figure 3.21. Changes in daily precipitation (mm) under RCP 4.5 and its impact on water bodies.

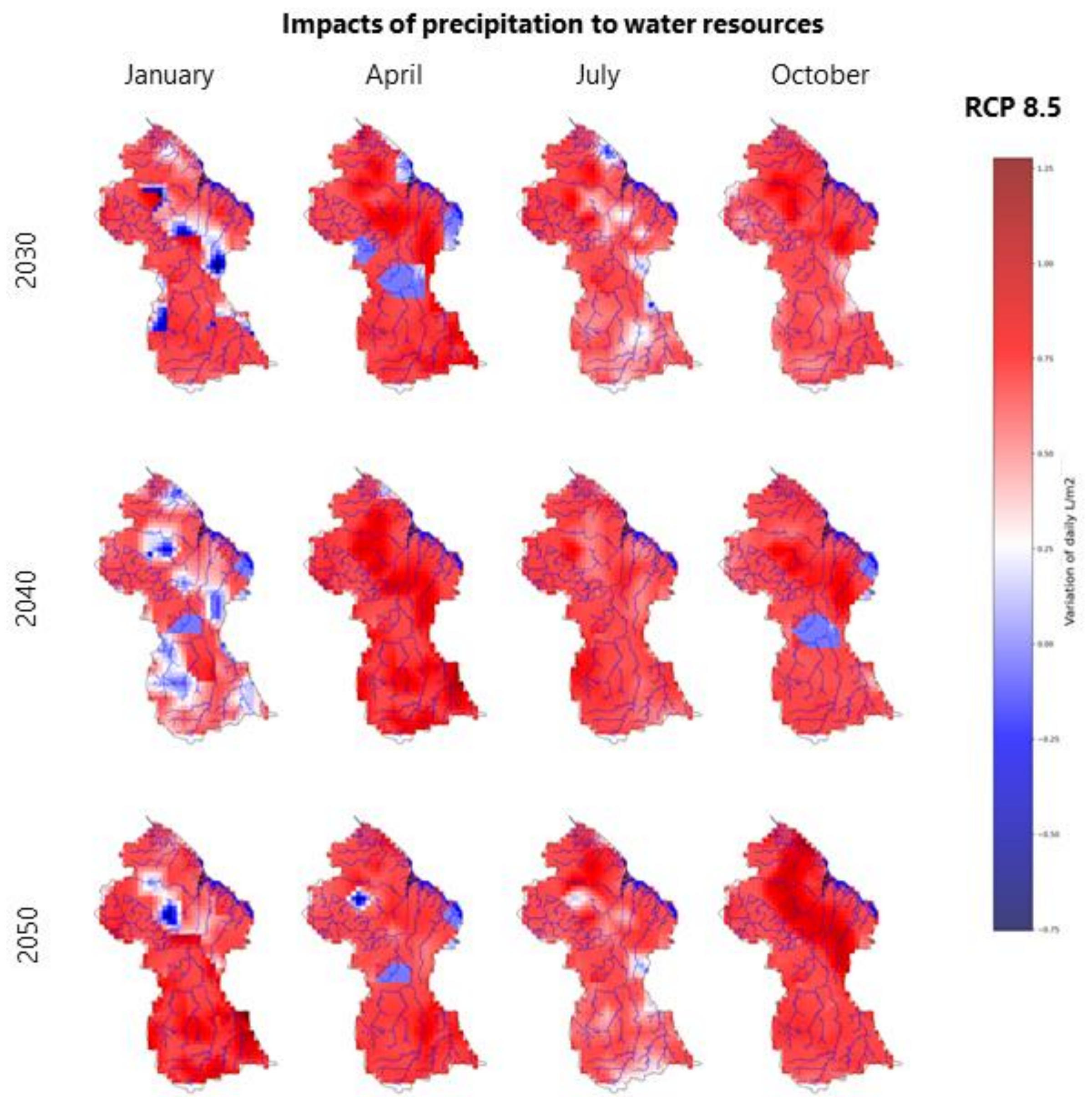

Figure 3.22. Changes in daily precipitation (mm) under RCP 8.5 and its impact on water bodies.

3.2.3. Coastal zones

Guyana's coastal zone is extremely vulnerable to **coastal flooding** and **coastal erosion** because of its geophysical and socio-economic characteristics. Located on the Northern boundary with the Atlantic Ocean, it is a long narrow flood plain approximately 430 km long and varies in width from 26 km to 77 km. Most of the coastal strip is 0.5-1.0 m below the current average sea level, lying up to 1.4m-3m below current mean high-tide level. As such, coastal inundation is already frequent. When combined with the effect of super-tides and competing river discharge during heavy precipitation period, this coastal inundation leads to backwater effects that extend to upstream locations.

Although it constitutes only 5% of the country's territory, approximately 90% of the Guyanese population resides in this coastal zone. Alongside the main urban centres, industrial and commercial activities, coastal assets include agriculture lands for large-scale production and export, as well as major infrastructure, such as energy generation and transmission systems, roads, and communication networks. Under this context, frequent and extensive inundation of the coastal zone has detrimental socioeconomic effects, which will be further exacerbated by sea level rise induced by climate change. Further, about 45% of the coastline is currently subjected to erosion. The rate of shoreline recession and coastal flooding will significantly increase in areas not protected by seawalls.

The following Figure 3.23 illustrates the expected extent of coastal flooding on various residential and agricultural lands in the greater Georgetown metropolitan area assuming a 0.26m sea level rise and a 5m storm surge, with projected flood areas extending inland as much as 15-20km. Table 3.7 summarises the projected loss of lands and infrastructure under differing magnitudes of sea level rise.

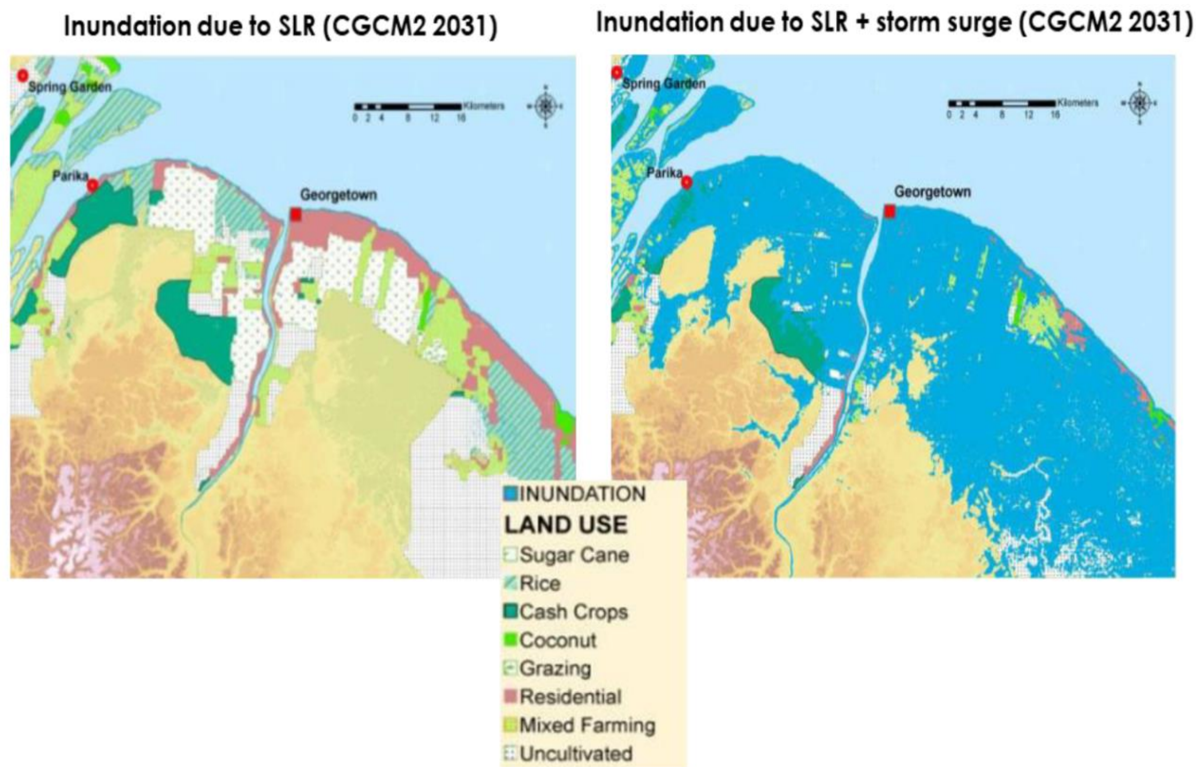

Figure 3.23. Future Projected Sea Level Rise and Storm Surge Inundation Areas.
Source: (GoG, 2019)

Under this context, the coastal zone - and the socioeconomic activities it sustains - relies largely on an elaborate system of engineered sea defences (sea walls, dams, dykes, and polders) spanning approximately 110km of shoreline across Regions 2, 3, 4, 5, and 6, supported by a network of drainage channels and pumps.

Table 3.7. Predicted extent of impacts of sea level rise for Guyana.

	Parameter	Sea level rise					
		1m	2m	3m	4m	5m	6m
Percentage of country total affected	Land area	0%	1%	1%	2%	2%	3%
	Population	3%	8%	17%	25%	30%	32%
	Urban area	8%	21%	38%	48%	56%	60%
	Wetland area	1%	3%	6%	9%	11%	14%
	Agricultural land	1%	2%	4%	5%	6%	7%
	Major tourism resorts	50%	50%	75%	100%	100%	100%
	Road network	6%	14%	24%	30%	33%	35%

Source: (GoG, 2019).

As shown in Table 3.8, according to the Ministry of Public Works (2024) most recent coastal flood defences infrastructure inventory summary, 15% of Guyana´s engineered sea defences are in need of rehabilitation and 4% are in critical condition with urgent need of maintenance and replacement, as overtopping, seepage, and erosion is very recent. Sea level rise will further damage such structures and increase the frequency of overtopping, seepage, and erosion, posing severe inundation risks to the coastal zone.

Table 3.8. Total length (km) of sea defence structures categorized by district and condition.

Condition	Length of Sea Defences and Condition by District (km)							
	District 1	District 2	District 3	District 4	District 5	District 6 & 7	District 8	Total Length
Good	24.676	20.3	27.56	13.981	36.999	34.66	60	218.18
Fair	38.914	9.17	1.35	48.132	42.114	31.44	40	211.12
Poor	52.294	6.75	0.47	3.95	0.037	0.5	52	116
Critical	0.68	4.58	8.62	3.667	0	0	10	27.55
Total	116.564	40.8	76	69.73	79.151	66.6	162	610.85

Source: (Ministry of Public Works, 2024).

Critical refers to defences in a state of total disrepair. It may lead to imminent (1- 2 years) flooding and requires urgent attention. In general, they will require intervention within a period of 1 to 3 years. Poor is used to describe sea and river defences that are in a state of disrepair but are not as vulnerable as those considered critical. The anticipated residual life of poor sea defences is generally 3 to 8 years. Fair condition exists where there is little indication of structural failure or collapse of the defences but where flooding and inundation is incidental, with an anticipated residual life between 10 to 15 years. Good represents sea and river defence that is fully functional but requires some form of maintenance intervention to extend its useful life, generally above 15 years.

It is therefore evident that portions of the sea defence structures across various districts are in need for maintenance and upgrades to ensure the continued protection of Guyana's coastal regions against the escalating threats of sea level rise and coastal erosion. The distribution of these conditions highlights the areas requiring immediate attention, particularly in Districts 1 (Essequibo Coast, Pomeroon River, Region 2), District 3 (Leguan Island), and District 8 (Corentyne Coast, East Bank Berbice & Canje River), where the highest lengths of critical and poor-condition defences are located (Ministry of Public Works, 2024).

Guyana´s drainage network supports the sea defences to maintain the integrity of the low-lying coast by draining excess sea water overtopped or seeped. While some channels drain by gravity flow, others require direct pumped action. Due to sea level rise, it has been found that the pressure of the water flowing from the ocean to the coast is already exceeding the water being drained out of the coast, which will be further exacerbated as sea level rise continues. Consequently, existing pumps are overworked and may become non-operational in the future.

Guyana also relies on natural defence mechanisms (**mangroves**) to provide coastal flooding protection from the Atlantic Ocean. Figure 3.24 presents the location and extent of the mangrove ecosystems along Guyana's coastline.

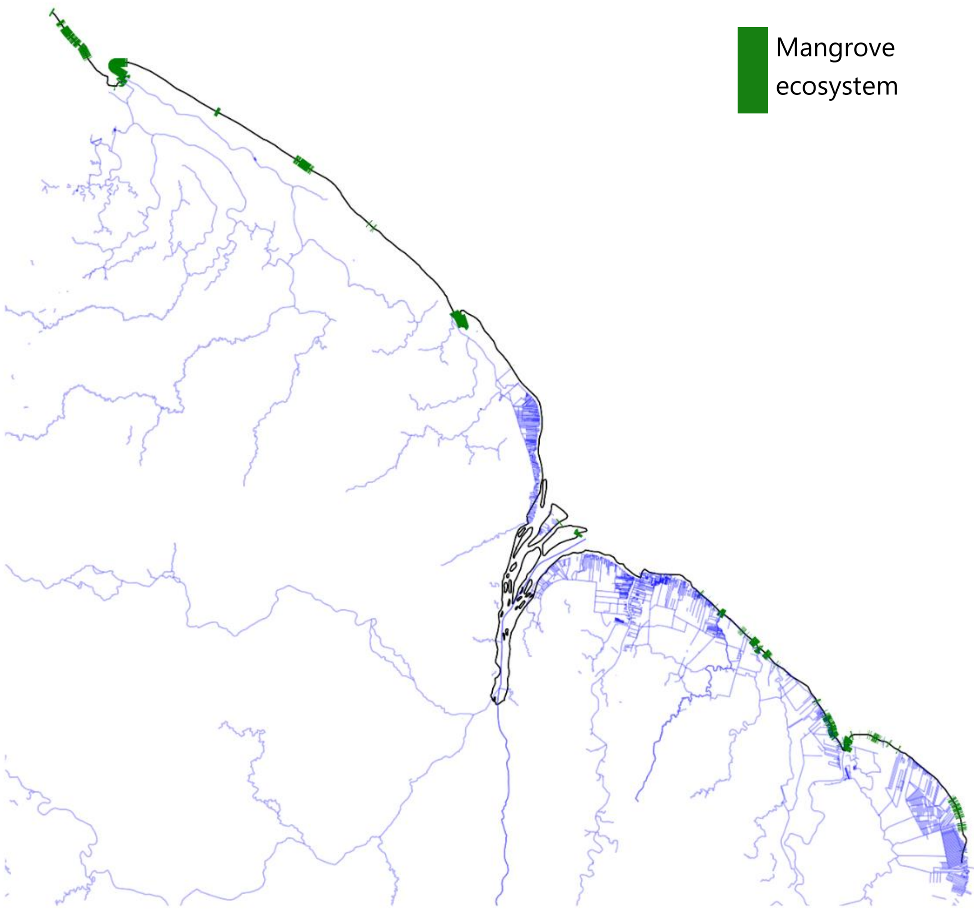

Figure 3.24. Mangrove ecosystem locations in Guyana’s coastline.

While approximately 250km of Guyana's coastline is protected by a mangrove belt, coastal mangroves have been depleted in some areas, due to damage by human use, rise in sea level, increased wave force, and impacts from pollution from timber operations as well as industrial and agricultural run-off.

Climate change will further strain the health of mangrove ecosystems and the flood regulation capacity due to increased mean and maximum temperatures, as well as changing water levels from fluvial flooding.

Figures 3.25, 3.26 and 3.27 show projections of precipitation variation (mm/day) in 230, 2040, and 2050 with respect to the historical trends to analyse the impact of this variation on the mangrove ecosystem under RCP 2.6, 4.5, and 8.5 scenarios, respectively.

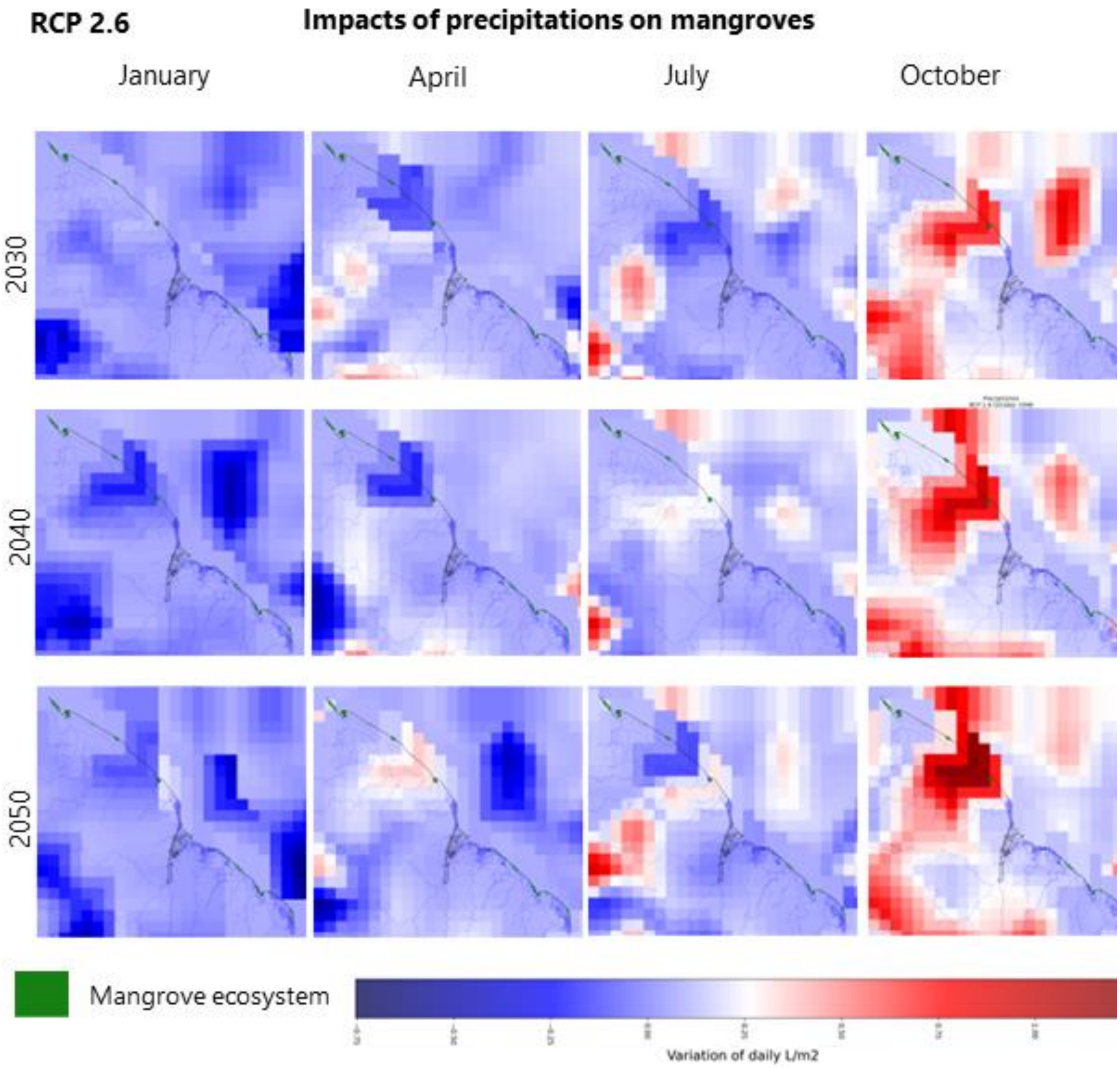

Figure 3.25. Impact on mangrove ecosystems from changes in daily precipitation (mm) under RCP 2.6

Under RCP 2.6 and 4.6, projections indicate that mangrove ecosystems, particularly in Region 2, are likely to experience significant stress due to reduced precipitation, except in October where increases are noted. These changes can lead to increased salinity and reduced freshwater availability, negatively impacting mangrove health, biodiversity, and their ability to protect against coastal erosion, highlighting the need for proactive conservation efforts.

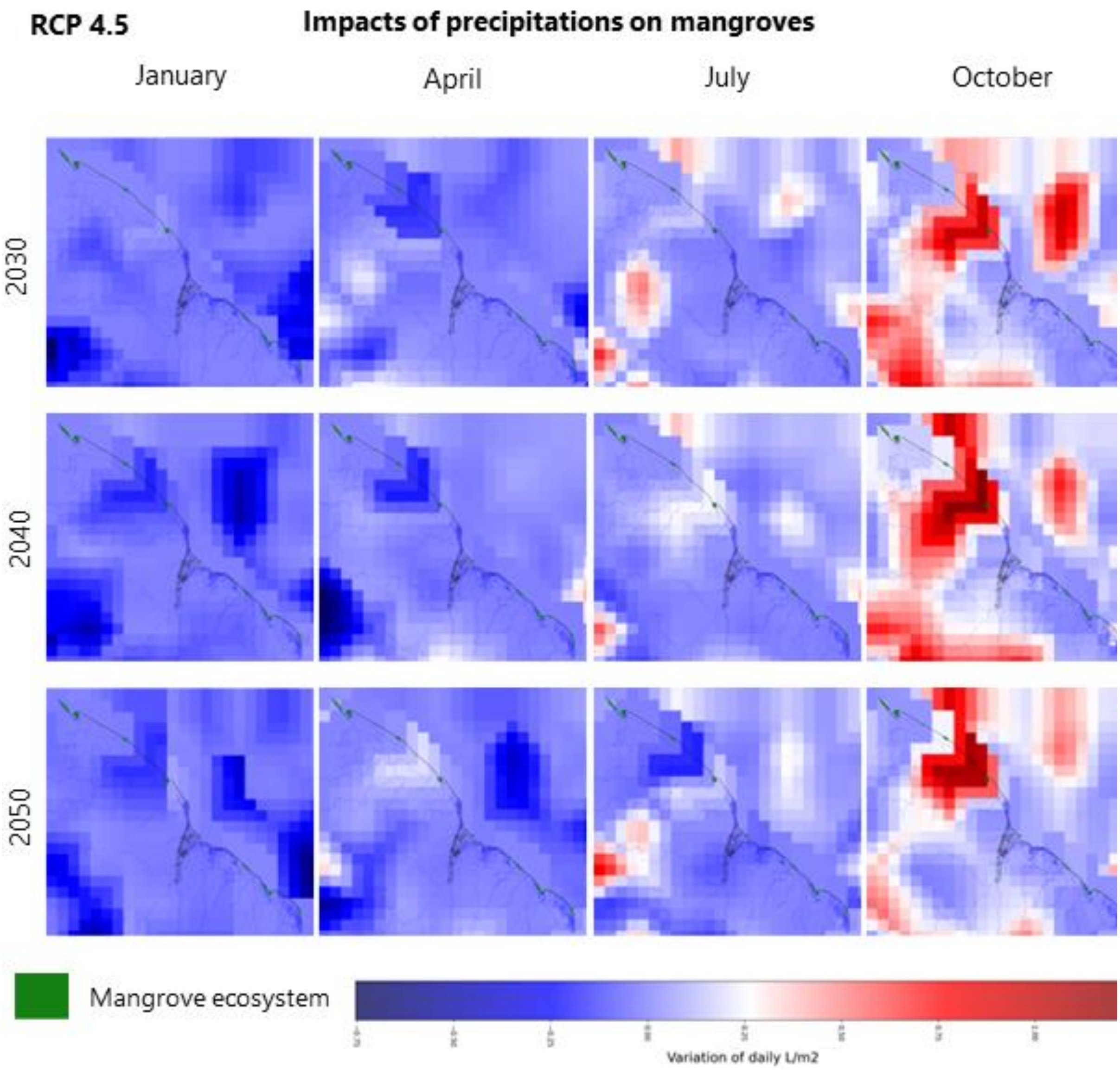

Figure 3.26. Impact on mangrove ecosystems from changes in daily precipitation (mm) under RCP 4.5.

Under RCP 8.5, on the contrary, precipitation rates are expected to dramatically increase, leading to deepened water levels in mangrove wetland areas, also impacting the health and ecosystem functions of these fragile systems.

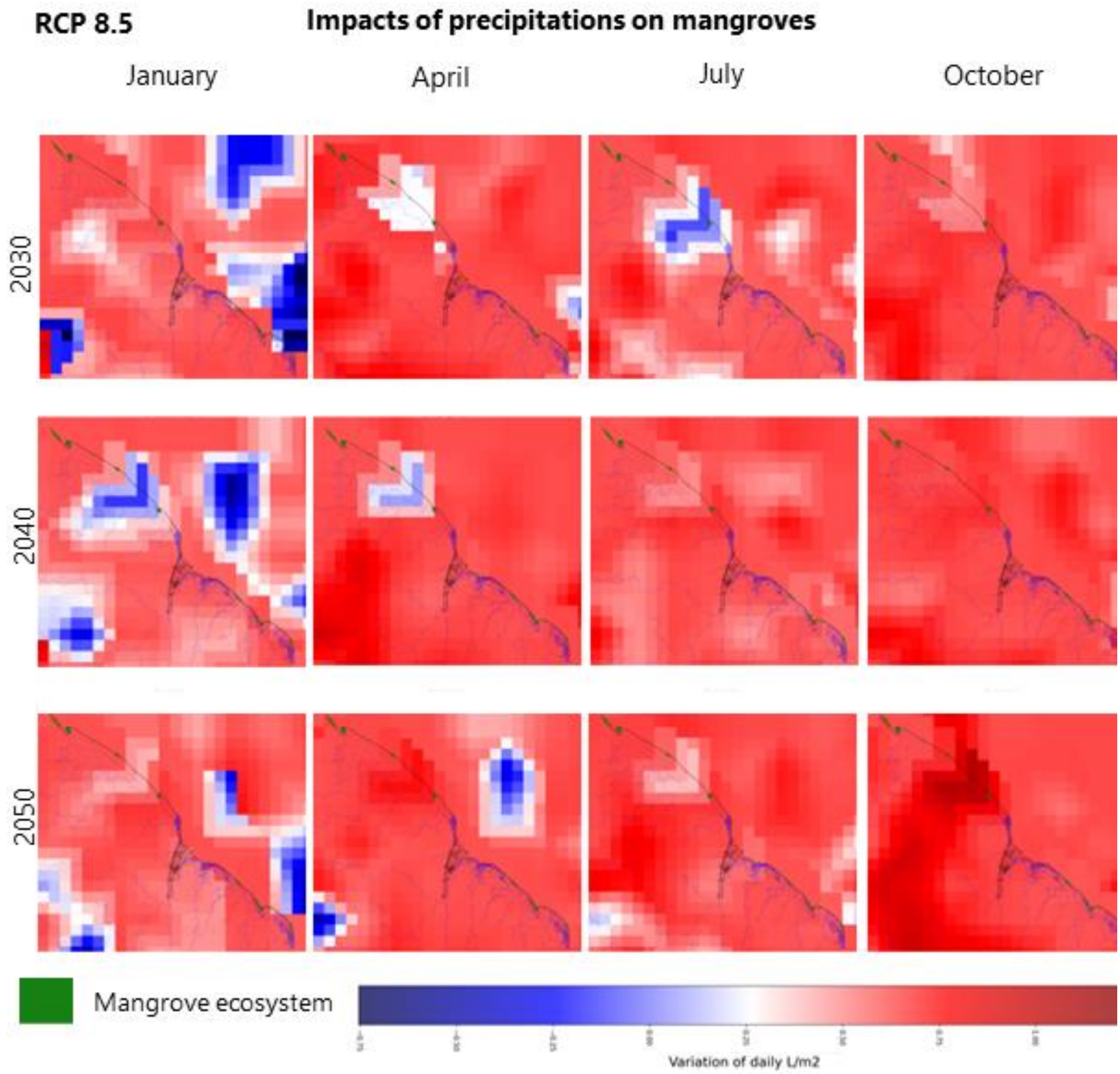

Figure 3.27. Impact on mangrove ecosystems from changes in daily precipitation (mm) under RCP 8.5.

Figures 3.28, 3.29 and 3.30 illustrate the impact of maximum temperature variation on mangrove ecosystems for the years 2030, 2040, and 2050 during July and October (the two periods of most extreme temperature variation), corresponding to RCP 2.6, 4.5, and 8.5, respectively.

All scenarios indicate negative impacts on mangroves due to rising temperatures, though the extent and distribution of these impacts vary. The Central and Western coastal regions appear consistently more vulnerable, especially under higher RCP scenarios. Conversely, periods of decreased maximum temperatures could offer temporary relief but may also disrupt normal physiological processes and seasonal cycles.

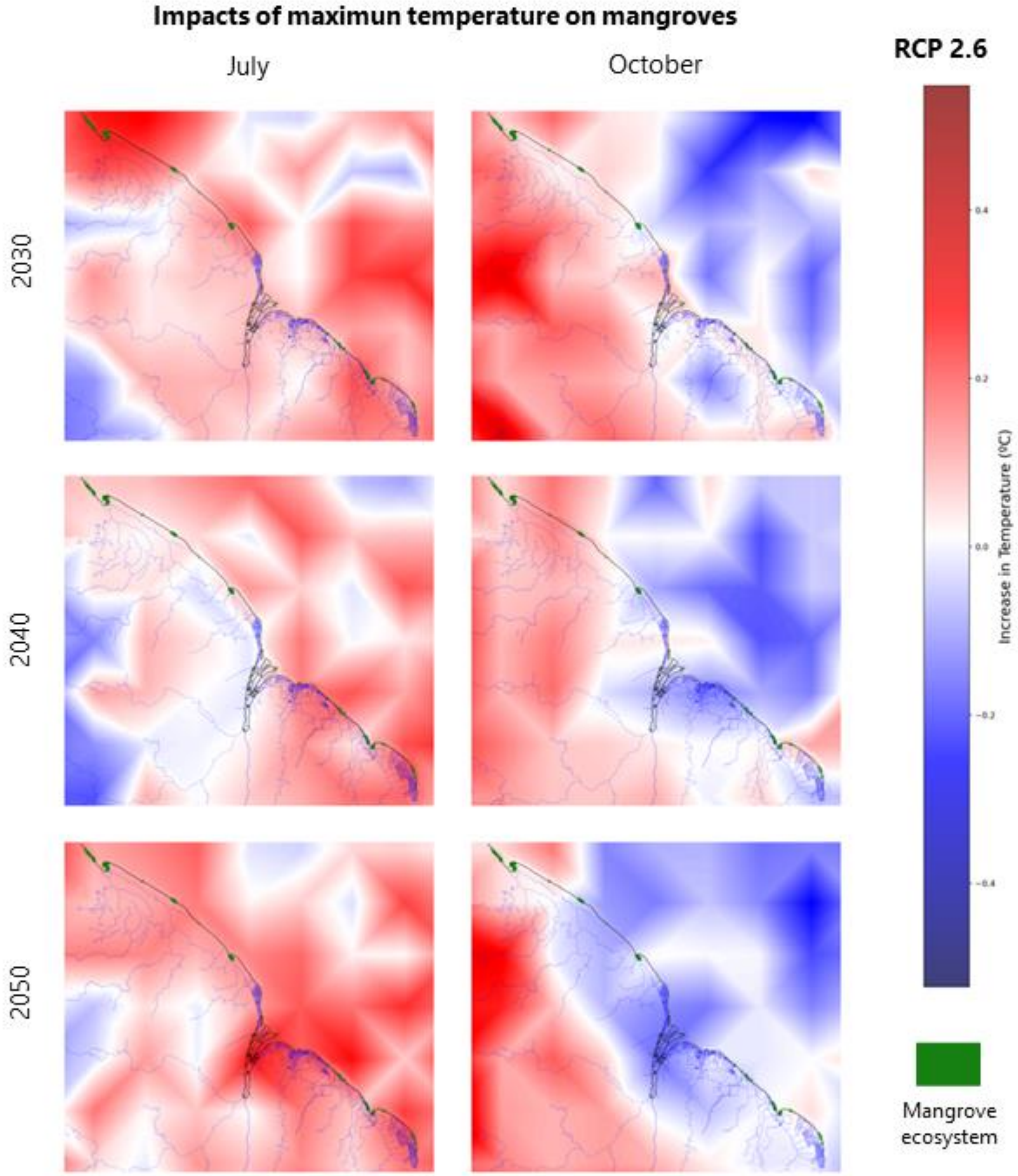

Figure 3.28. Impact on mangrove ecosystems from variations in maximum temperature (°C) under RCP 2.6.

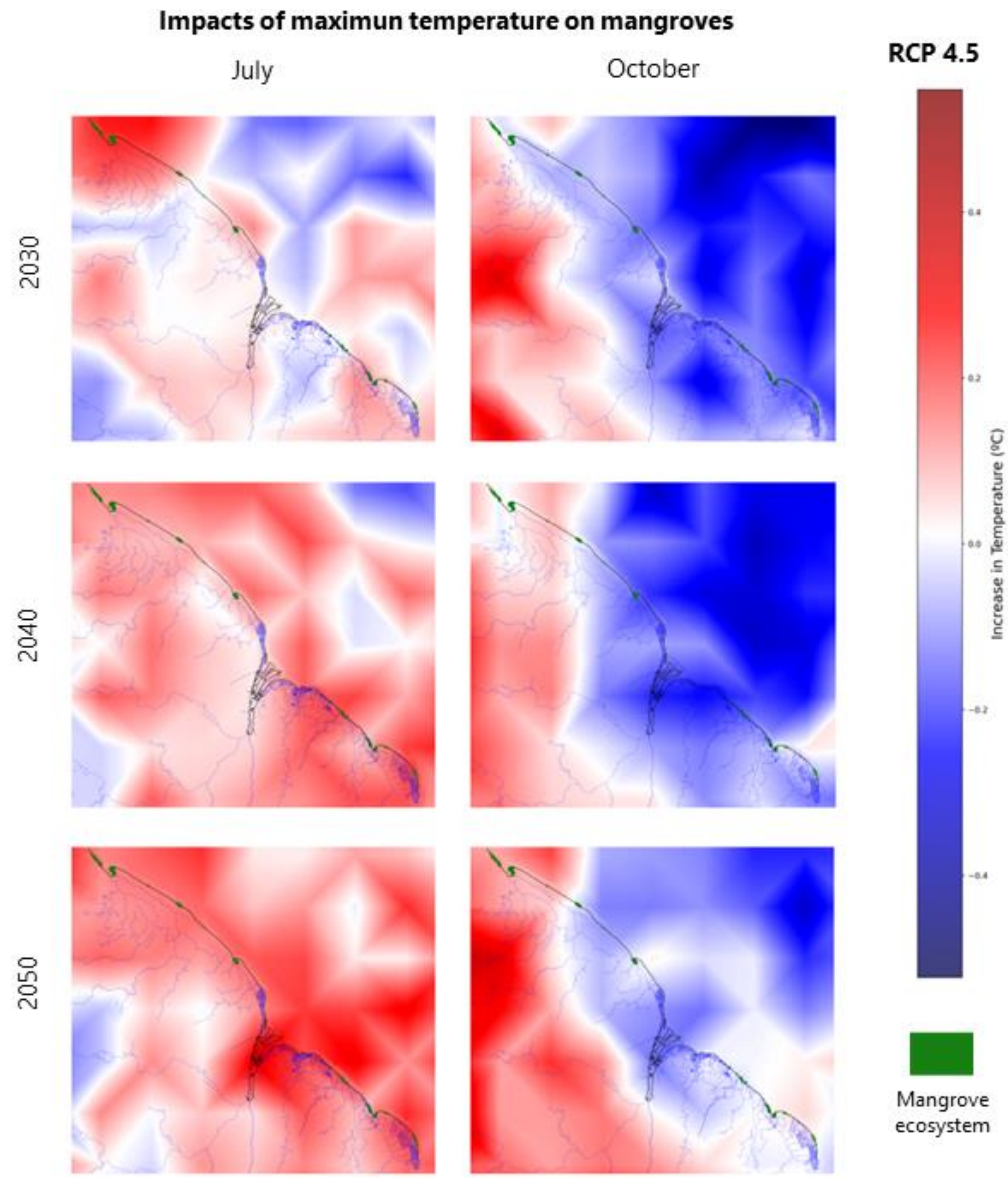

Figure 3.29. Impact on mangrove ecosystems from variations in maximum temperature (°C) under RCP 4.5.

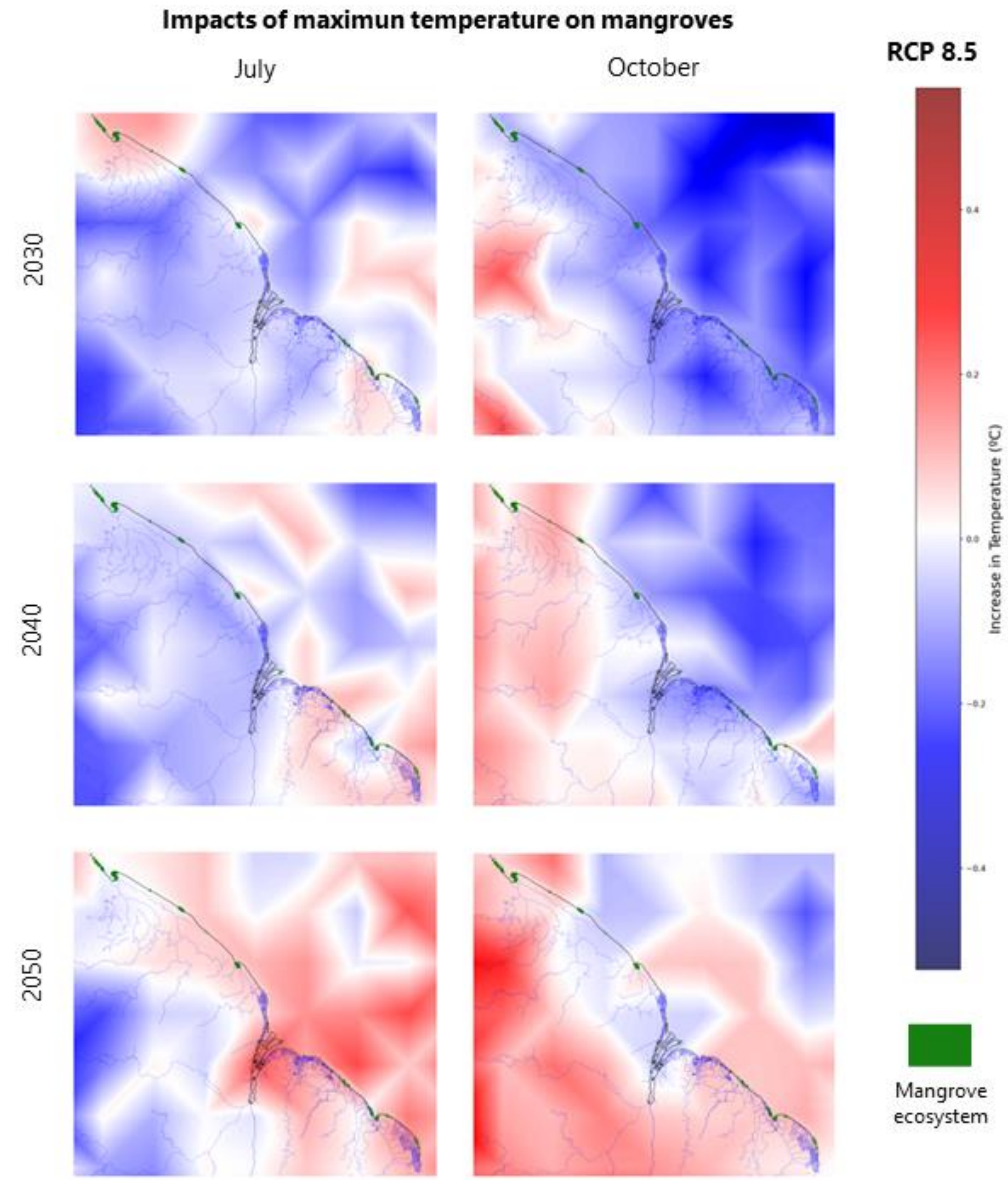

Figure 3.30. Impact on mangrove ecosystems from variations in maximum temperature (°C) under RCP 8.5.

3.2.4. Health

The health sector in Guyana faces significant challenges due to various climate change impacts including:

- **Increased precipitation and flooding**: Flooding increases the incidence of water-borne diseases due to compromised sanitation and water contamination. The main waterborne disease in Guyana is Diarrhoea and Hepatitis A, Hepatitis E and Typhoid fever. Vector-borne diseases also spread as stagnated water provides more breeding grounds for mosquitoes infected with malaria, dengue, chikungunya and zika already prominent in Hinterland communities and among mine workers. Flooding events also lead to injuries, loss of lives, and psychological stress.
- **Increased temperatures and heat waves**: Rising temperatures exacerbate the transmission of vector-borne diseases, as higher mean temperatures favour the proliferation of disease vectors. Heat stress poses a significant health risk, particularly in urban areas and among outdoor workers, including farmers and miners across the Hinterland.
- **Droughts and malnutrition:** Water scarcity poses severe dehydration risks and hampers access to clean drinking water and sanitation, exacerbating existing inequalities related to gender, education, and poverty. Further, reduced agricultural yields pose a risk to malnutrition.
- **Fires:** Prolonged wildfire smoke exposure is a serious hazard to air quality and health.
- **Saltwater intrusion**: Saltwater intrusion could also lead to increase the number of persons with hypertension, with greater occurrence in pregnant women living in coastal regions compared to further inland (GoG, n.d.). Saltwater intrusion is particularly concerning as 90% of Guyana´s population is dependent on the two main coastal groundwater aquifers as the source of potable water.
- **Sea level rise**: Coastal flooding elevates the risk of human injury and death, damaging healthcare facilities, and displacing communities. This is particularly concerning s 90% of Guyana´s population lives in the narrow coastal strip already below mean sea level.

Several conditions amplify the health sector's vulnerability in Guyana. The country is already facing a shortage of health care professionals, exacerbated by aggressive recruiting of medical personnel from Guyana by developed countries. The health system´s response capacity will thus be affected by climate change and extreme weather events.

On another note, almost 90% of Guyana’s population lives in coastal areas, whereas only about 10% of the population lives in the rural Hinterland. As a result, there is a far greater concentration of healthcare facilities and resources in the coastal areas but are highly vulnerable to the effects of sea level rise and fluvial flooding at the mouth of river deltas.

Access of medical services to Hinterland communities and mines is particularly challenging due to their remote location and limited access through long trajectories in dirt roads, air strips, or riverine transport.

The following Figures 3.31, 3.32, and 3.33 illustrate the projected impacts of heatwaves on settlements for three different representative concentration pathways (RCP 2.6, RCP 4.5, and RCP 8.5) across three decades (2030, 2040, and 2050). General trends indicate a projected increase in both the frequency and intensity of heatwaves under all RCP scenarios from 2030 to 2050, most impacting Hinterland communities in the interior of Guyana. Under RCP 8.5, however, coastal urban centres will be particularly impacted by heatwaves, whose health impacts will be exacerbated by the urban heat island effect. This highlights an urgent need for targeted health interventions and robust climate adaptation strategies to mitigate the escalating health risks associated with rising temperatures across the entire territory of Guyana.

Subsequent Figures 3.34, 3.35, and 3.36 illustrate the projected impacts of precipitation on settlements. Under RCP 2.6 and 4.5, Central Guyana will experience a significant decrease in precipitation, which will adversely affect small Hinterland municipalities through a lack of access to constant, safe and reliable water supply, Northern Guyana will be at risk of flooding and its related health impacts during October which consequently affects the most densely populated coastal areas. Under the RCP 8.5 scenario, most dramatic increases in precipitation and associated health affects is expected across all regions and months in the country.

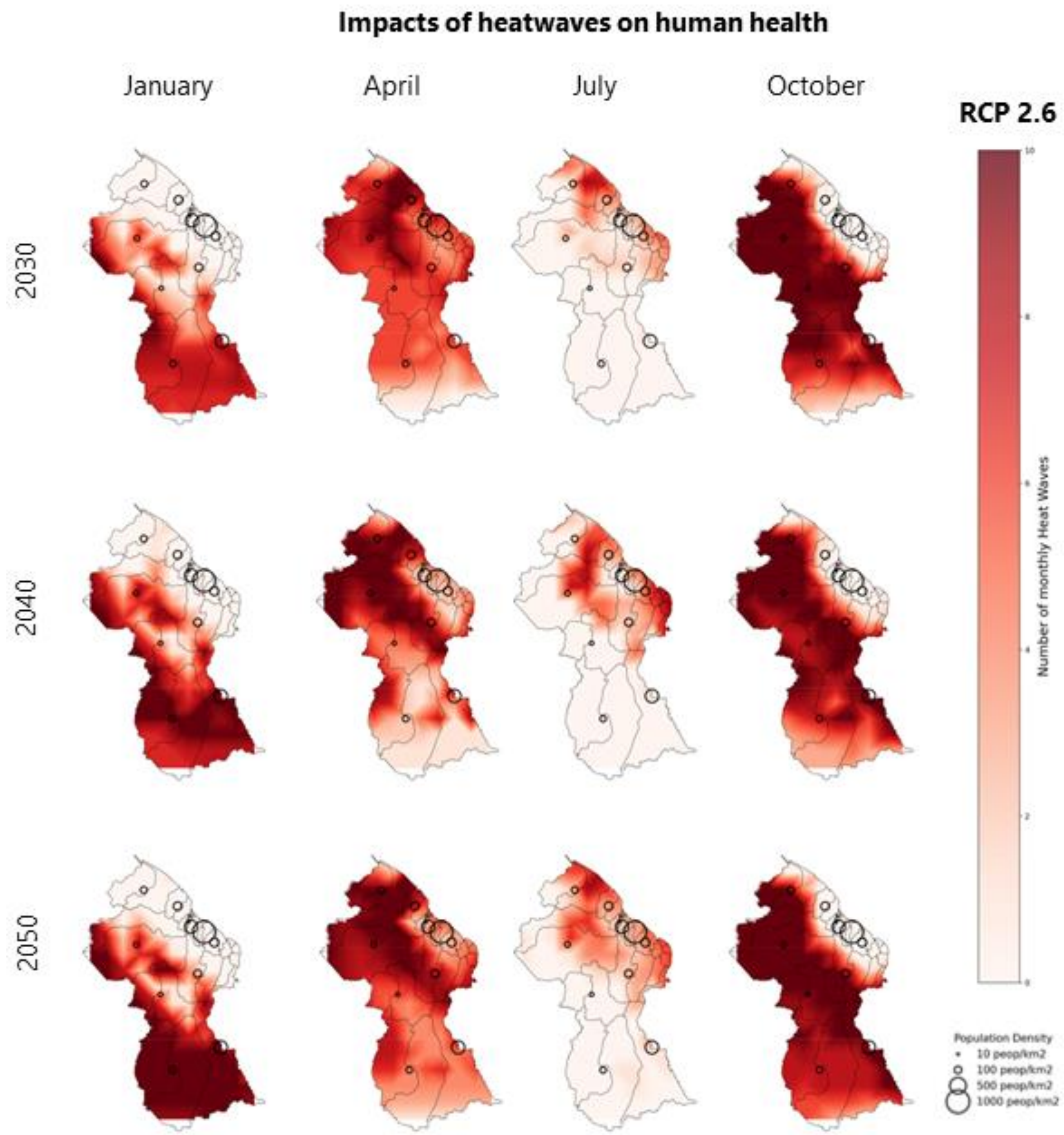

Figure 3.31. Number of monthly heatwaves and its impact on population size and distribution under RCP 2.6.

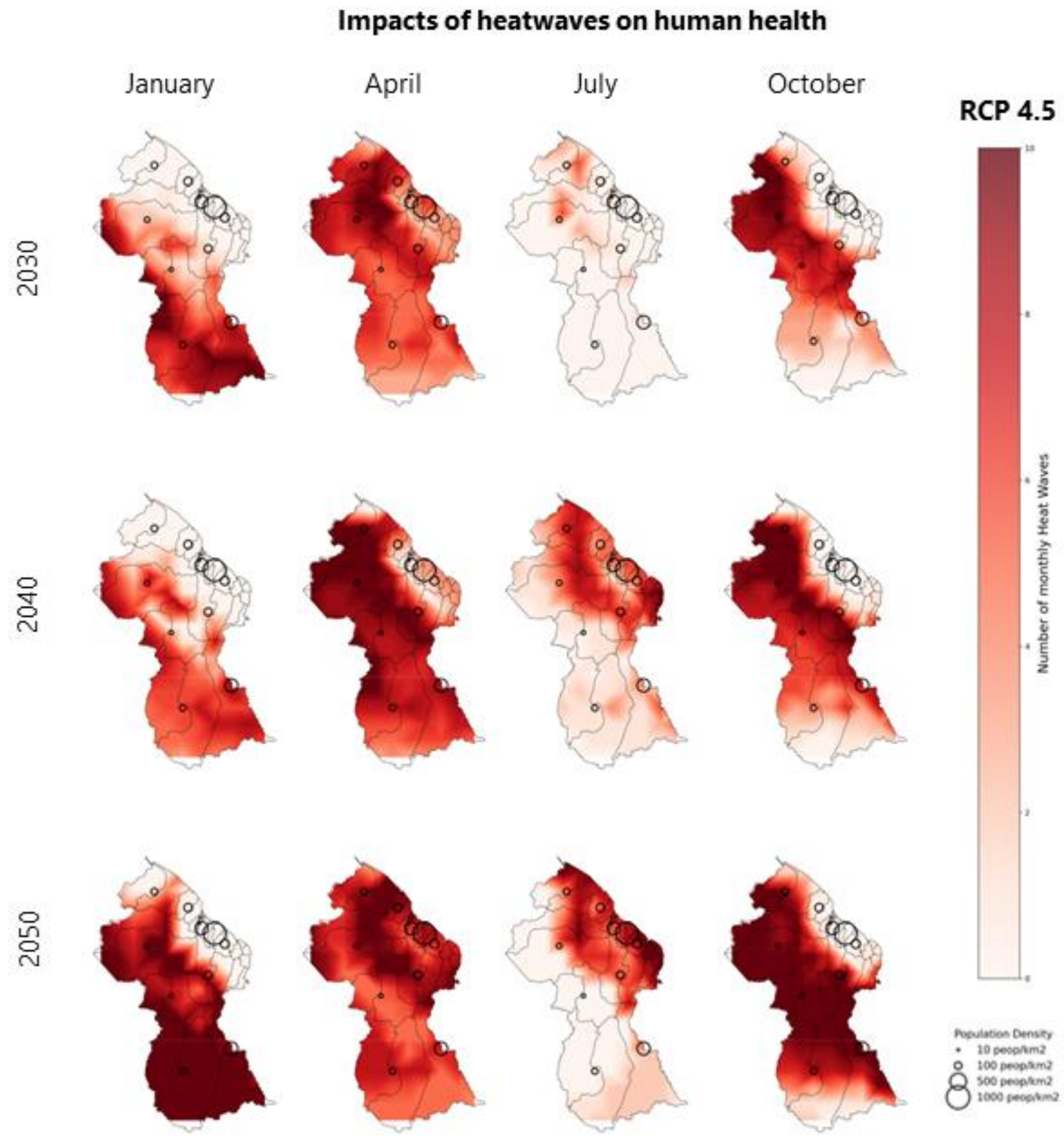

Figure 3.32. Number of monthly heatwaves and its impact on population size and distribution under RCP 4.5.

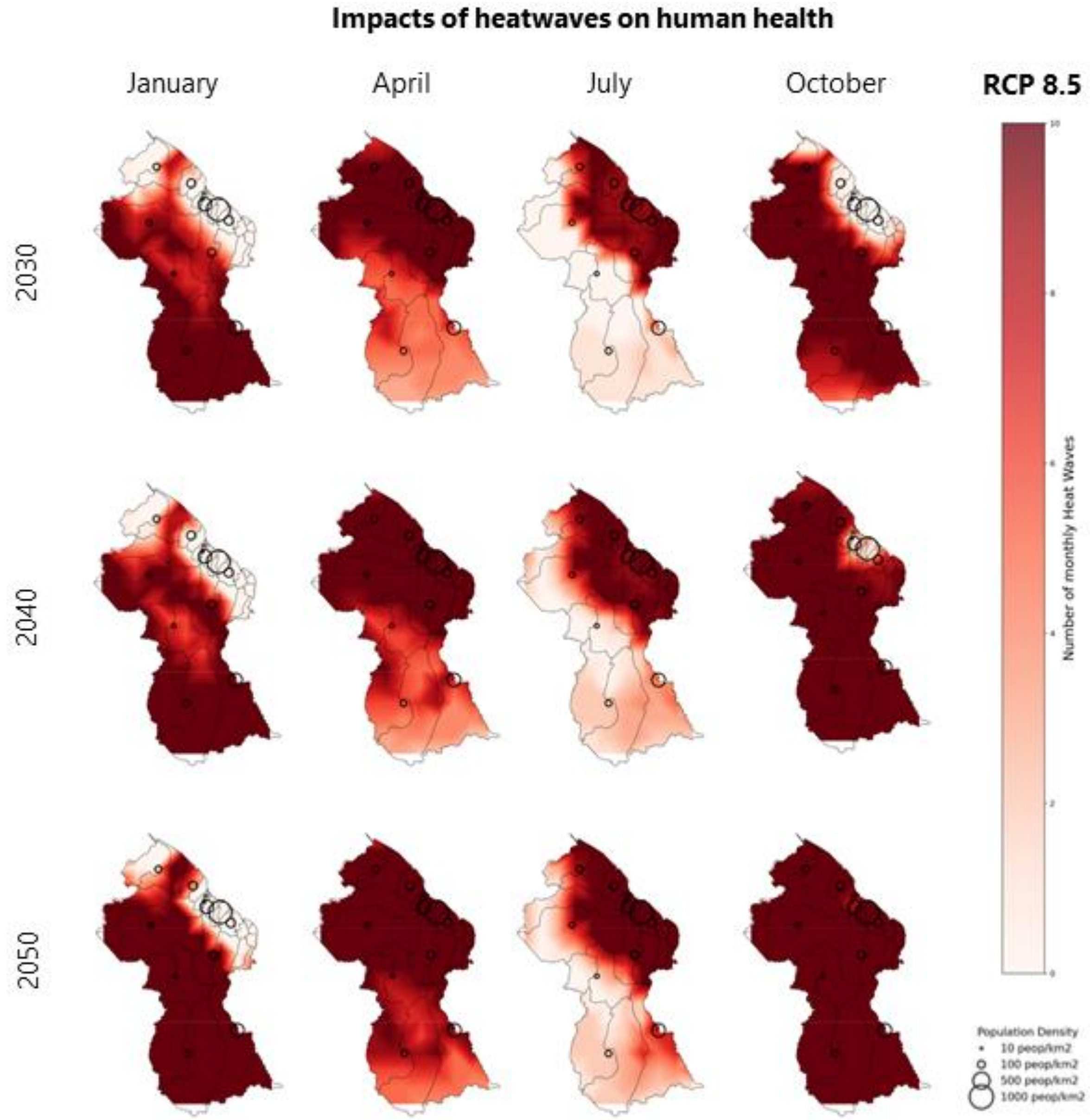

Figure 3.33. Number of monthly heatwaves and its impact on population size and distribution under RCP 8.5.

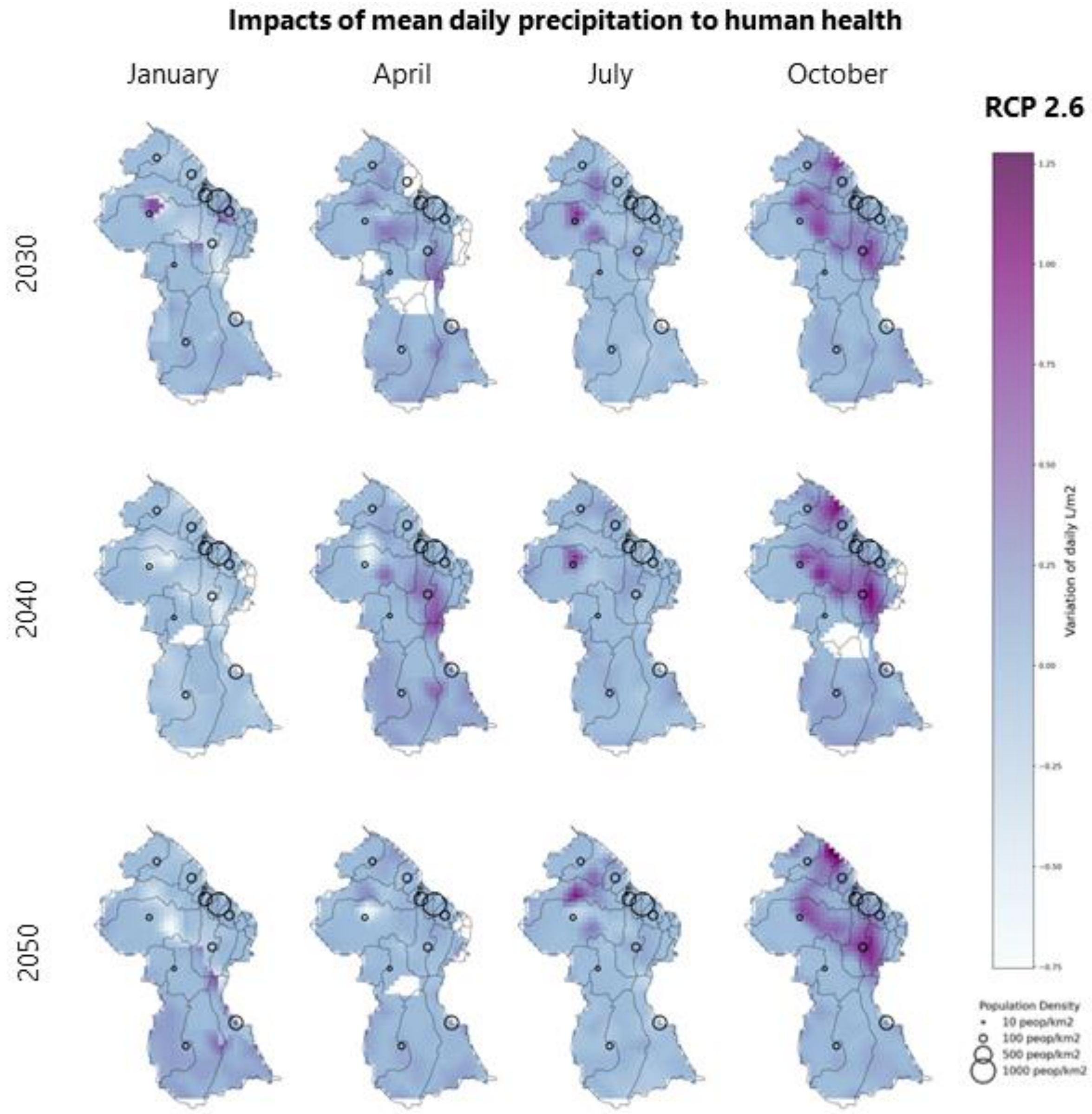

Figure 3.34. Change in mean daily rainfall (mm) and its impact on population size and distribution under RCP 2.6.

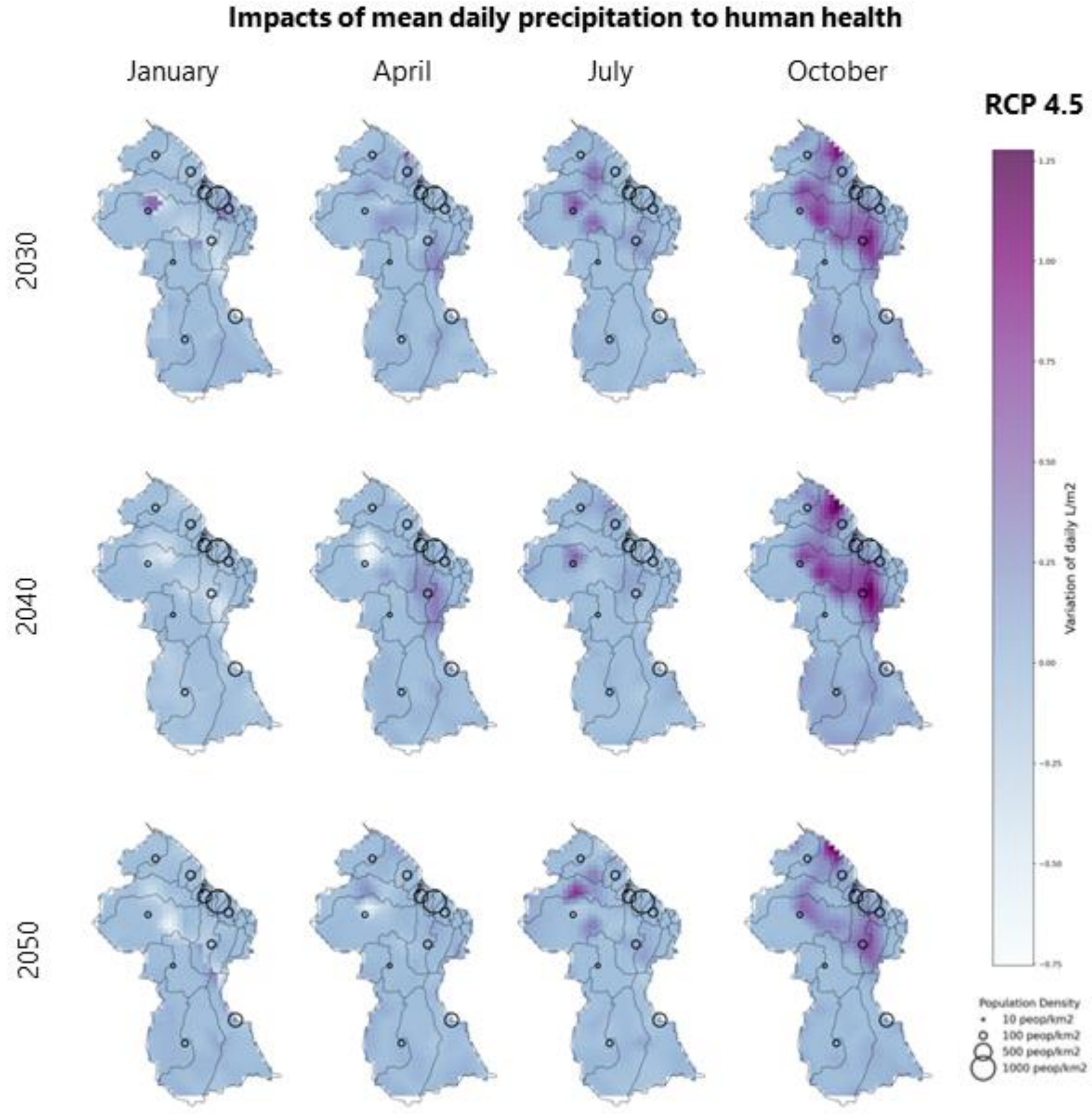

Figure 3.35. Change in mean daily rainfall (mm) and its impact on population size and distribution under RCP 4.5.

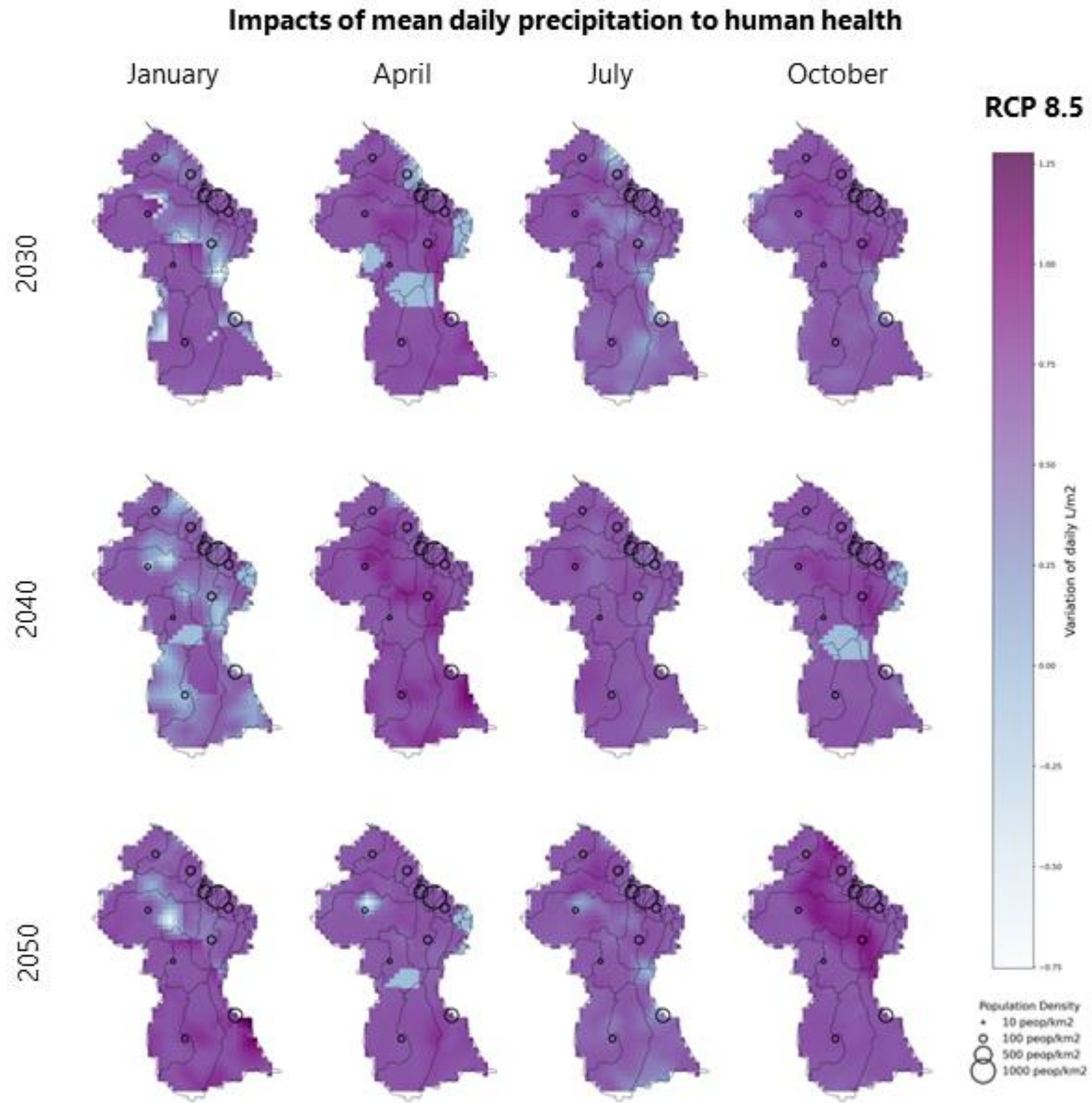

Figure 3.36. Change in mean daily rainfall (mm) and its impact on population size and distribution under RCP 8.5.

3.2.5. Education

The education sector in Guyana faces significant challenges due to various climate change impacts which disrupt the continuity and quality of education and hinder the overall development of children. Observed and predicted changes in climate and their effects on education in Guyana include:

- **Extreme rainfall and flooding events**: Flooding damages education facilities and teaching materials, leading to a loss of educational quality and delaying study programs, which adversely affect educational outcomes and children's development. School closures due to flooding force students to study at home or in overcrowded classrooms, disrupting the continuity of education. Additionally, flooded roads and dams make schools inaccessible, further delaying study programs and severely impacting educational outcomes. Flooding also destroys educational records and the processes of data collection and school inspections. Use of sanitary facilities may be hindered, particularly impacting girls. Floods also cause temporary school closures and high absenteeism rates that negatively impact educational performance. Furthermore, schools often serve as shelters after disasters. These risks result in a significant loss of instructional time and health issues that negatively impact student performance. Extreme events can also lead to disease outbreaks, prompting school closures to prevent the spread of diseases. Psychosocial distress is common among students and teachers following disasters due to food shortages and health problems.
- **Periods of decreased precipitation leading to droughts**: Water scarcity leads to health issues and increased inequalities, with additional expenses for water provision impacting the education sector, and particular impact on boys on their expected role in supporting water supply acquisition. There is also an increased risk of airborne diseases due to unhealthy and unsanitary conditions. These factors can result in premature school closures, as food shortages and forced displacement of teachers lead to the abuse of leave concessions. Decreased agricultural production and revenue at various levels affect education community services, leading to malnutrition and increased disparities between rural and coastal areas. Psychosocial distress is common among students and teachers following disasters due to food shortages and health problems.
- **Fires**: Fires destroy school buildings and learning materials, and smoke pollution forces temporary school closures and displaces learners and teachers, leading to learning loss. Psychosocial distress increases absenteeism due to the destruction of students' homes and a loss of confidence among students.
- **Increased mean temperatures and heat waves**: Schools in Guyana would need to be resourced with climatization equipment, to alleviate overheating within classrooms which increases fatigue, causes heat stress, and reduces learning productivity.

The education sector in Guyana is particularly vulnerable due to several conditions. Many school structures face challenges in withstanding natural hazards such as flooding, requiring hazard-resilient storage for materials, needing expanded sanitation facilities, and climatization equipment to foster regular attendance and performance.

3.2.6. Ecosystem and biodiversity

Numerous climate change impacts pose significant threats to the health and stability of Guyana´s ecosystems and biodiversity, highly vulnerable to environmental disruptions yet vital for its ecosystem services sustaining the country´s socioeconomic well-being and development.

There are 47,677 unique species classified as part of Guyana, of which 17,291 (36.27%) are already classified as an endangered species. **Incremental climate change and extreme events cause shifts in ecosystem boundaries, changes in natural habitats, and sharp increases in extinction rates**. These changes can cascade through ecosystems, disrupting other species and natural food chains. For animal species that call the forests home, climate-induced loss of habitat also means that are forced to live in fragments areas where it becomes difficult to survive. They become more accessible to hunters and poachers, their numbers begin to dwindle and some eventually face extinction. As such, extreme weather events and incremental climate changes can have detrimental consequences for Guyana's high levels of biological diversity and endemism, potentially affecting its national cultural identity.

Over 85% of Guyana´s territory is covered by forests, which are a critical source of ecosystem services including soil erosion control, flooding control, water filtration, sustainable timber products, and ecotourism. Sustainable forestry, for example, is an important sector in Guyana as it employs many people, especially in the interior. In 2013, for example, 22,561 people were directly employed in the forestry sector, including sawmilling, timber dealership, plywood and veneer and manicole palm, with almost half involved in logging activity. Furthermore, timber is an important export, valued at US $26.5 million in 2021, and continuously increasing in importance through the FLAG-VTA agreement with the European Union.

Environmental degradation and loss of critical forest ecosystems though land-use activities such as mining, agriculture, and infrastructure development are main drivers of forest habitat loss in Guyana. While this degradation is extremely low by global standards due to the proactive measures to embed sustainable forestry management practices and other policies, the degradation that does occur threatens the overall health of ecosystems and the services they provide, which in turn jeopardises community livelihoods and the national economy. Such degradation is exacerbated by the impacts of climate change, including changes in temperature and precipitation patterns, facing significant threats from a range of climate hazards, including flooding, soil erosion, ground instability, droughts, wildfires, and pests and diseases.

Forests in dry evergreen regions with white sandy soils are particularly susceptible to wildfires. Once these areas are damaged by fire, they become prone to erosion from wind and water, leading to the sedimentation of waterways.

Sea level rise and increased storm surges result in coastal flooding, erosion, and saline intrusion, affecting water resources, and damaging and destroying **coastal ecosystems**, particularly mangroves. Mangrove forests along the coast and river estuaries are critically at risk. Their destruction compromises land stability in the coastal zone. Young mangroves, essential for coastal protection, are particularly susceptible to damage, and man-made infrastructure can hinder their natural adaptation to rising sea levels. The Hilly Sand and Clay Region, found just inland of the coastal zone, forms the most vulnerable ecosystem in Guyana, with permeable white, sandy soil low in nutrients (Ministry of Natural Resources and the Environment, 2014).

Rising water temperatures further disrupt and degrade marine ecosystems and biodiversity. Changes in water temperature, ocean currents, and coastal upwelling due to climate change can shift the distribution of marine species. The fisheries industry in Guyana, which relies on marine biodiversity, could see significant effects on its productivity and profitability.

Figure 3.37 illustrates the main land use categories in Guyana, encompassing significant ecosystems in the country, protected areas, and croplands. It is important to note that this land use map, available in the required raster format for conducting climate change projections, contains a substantial gap in the Northwest corner of Guyana due to international satellite restrictions in that region. As such, subsequent analysis of climate change impacts on land-use maintain this gap.

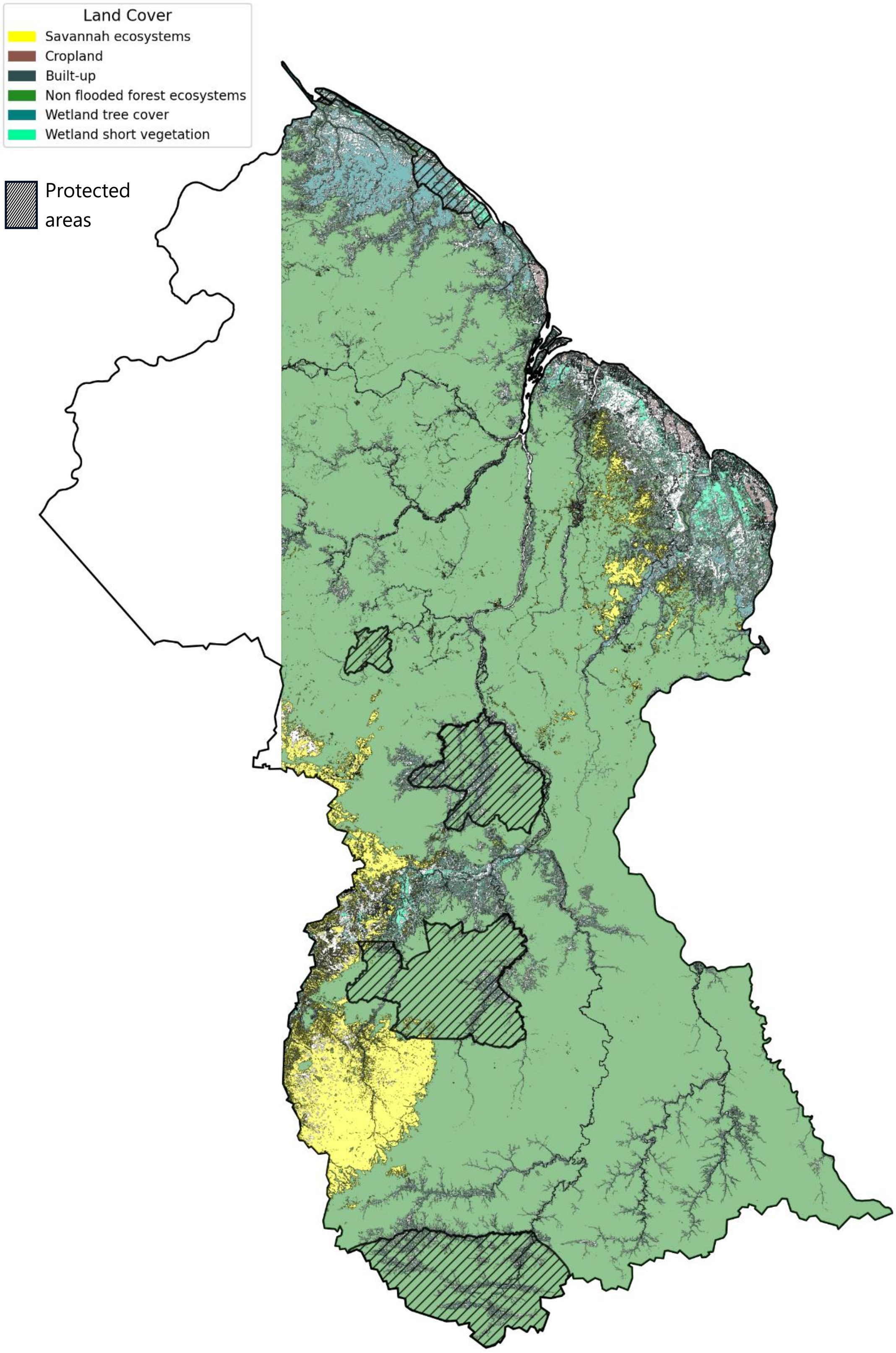

Figure 3.37. Various land uses in Guyana.

The impact of changing temperatures for various land use classifications are presented in Figures 3.38, 3.39 and 3.40 below. It can be observed that all ecosystems will be impacted by both temperature increases and decreases at different times of the year, subsequently augmenting in differential intensity through time and under RCP 2.6, 4.5, and 8.5.

Figures 3.41, 3.42 and 3.43 illustrate the impact of droughts and wildfires on various land use categories. A moderate increase in drought conditions over time are expected under all climate scenarios.

Under RCP 2.6 and 4.5, significant droughts will risk forests in Southern Guyana southern parts of the country during October, primarily affecting forest ecosystems. However, Coastal regions show an expected decrease in droughts, benefiting wetlands, croplands, mangroves, and forest ecosystems in these coastal regions. Under, RCP 8.5, October droughts spread further across Central and Northern Guyanese forests, especially affecting the Southern portion of the country. However, wetlands and cultivated areas near the coast generally show a decrease in drought propensity.

Across all scenarios, the Rupununi savannahs will consistently experience severe drought impacts, particularly in October. Extensive wildfires have predominantly impacted savannahs in the Southwestern regions, which will therefore increase in extent and frequency due to augmented droughts. It is important to note that protected areas in the Southwest of Guyana are encircled by these wildfire-prone savannah areas, making them vulnerable to the effects of smoke and at risk of also becoming engulfed by wildfires. Fires are also frequent in croplands rear the urban hubs of Guyana's Northeastern coast, although a decrease in drought propensity may favour a lower risk of fire spread in these coastal regions.

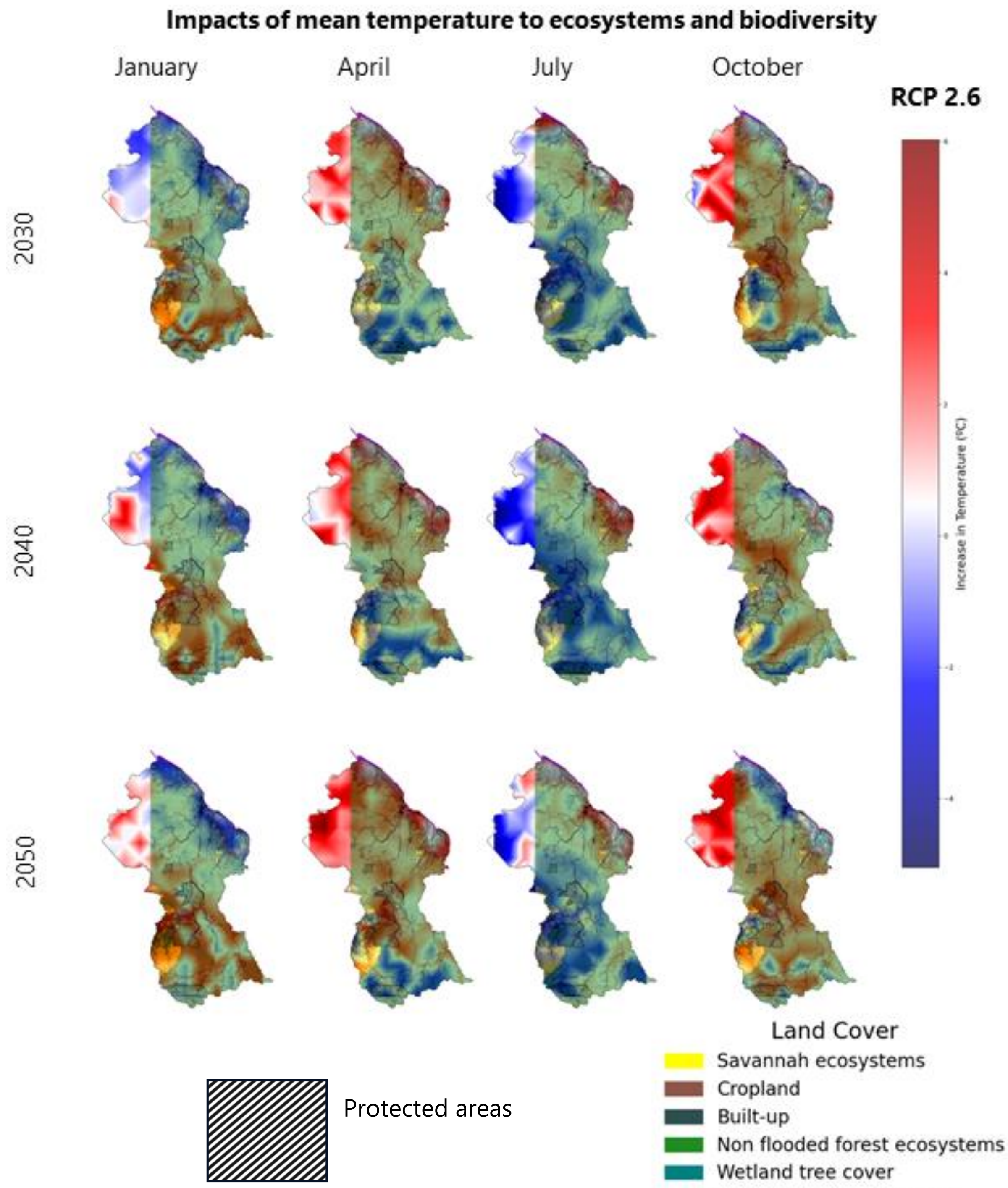

Figure 3.38. Change in mean daily temperature (°C) *and its impact on land use under RCP 2.6.*

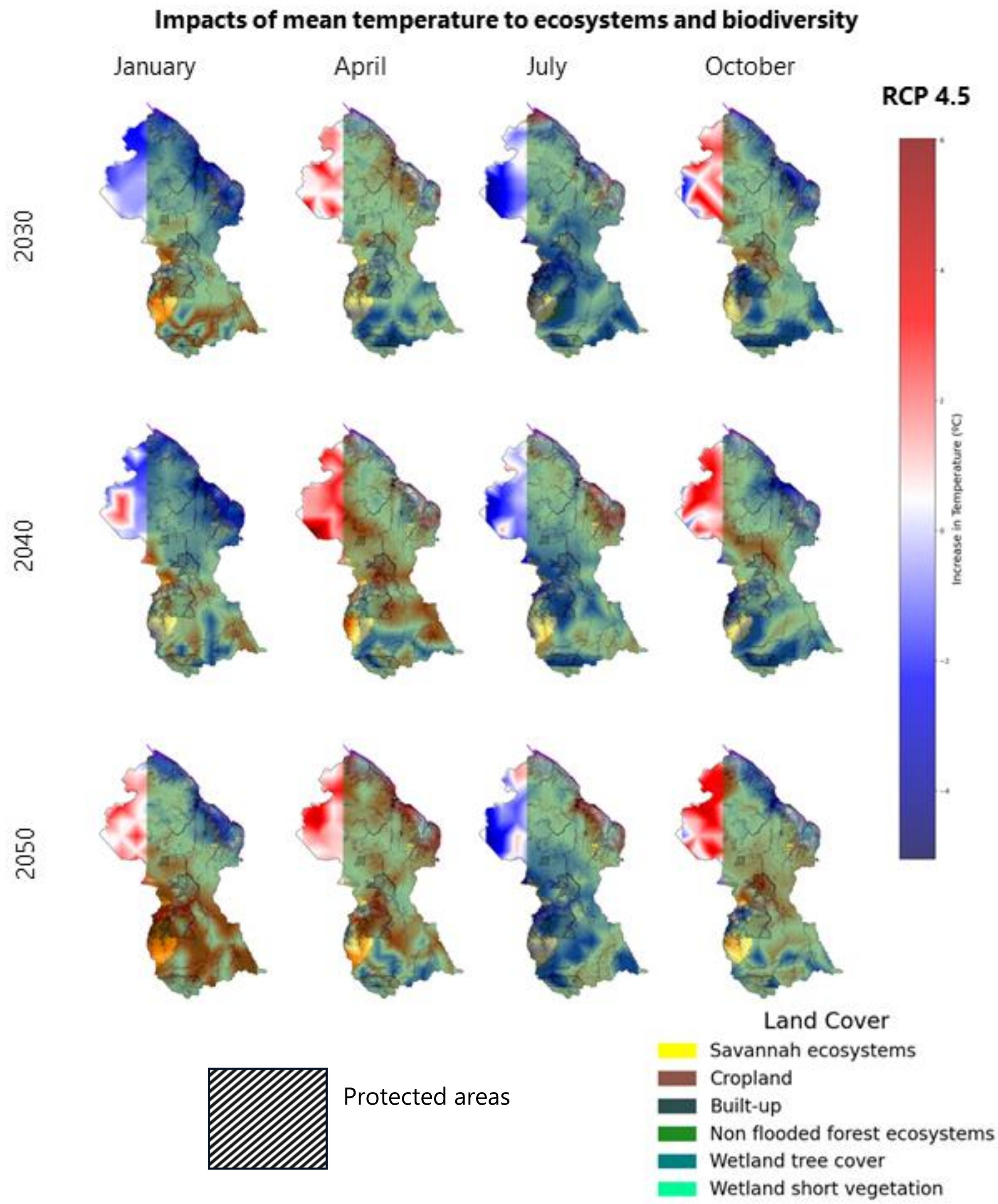

Figure 3.39. Change in mean daily temperature (°C) *and its impact on land use under RCP 4.5.*

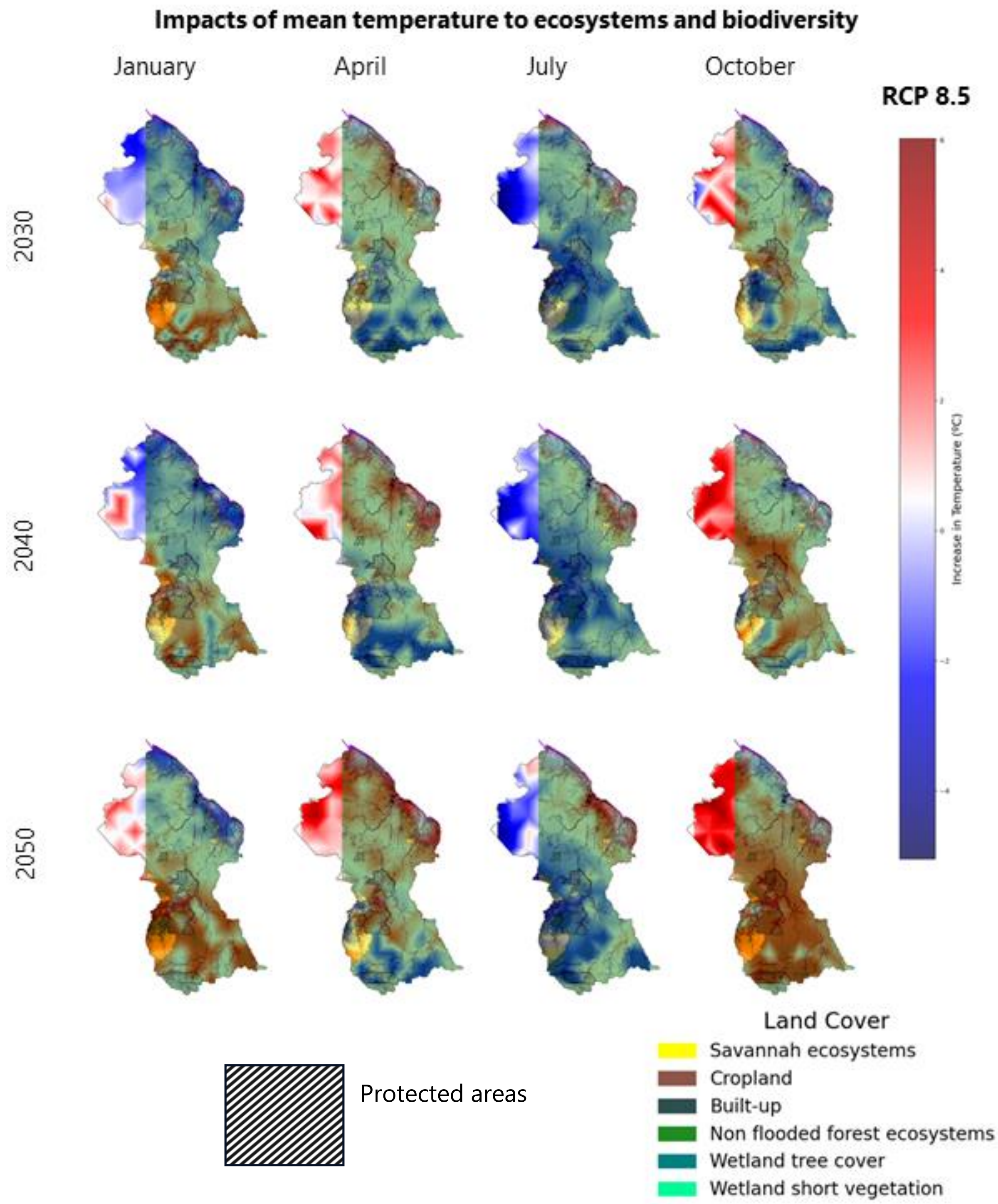

Figure 3.40. Change in mean daily temperature (°C) *and its impact on land use under RCP 8.5.*

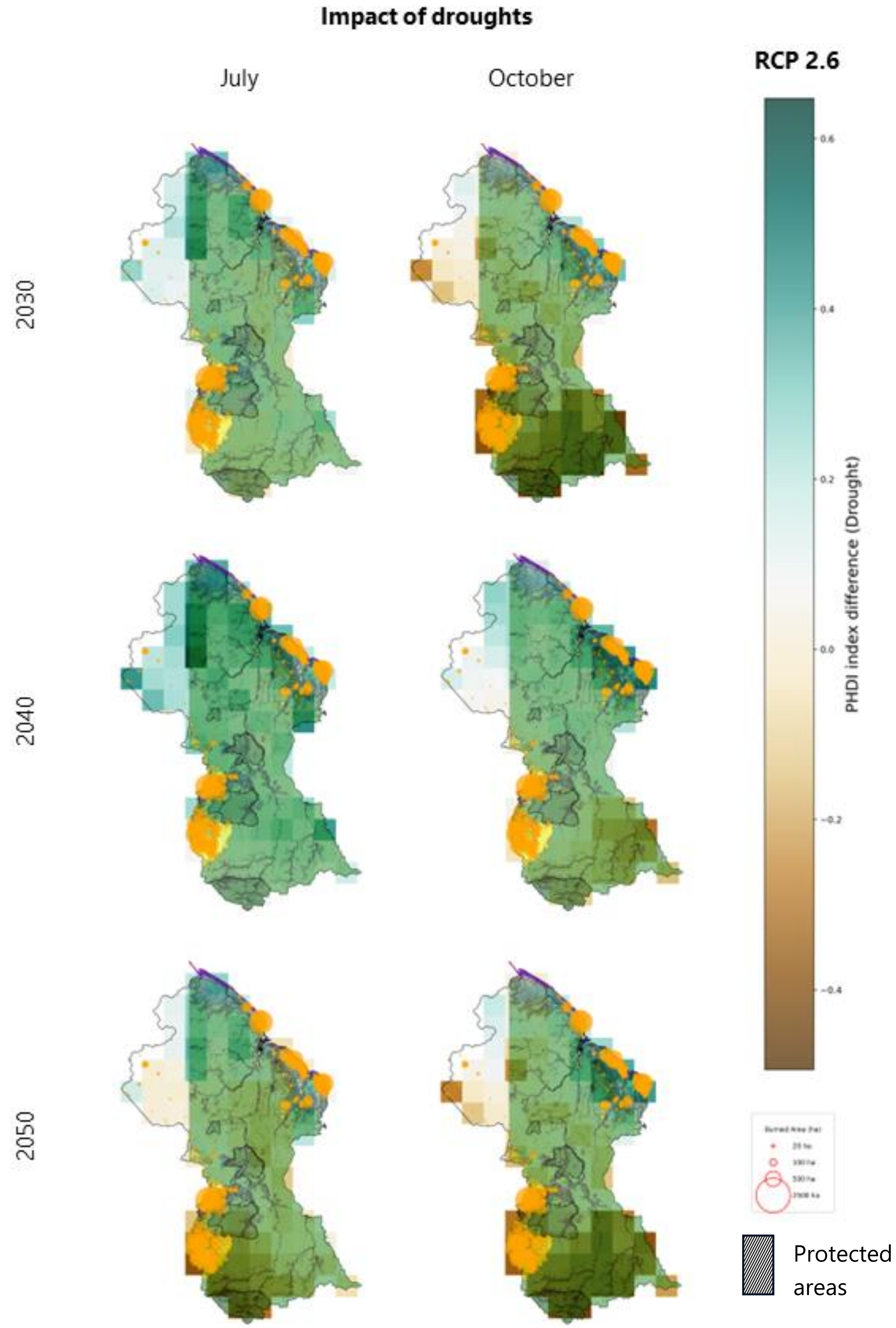

Figure 3.41. Change in PHDI index difference (drought), wildfires and their impact on land use under RCP 2.6.

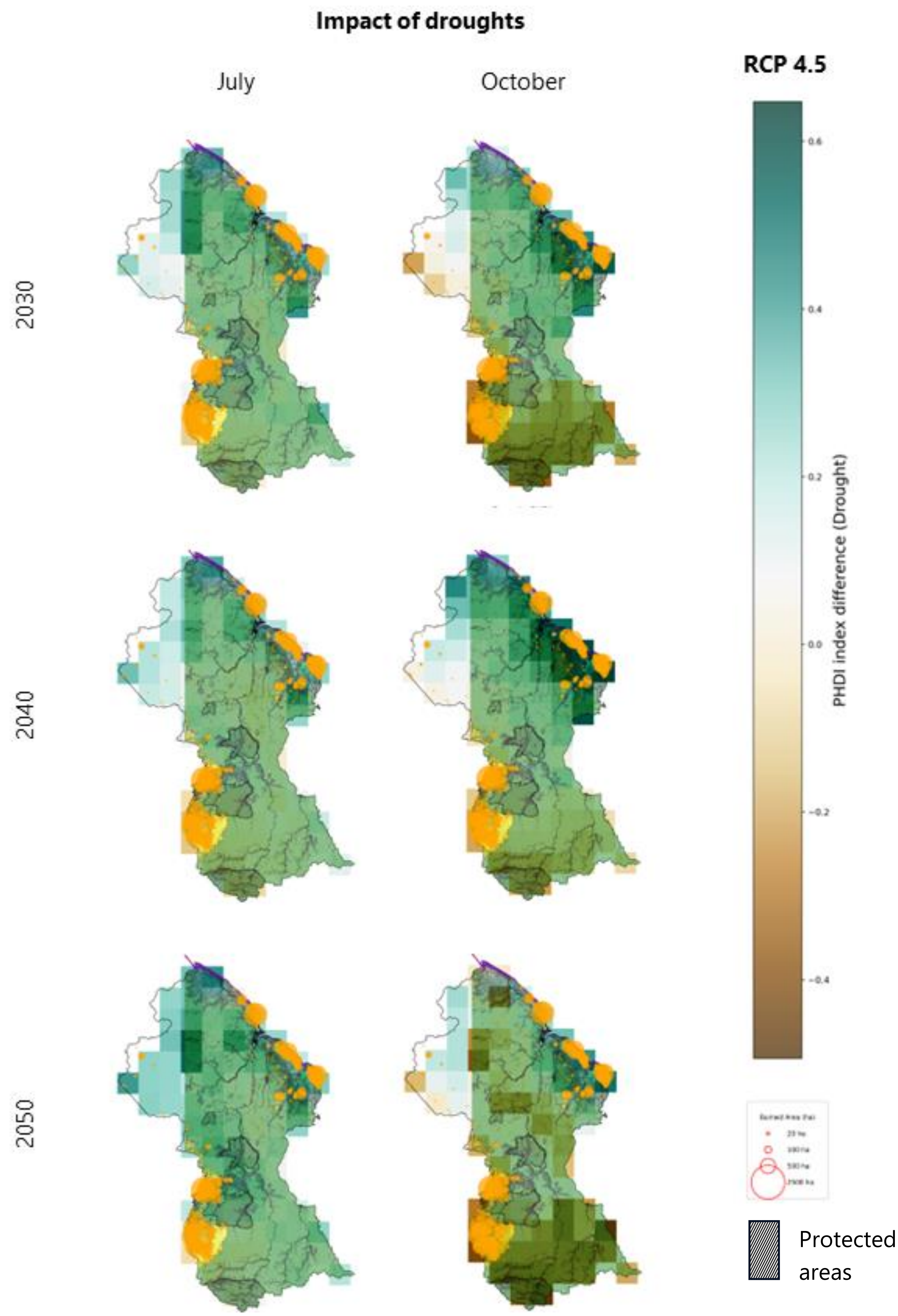

Figure 3.42. Change in PHDI index difference (drought), wildfires and their impact on land use under RCP 4.5.

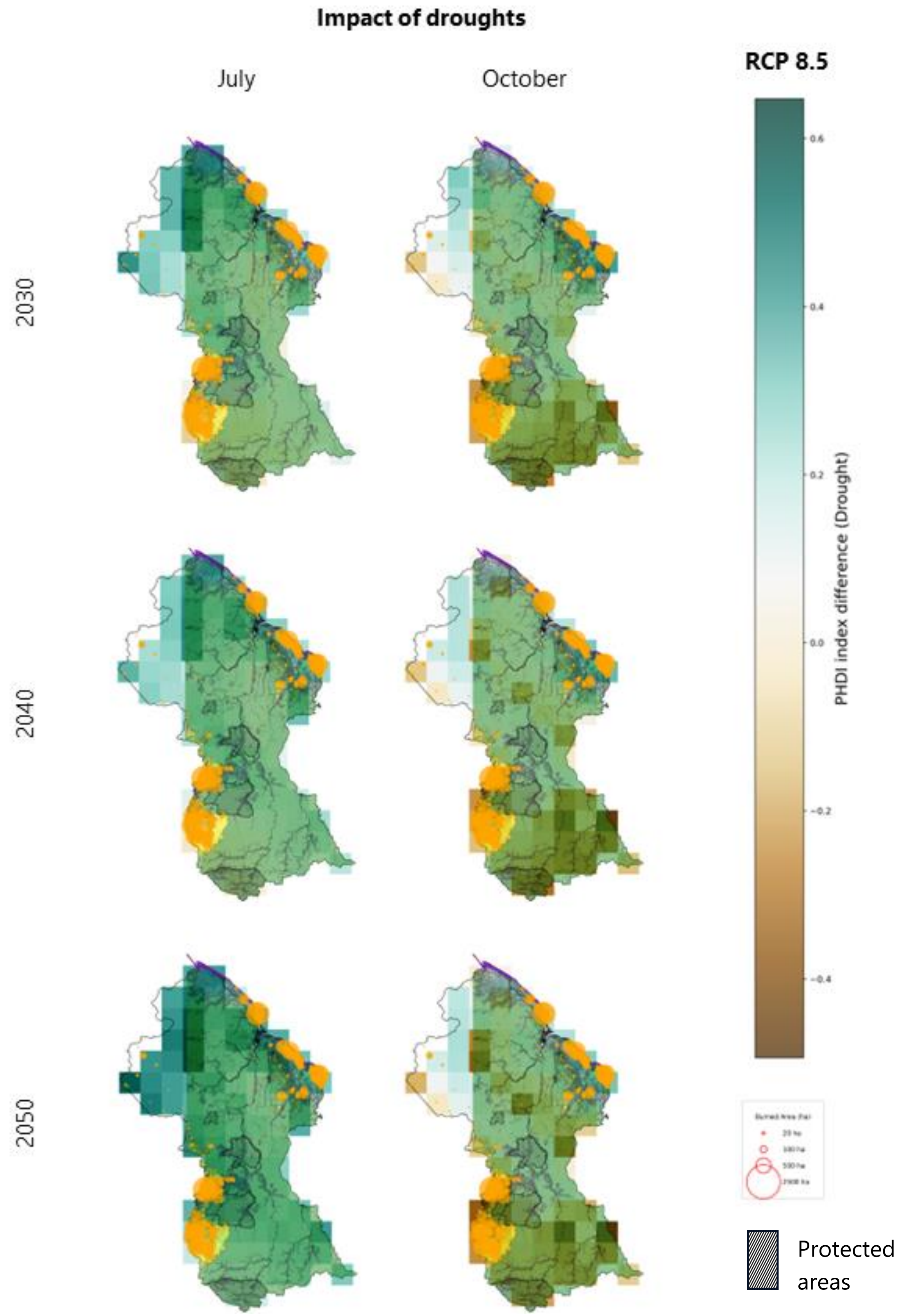

Figure 3.43. Change in PHDI index difference (drought), wildfires and their impact on land use under RCP 8.5.

3.2.7. Energy security

Guyana's energy sector is highly susceptible to various climate change hazards, including increased precipitation intensity, storms, and rising temperatures. This analysis outlines the observed and predicted climate changes, associated hazards, sectoral impacts, and the conditions that exacerbate these vulnerabilities.

Heavy rainfall and wind gusts frequently damage power stations, transmission lines and distribution networks, leading to extended power outages. This situation highlights the vulnerability of Guyana's current infrastructure to frequent interruptions, especially in low-lying coastal floodplains where most infrastructure is concentrated. The System Average Interruption Frequency Index (SAIFI) indicates significant outages in regions like Demerara, Berbice, and Essequibo. Additionally, **coastal flooding** due to sea level rise poses additional threats, inundating vital energy infrastructure and exacerbating power failures as all key energy infrastructure in Guyana is concentrated along the coast.

Elevated temperatures and heat waves strain the electric grid, already burdened by aged infrastructure, causing overheating and failure of generation, transmission, and distribution lines. Increased energy demand for cooling exacerbates these challenges, necessitating substantial upgrades to meet growing needs during peak periods. While 91.4% of the Guyanese population has access to electricity as of 2021, there is an urgent need to upgrade and expand the transmission and distribution systems of the national grid, at varying levels of quality, to cater for the projected increase in power demand from a growing population, coupled with increased energy demands for cooling during heat waves.

The following Figure 3.44 illustrates the impact of temperature increases on population density, which subsequently will affect energy demands for cooling as follows:

- In the RCP 2.6 scenario, a notable increase in temperatures is projected for the densely populated coastal areas in April, leading to a higher demand for energy for cooling infrastructure.
- Under the RCP 4.5 scenario, October temperatures are expected to decrease along the coastline for 2030 and 2040, which will result in reduced energy demand for cooling in these densely populated areas, further underscoring the extremization of temperature patterns within the country.
- The RCP 8.5 scenario forecasts high temperatures in the densely populated coastal regions of Guyana in April, coupled with a decrease in temperatures in the southern region. October 2050, under RCP 8.5, is anticipated to experience the most significant temperature increase, affecting densely populated areas across the country.

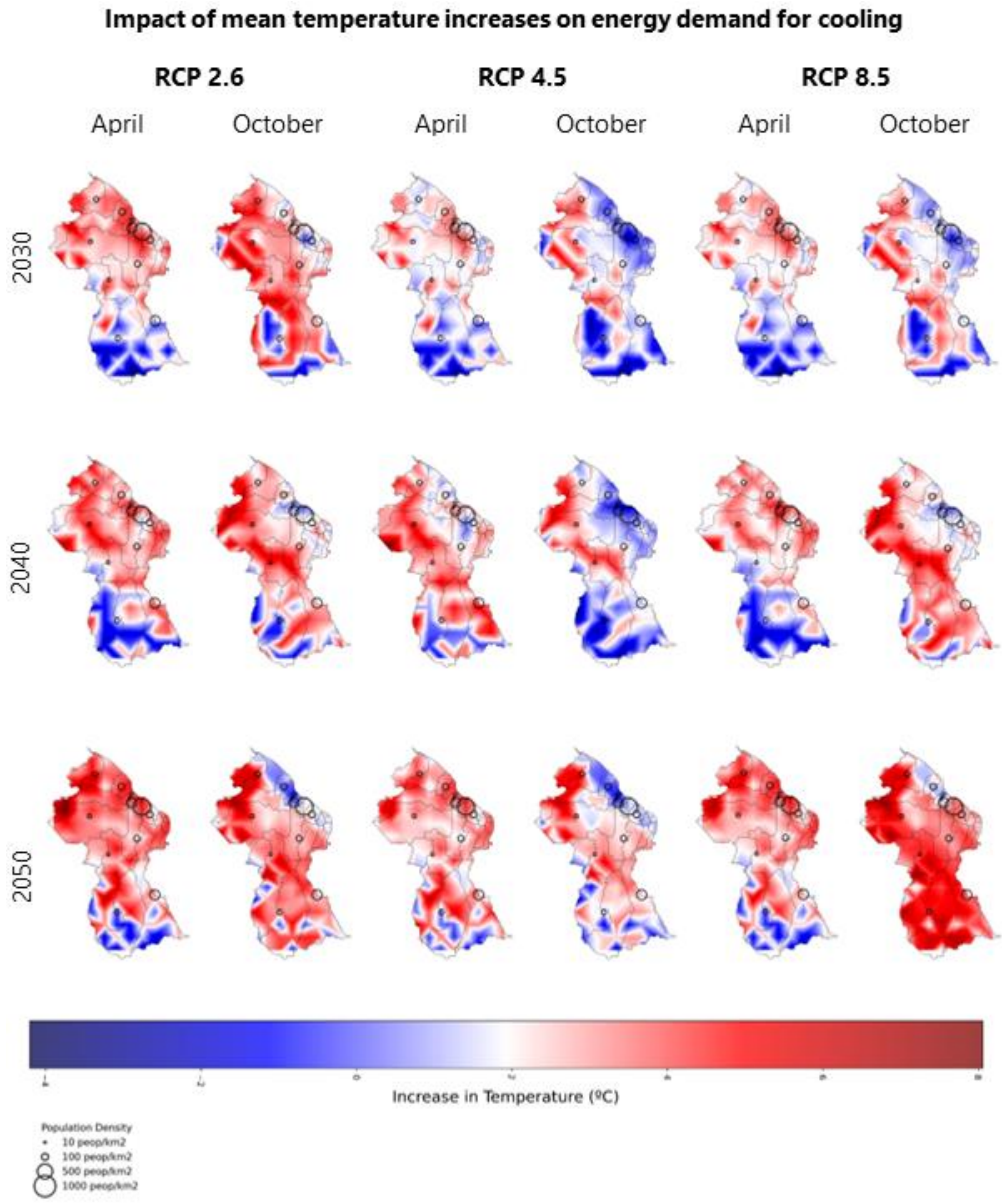

Figure 3.44. Change in mean temperature (°C) and its impact on energy demands for cooling.

Existing energy infrastructure in Guyana is almost entirely dependent on imported heavy fuel oil and diesel for electricity generation in the 12 public grids operated by Guyana Power and Light (GPL) and Hinterland Electrification Company Inc (HECI). Consequently, Guyana has some of the highest electricity rates in the broader region, and energy security and affordability is therefore extremely vulnerable to fuel supply disruptions and external fuel price shocks.

In light of these vulnerabilities, Guyana is in the process of driving a hydropower transition to support clean and affordable in-country electricity generation. While Guyana has a potential for 8.5GW of hydropower from some 33 hydropower sites (including storage capacity and run-of-river), existing hydroelectric dams such as Moco Moco and Tumatumari in Region 8 and Hossororo in Region 1 have become defunct due to lack of maintenance over the years. As part of the hydropower transition, the country plans on constructing three large-scale hydropower plants by 2040, to power the Demerara-Berbice Integrated System, namely a 165MW hydroelectric dam at Amaila Falls in Region 8 and another two sites still to be determined with the goal of providing 205MW of capacity by 2035 and a further 150MW of capacity by 2040. The Lethem grid will be reinforced though the construction of a new 1.5MW Kumu hydropower plant and the rehabilitation of the defunct Moco Moco hydropower plant with increased capacity to 0.7MW in Region 9, while the Mahdia grid will be reinforced by a 150kW plant in Kato in Region 8. Further, micro and pico hydropower grids are envisaged to provide renewable energy to disconnected rural and Indigenous communities throughout the country.

Figures 3.45, 3.46, and 3.47 showcase the impact of precipitation on hydroelectric power, while Figures 3.48, 3.49, and 3.50, illustrate the impact of drought on potential hydroelectric dam sites with a capacity greater than 1MW.

Across all RCP scenarios, there is a clear trend of increasing rainfall, particularly in the northern regions of Guyana, where most dams are located. Larger dams in these regions are likely to benefit from increased water availability, potentially boosting energy generation. However, smaller dams may face challenges due to manage water surplus, requiring infrastructure upgrades and enhanced management strategies to handle the higher water flow. The Central regions show mixed trends, with both increases and decreases in water availability depending on the time frame and RCP scenario. Conversely, Southern dams will likely face challenges due to reduced water levels, potentially impacting energy generation.

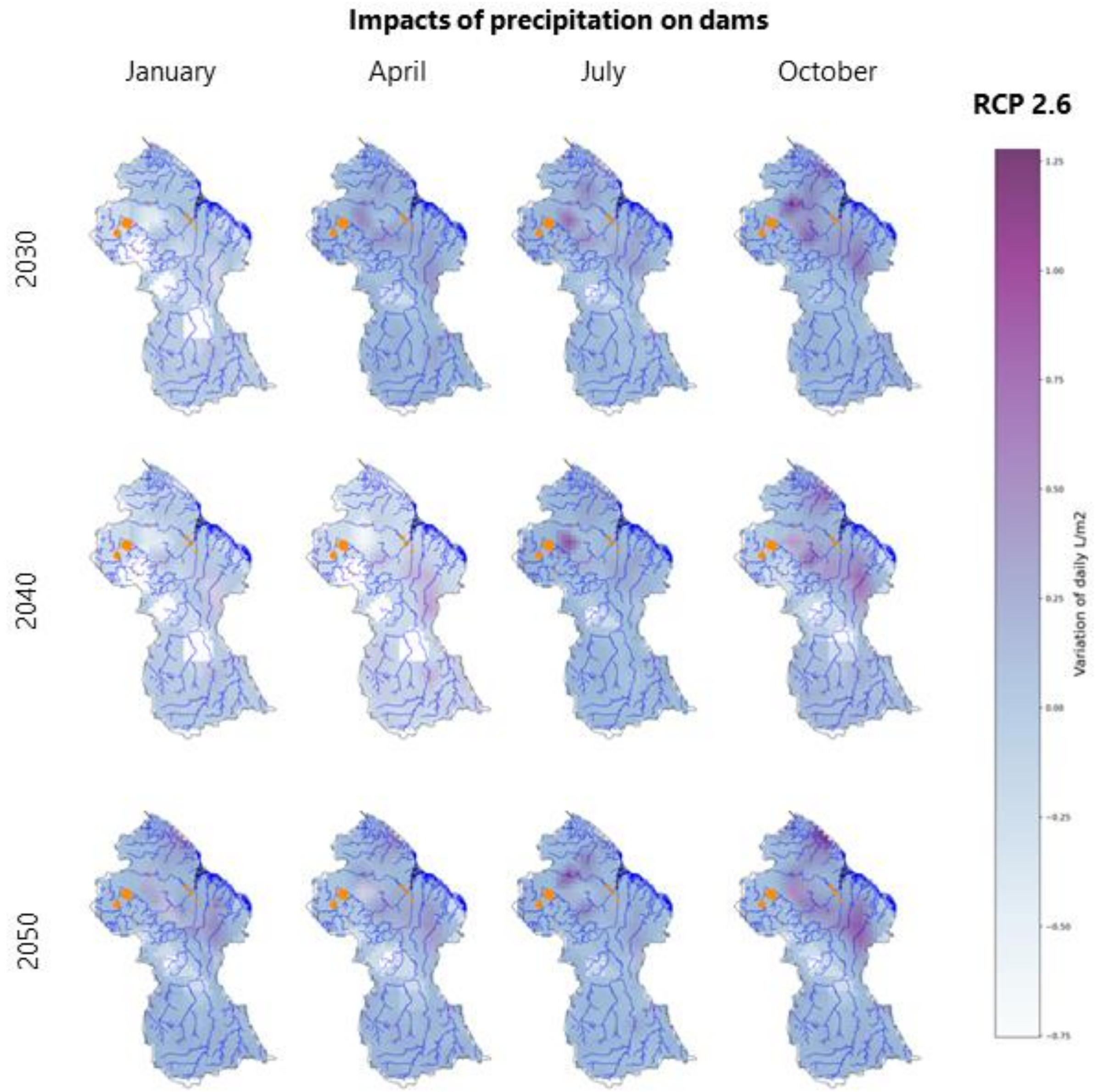

Figure 3.45. Change in daily precipitation (mm) and its impact on electric dams under RCP 2.6.

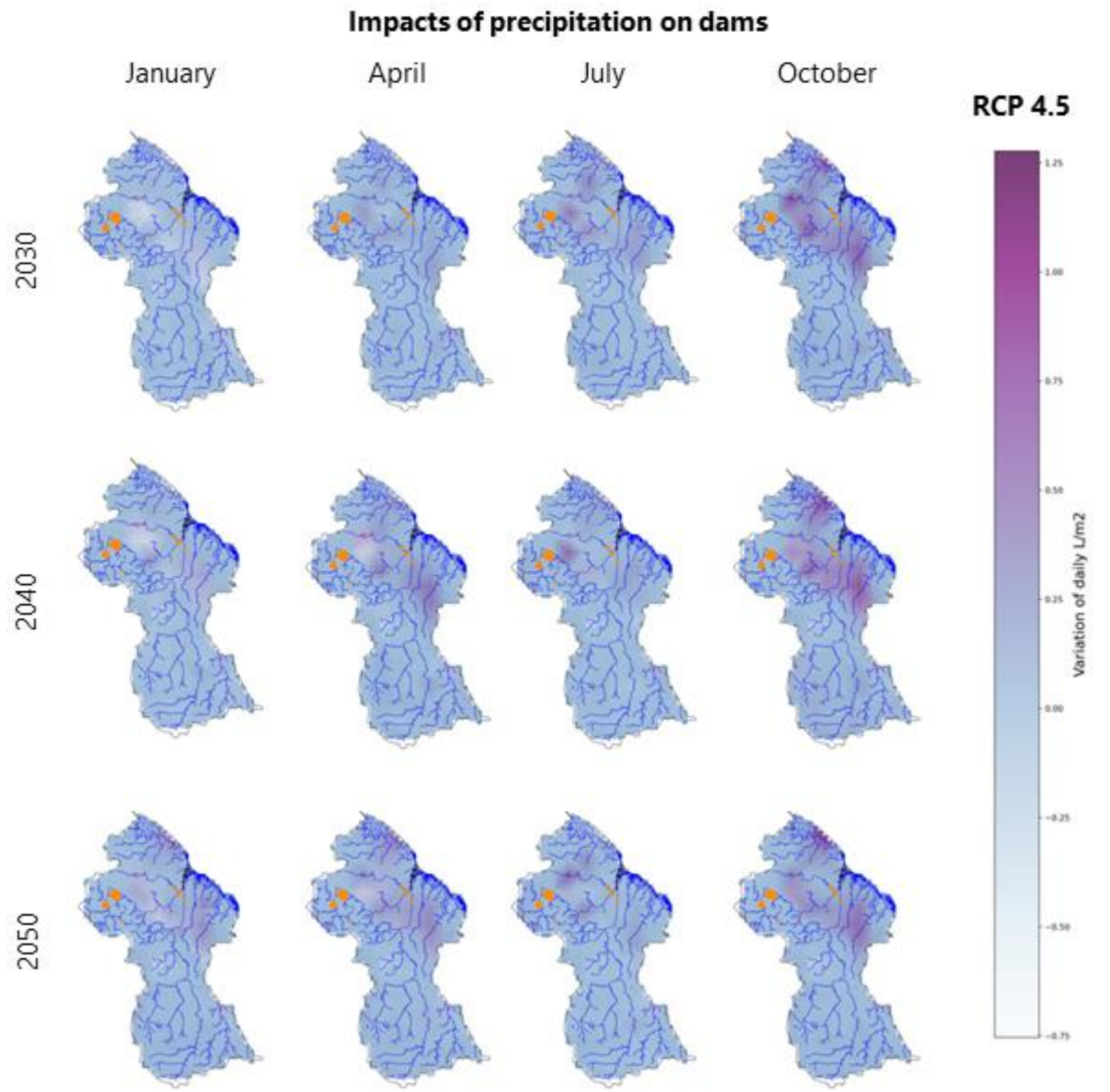

Figure 3.46. Change in daily precipitation (mm) and its impact on electric dams under RCP 4.5.

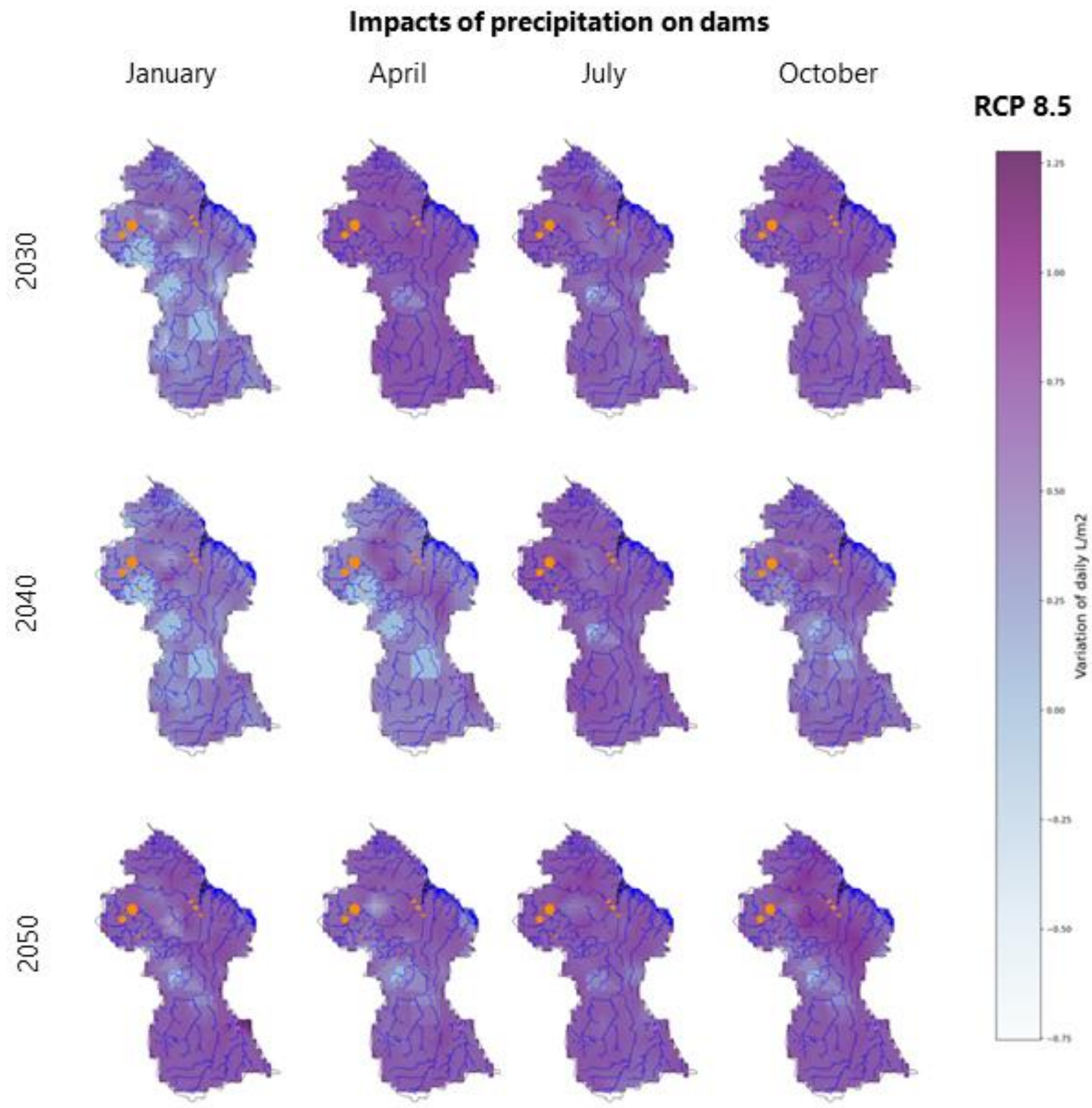

Figure 3.47. Change in daily precipitation (mm) and its impact on electric dams under RCP 8.5.

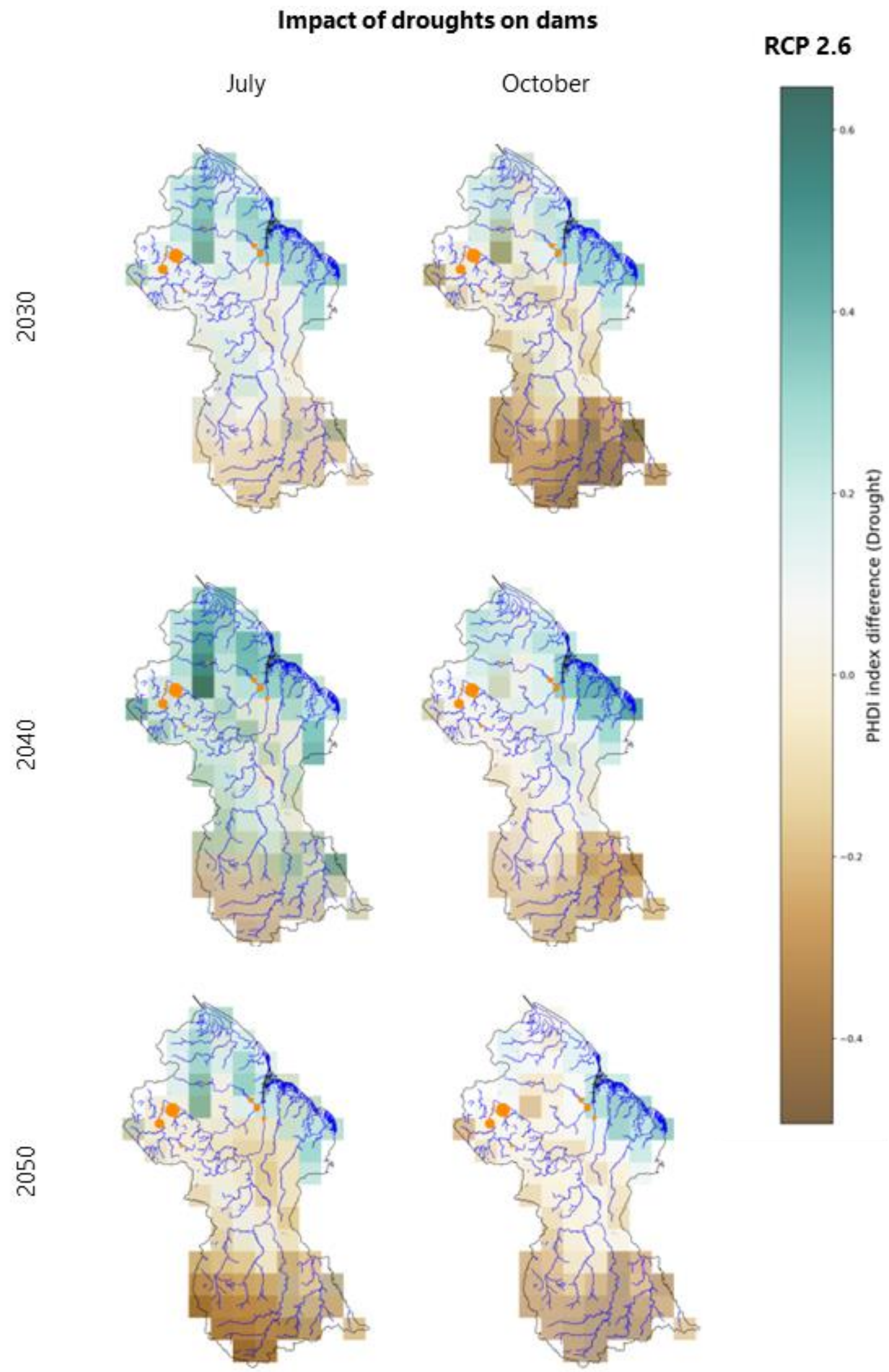

Figure 3.48. Change in PHDI index difference (drought) and its impact on electric dams under RCP 2.6.

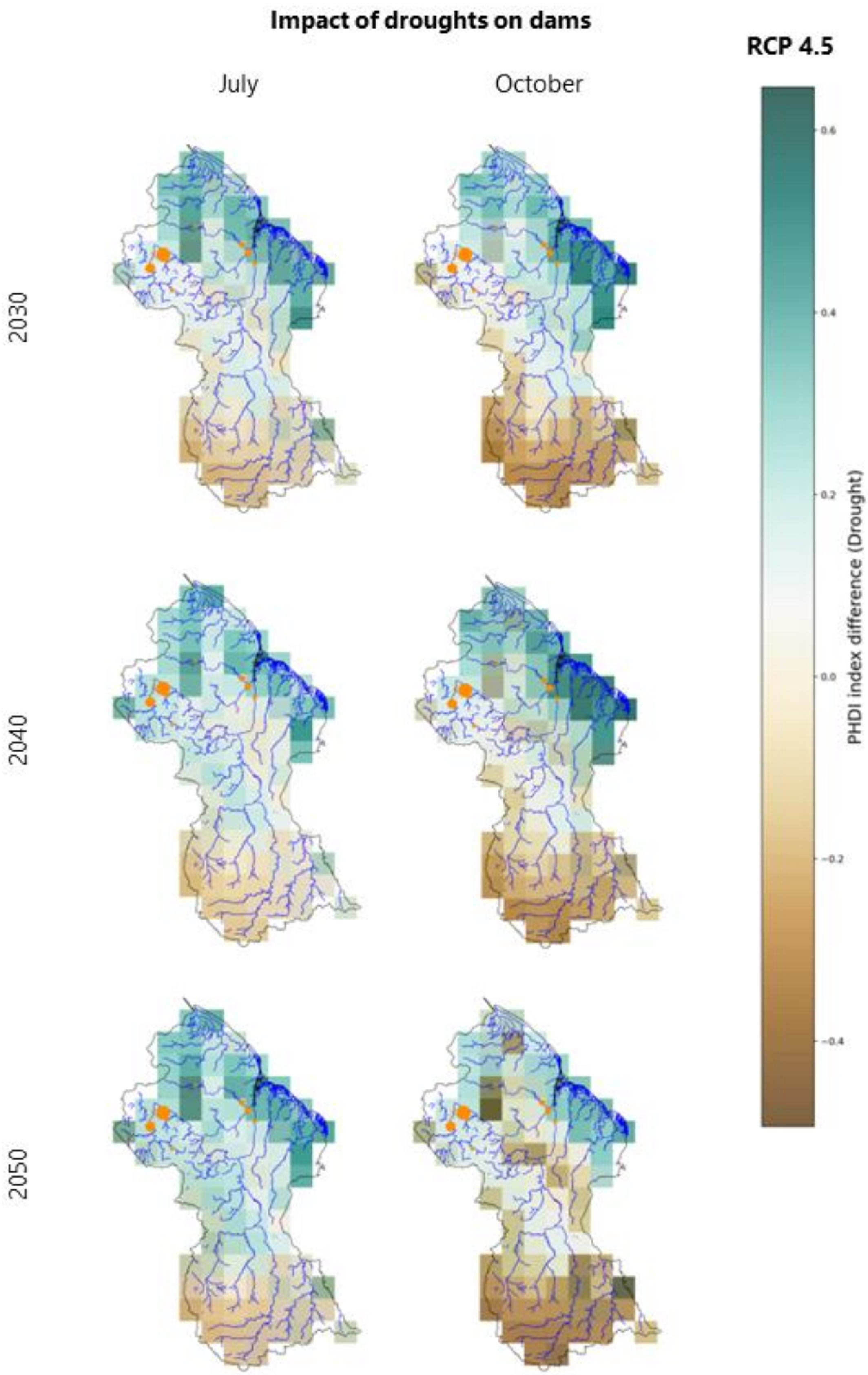

Figure 3.49. Change in PHDI index difference (drought) and its impact on electric dams under RCP 4.5.

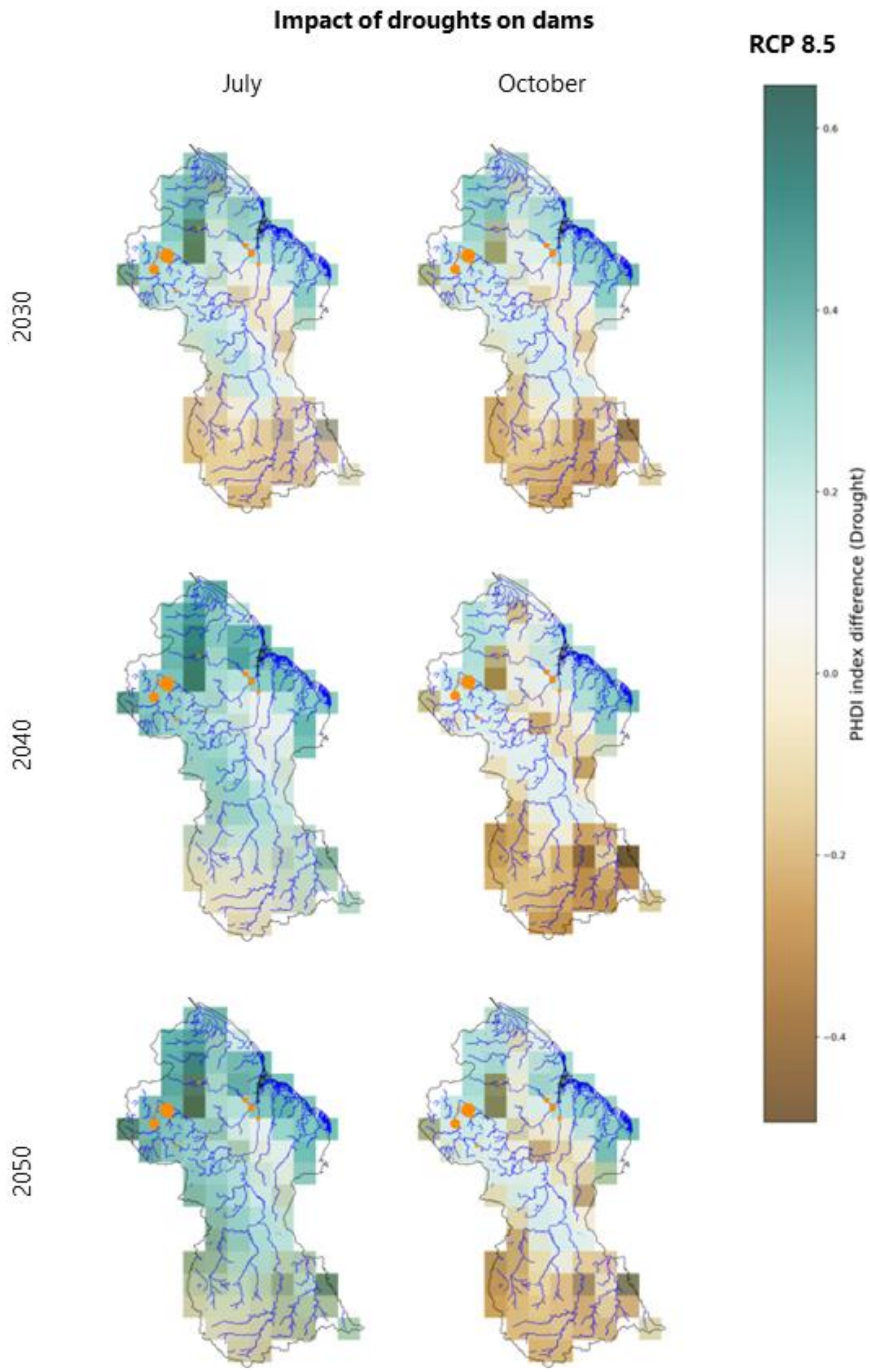

Figure 3.50. Change in PHDI index difference (drought) and its impact on electric dams under RCP 8.5.

3.2.8. Land use, infrastructure, settlements, and services

Guyana's low-lying coast and varied mix of topography across the country demand substantial resources to deliver public services and infrastructure. The dispersed population immediately beyond the coast and persisting infrastructure gaps further complicate the logistics and elevate disparity of access to and quality of public services across the country. As the first line of defence, resilient infrastructure saves lives and protects investment. The health and well-being of Guyanese citizens is directly linked to safety and access to required services in homes, workplaces, schools and communities. Insofar as infrastructure investment shapes economic activity and stimulates economic growth it becomes imperative for developing countries like Guyana to source financing to fund often critical and catalytic infrastructure including:

- **Transportation:** Climate change effects increase maintenance and repair costs of road transport infrastructure, while causing constant disruptions not only affecting human mobility, but also disrupting critical logistic networks supporting internal operations as well as interrupting trade connectivity. More precisely, increased mean temperatures and heat waves decrease the durability and lifespan of paved roads due to rutting, cracking, and other heat-induced damages, while heavy precipitation may cause infiltration and potholes from the degradation of paved surfaces. Although 71% of the paved national road network can be classified as in good condition this only represents 15% of the total road network in the country, most of which is unpaved. Further, most paved roads, as well as the country´s main international airport are concentrated across the urban coastal strip, which is also susceptible to damage and loss from sea level rise. Similarly, the main international road transport corridor connecting Guyana's ports with Brazil is being constructed right along the flood plan of the country´s main water conservancy. Heavy precipitation and flooding causes washouts of road infrastructure, particularly affecting unpaved roads which prevail across the Hinterland. Insufficient paved road connectivity across Guyana places Hinterland communities as well as critical mining, timber, and agricultural operations at risk of isolation. These communities and timber and mining operations are reliant on riverine or airstrip transport, whose operations are also hampered by either low water levels, extreme water speeds, as well as air navigation restrictions during extreme events.
- **Housing, settlements, and buildings:** Coastal and fluvial flooding of homes and buildings, rendering them operational and causing loss and damage to their contents, as well as permanent damage to their structural integrity is expected. On the other hand, there is a severe risk of building overheating, exacerbated by the urban heat island effect across the coastal urban hubs. Loss of coastal settlements and permanent migration inland due to encroaching of sea and overtopping of sea defences is a particular concern as the low-lying coastline represents 7% of Guyana's total area but

supports 90% of the population. In fact, most of Guyana´s urban centres are located in the low-lying coastal strip, whereby approximately 40% of Guyana´s population resides in the broader Georgetown Metropolitan area, with a further 35% in urban centres across the narrow coastal strip across the North of the country. On the other hand, Regions 8 and 9, have experienced dry periods with intense heat resulting in increased instances of open fires, which have, also destroyed some wooden bridges used to connect communities. These place increased pressures on government to continuously find resources to rebuild and replace damaged infrastructure which can crowd out capacity to embark on new infrastructure.

- **Communications:** Disruption of communications through flooded information, communications, and technology infrastructure, as well as overheating through increased temperature and heatwave events can be expected throughout Guyana. Sea level rise is also a risk to communications technology, as it is primarily concentrated along the coastal urban hubs.
- **Water and sewerage:** Less than 5% of Guyana´s population is currently covered by sewerage collection systems, whereas 30% of the population use pit latrines and 65% use septic tanks at varying levels of quality and limited sludge removal processes. Flooding places a particular risk to water and sewerage infrastructure by overtopping systems, spreading contaminated water, and causing water supply disruptions from flooded pumping stations.

Figure 3.51 illustrates the impact of extreme temperatures on Guyana´s key settlements. The greatest impacts on coastal urban centres are expected under RCP 4.5 and 8.5 in the month of July.

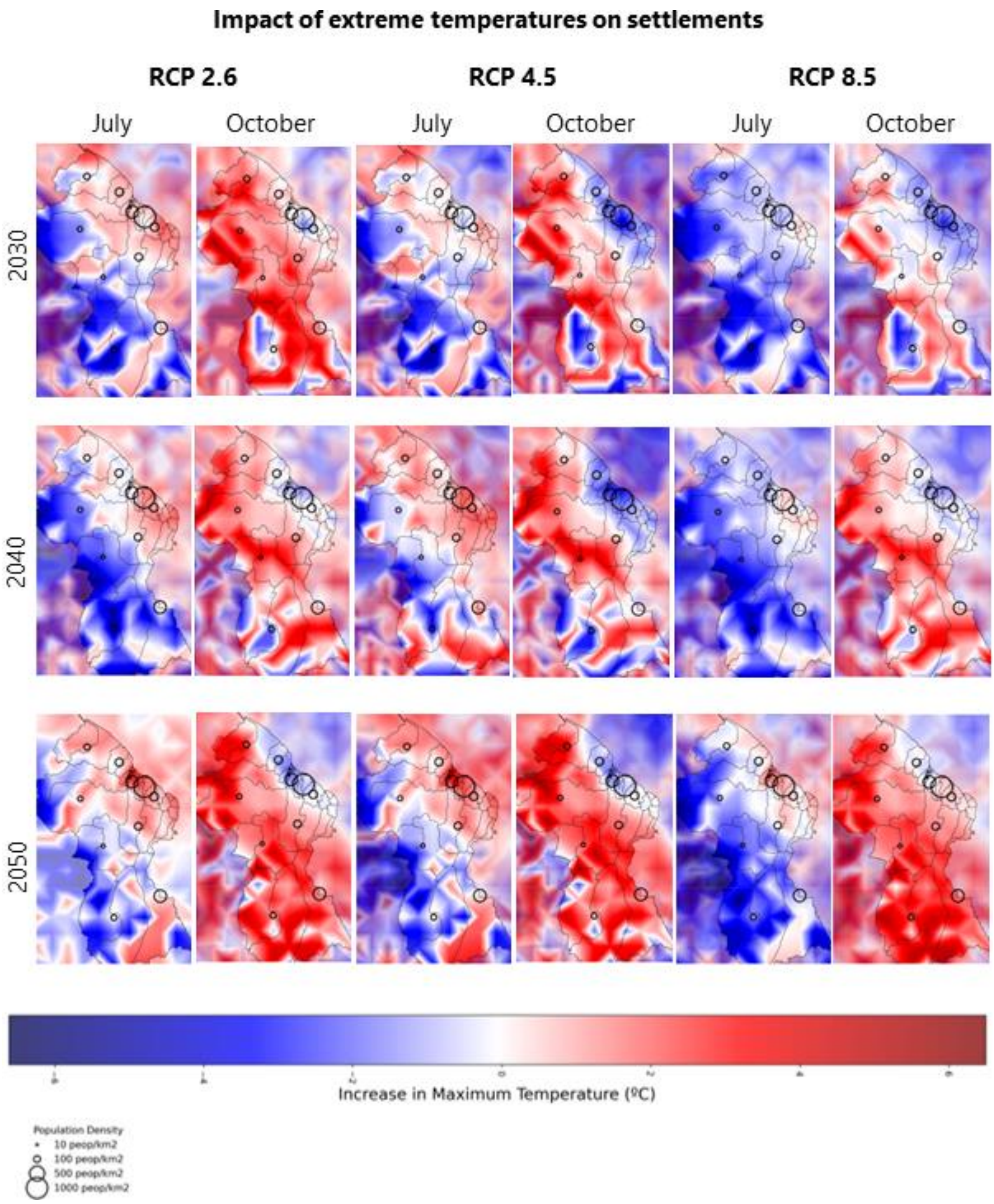

Figure 3.51. Extreme temperatures its impact on settlement size and distribution.

Figures 3.52, 3.53, and 3.54 illustrate the impact of rainfall on various types of critical infrastructure, including healthcare centres, ports, airstrips, and main roads. Under the RCP 2.6 and RCP 4.5 scenarios, increased precipitation during October is expected to affect some airports and healthcare centres in the central and coastal regions. In the case of RCP 8.5, all infrastructure, including key roads, health centres, airstrips, and ports, will face severe impacts from flooding events. The only exceptions are an extension of a key road and two airstrips located in areas projected to experience minimal increases in precipitation.

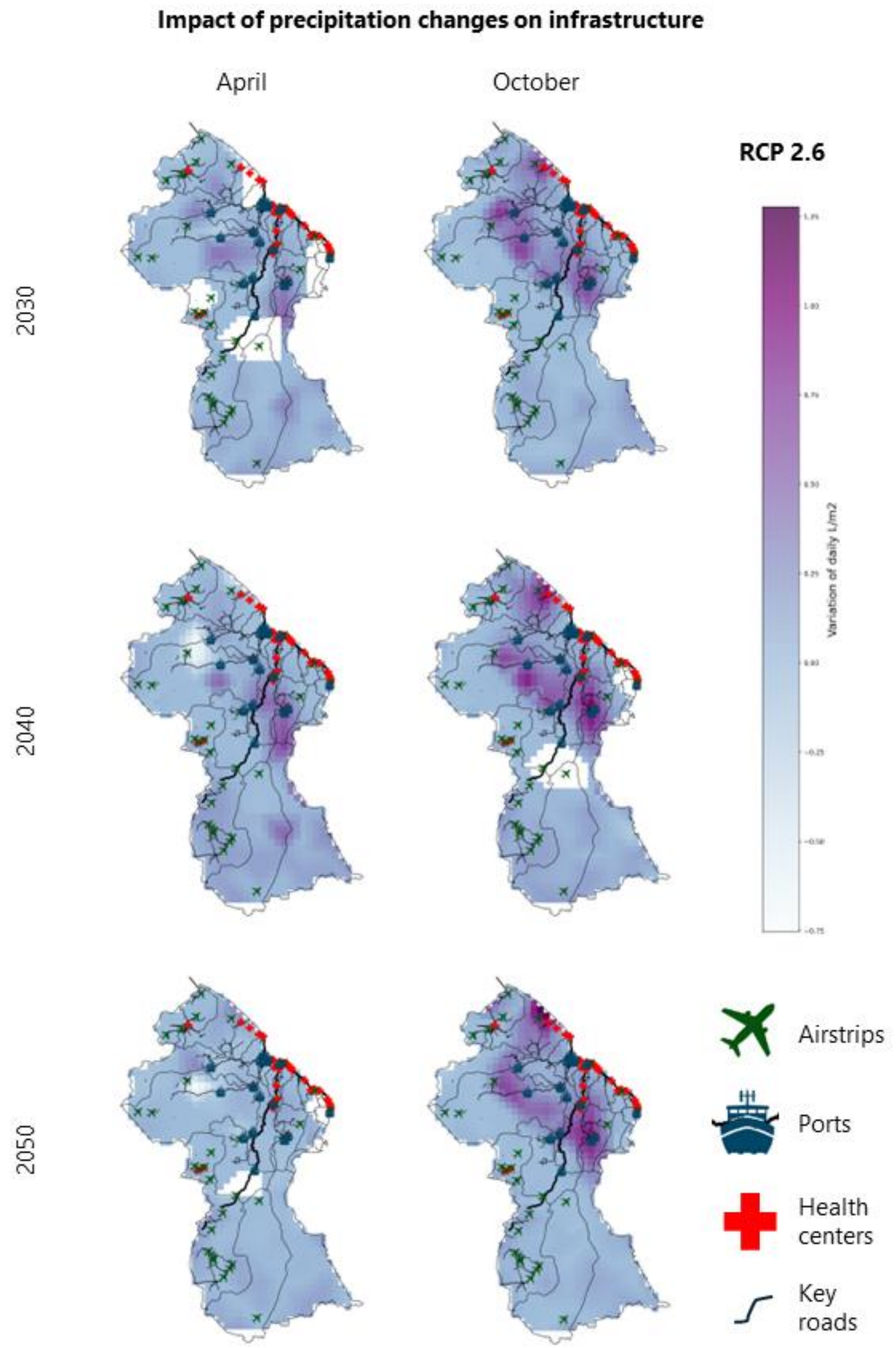

Figure 3.52. Change in precipitation (mm) and impact on key infrastructure under RCP 2.6.

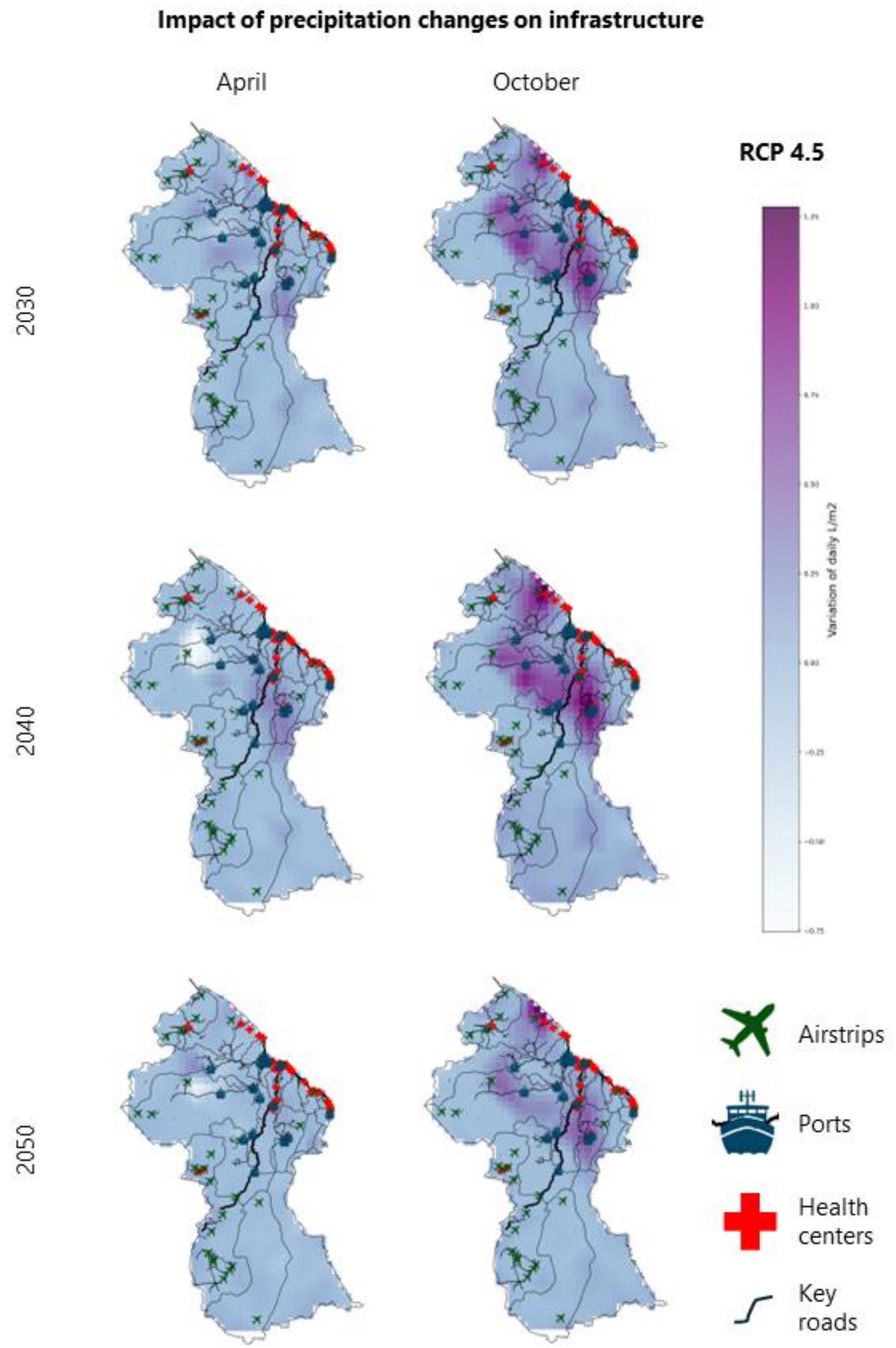

Figure 3.53. Change in precipitation (mm) and impact on key infrastructure under RCP 4.5.

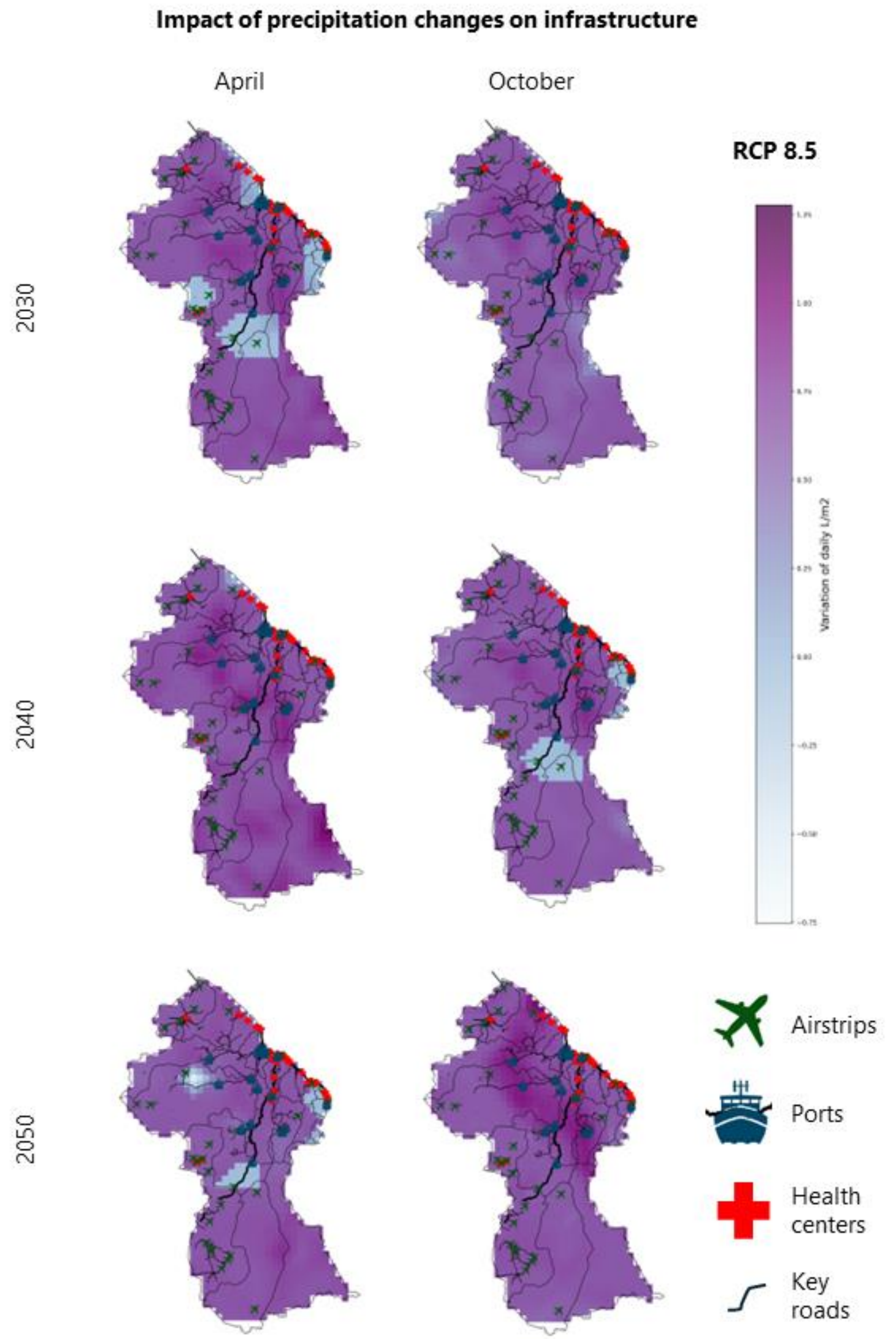

Figure 3.54. Change in precipitation (mm) and impact on key infrastructure under RCP 8.5.

3.2.9. Amerindian and Hinterland development

The Amerindian and Hinterland communities in Guyana are vulnerable to various climate change hazards, including **increased precipitation intensity and storms**, **sea level rise**, periods of decreased precipitation (**droughts**), and **fires**. These hazards lead to significant sectoral impacts, exacerbated by existing vulnerabilities in the Amerindian and Hinterland development sector by **shifting traditional livelihoods and well-being**.

Climate change profoundly impacts these communities in Guyana through increased precipitation intensity and storms, leading to fluvial flooding. These events disrupt critical livelihood activities like subsistence farming, fishing, hunting, and gathering, affecting thousands of families and undermining food security. Consequently, communities are compelled to rely more on store-bought foods, which alters diets and heightens health risks.

The situation is compounded by water-borne diseases and vector-borne diseases like malaria, posing severe health risks due to increased breeding grounds from flooding and further compounded by risks of respiratory illnesses.

Coastal flooding and sea level rise threaten not only physical infrastructure, but also traditional livelihoods and cultural practices rooted in the land. The loss of traditional natural resources due to these environmental changes amplifies pressures on already vulnerable communities, pushing them towards integration into cash-based economies and away from sustainable, traditional practices. Saltwater intrusion into freshwater systems further jeopardizes water security, where traditional water sources are increasingly polluted and compromised by climate change impacts.

Furthermore, periods of decreased precipitation and droughts devastate agriculture, leading to food insecurity and increased vulnerability to wildfires, especially in savannah regions. These fires, exacerbated by dry conditions, threaten both livelihoods and food sources, compounding the challenges faced by communities already grappling with climate-induced vulnerabilities.

Figures 3.55, 3.56 and 3.57 showcase the impact of heatwaves on Amerindian and Hinterland communities. In conclusion, the Northern and coastal areas of Guyana experience fewer heatwaves, while the central and Southern regions face more severe impacts, significantly affecting various of these communities, including small and medium-sized ones in the West and a highly densely populated Amerindian settlements in the South. By 2050, all scenarios show an extreme rise in heatwaves, particularly in October, severely impacting most Amerindian and Hinterland settlements.

Figures 3.58, 3.59, and 3.60 illustrate the impact of precipitation on these communities. Under RCP 2.6, some medium-sized Amerindian and Hinterland communities in the central region of

Guyana are projected to experience a significant decrease in precipitation, adversely affecting their water security. For both RCP 2.6 and RCP 4.5, maps indicate an increase in precipitation in the northeast region during October, leading to negative flooding impacts on small Amerindian and Hinterland settlements. The RCP 8.5 scenario shows the most dramatic increases in precipitation across all settlements and months, suggesting severe flooding impacts on small communities in the northern coastal areas, medium-sized populations in the west, and the highly densely populated community in the south, with the exception of some central areas where medium and small communities are located.

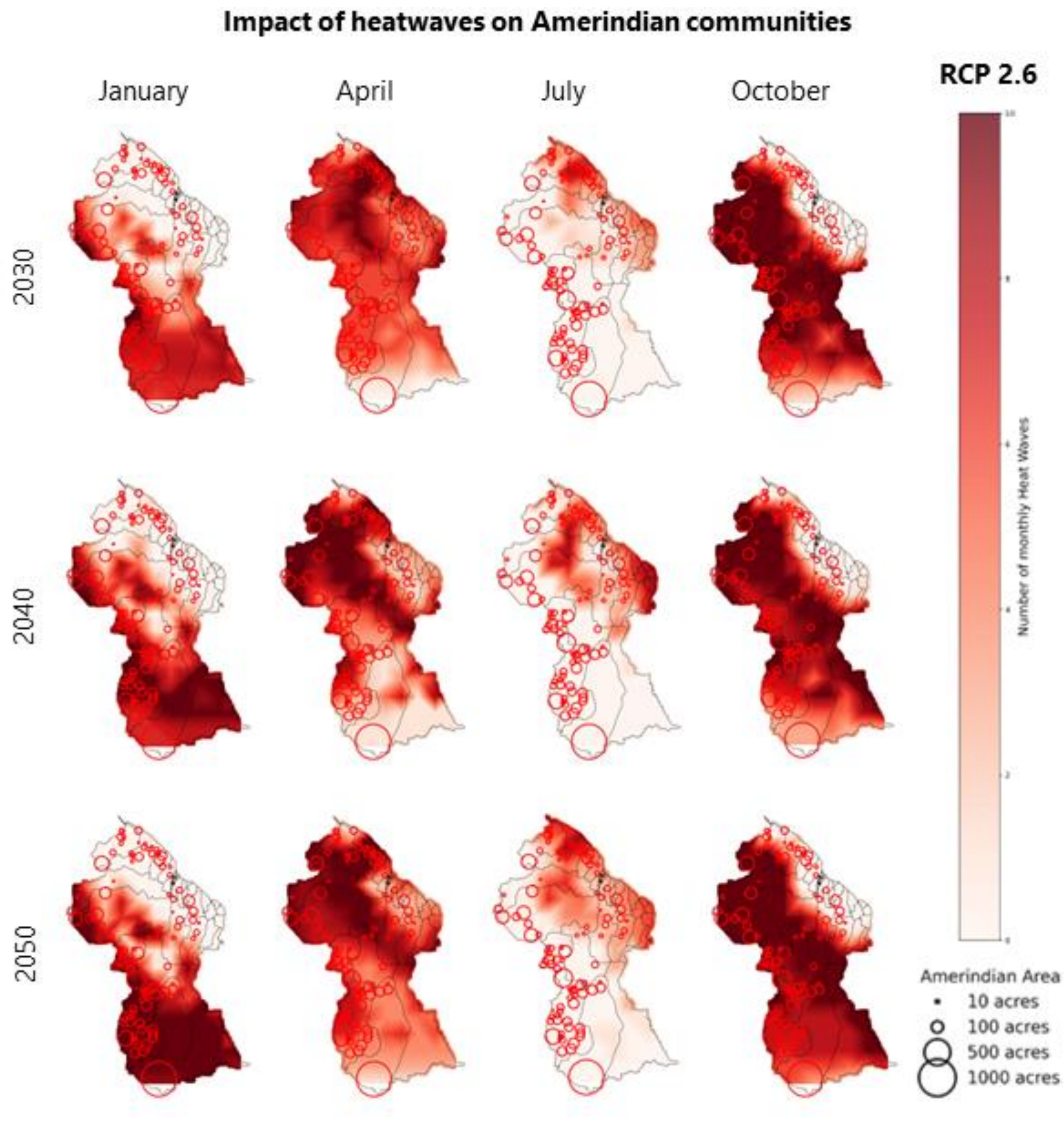

Figure 3.55. Impact of monthly heatwaves on Amerindian communities RCP 2.6.

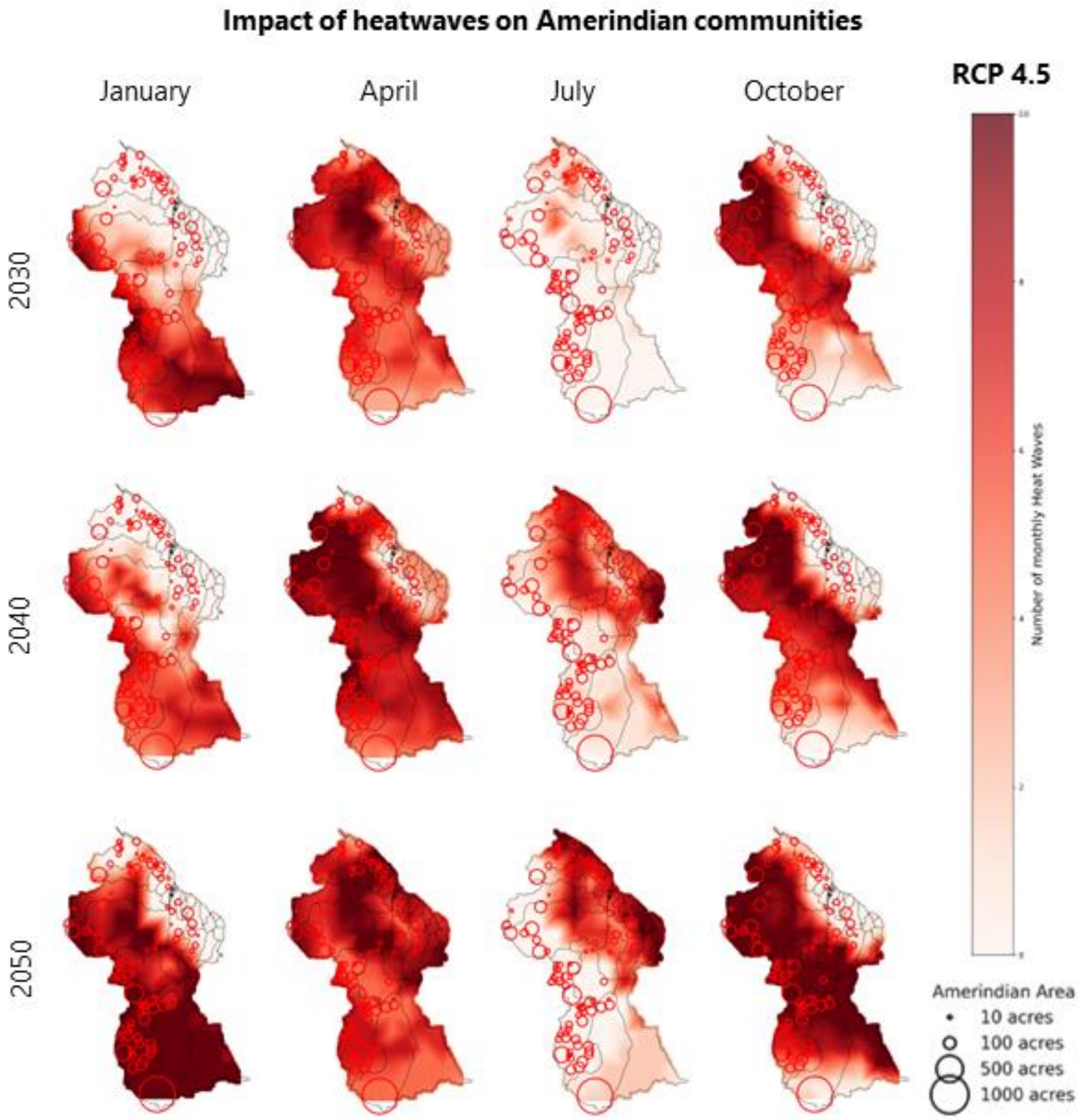

Figure 3.56. Impact of monthly heatwaves on Amerindian communities RCP 4.5.

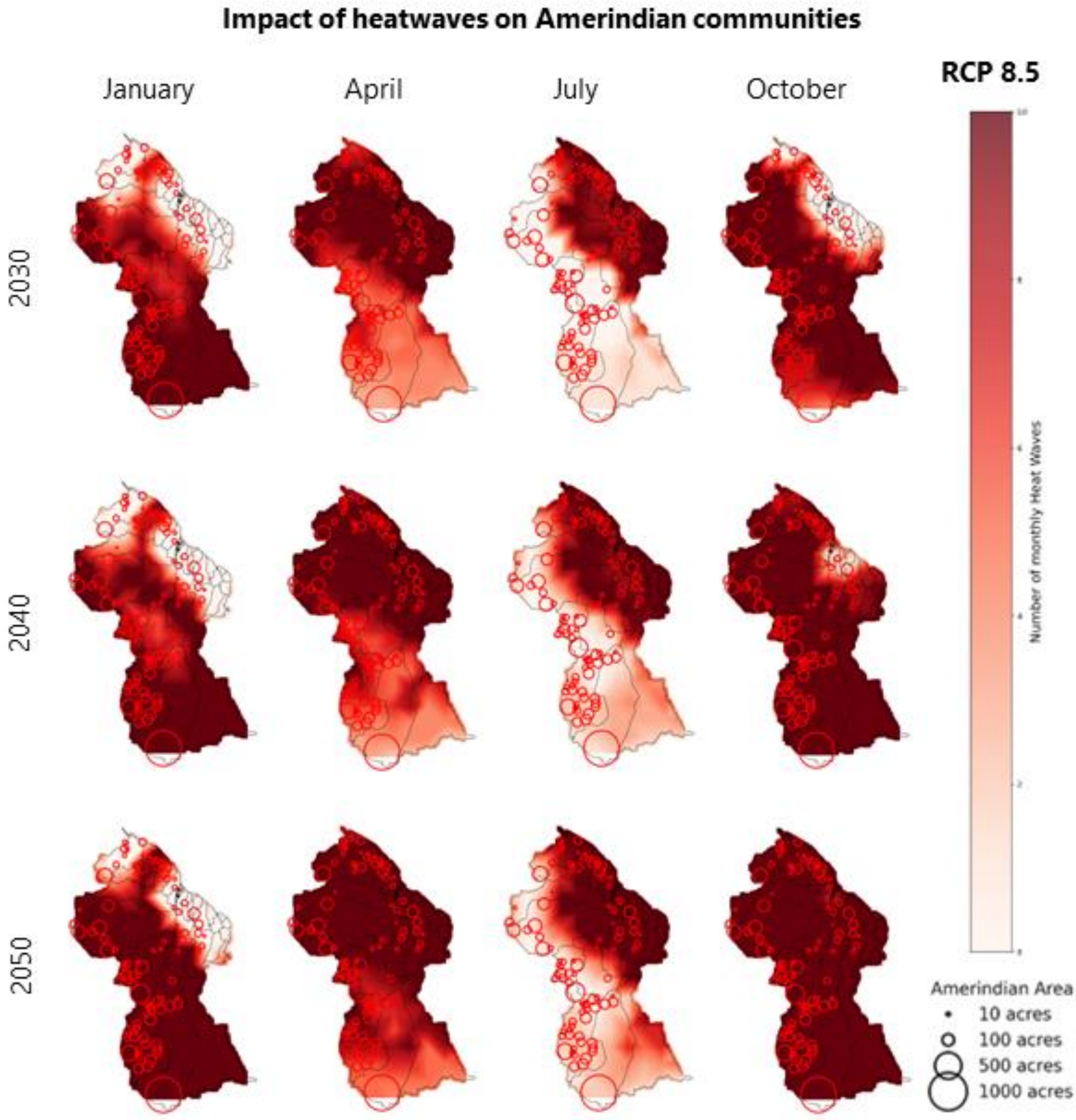

Figure 3.57. Impact of monthly heatwaves on Amerindian communities RCP 8.5.

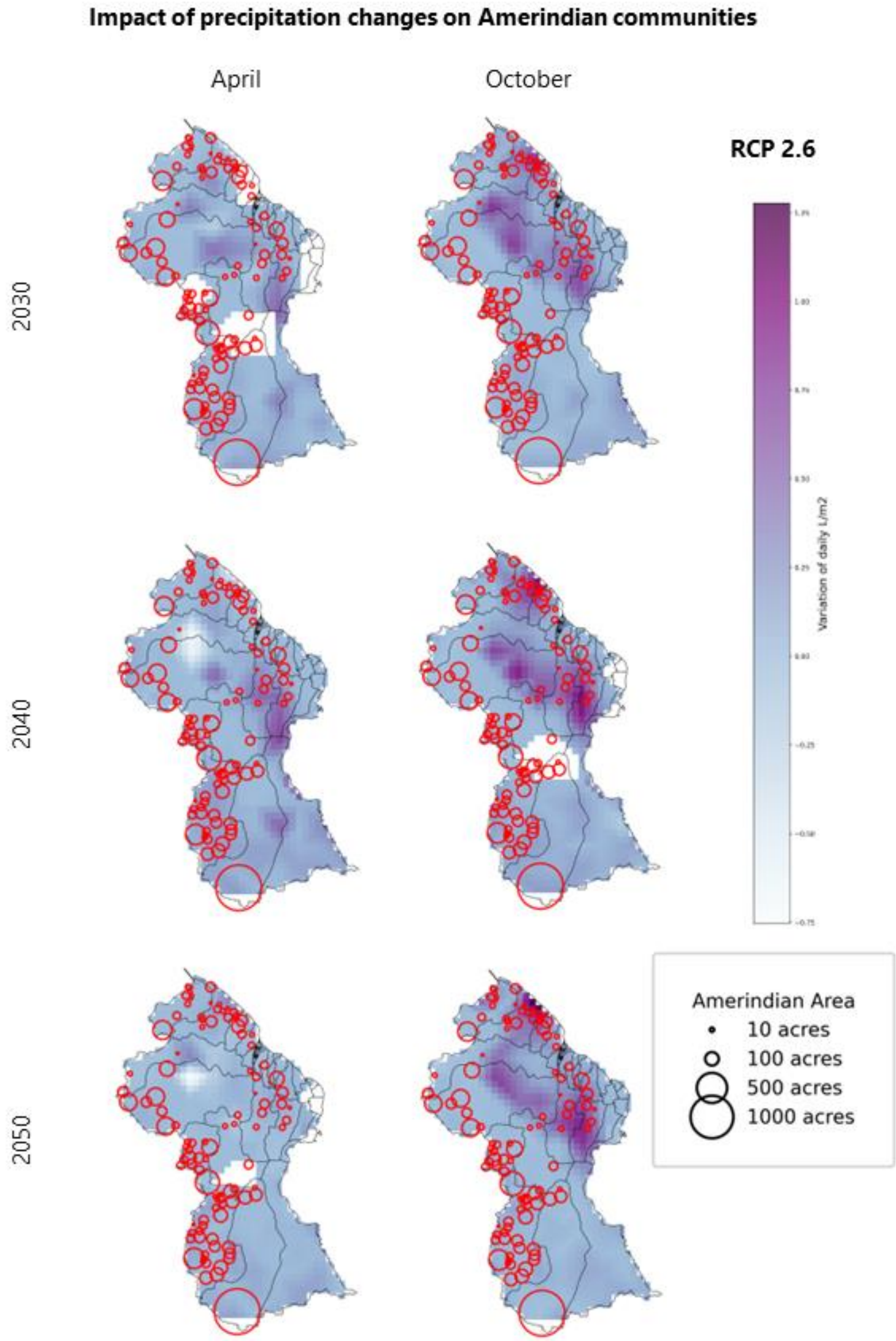

Figure 3.58. Impact of mean daily precipitation (mm) on Amerindian communities RCP 2.6.

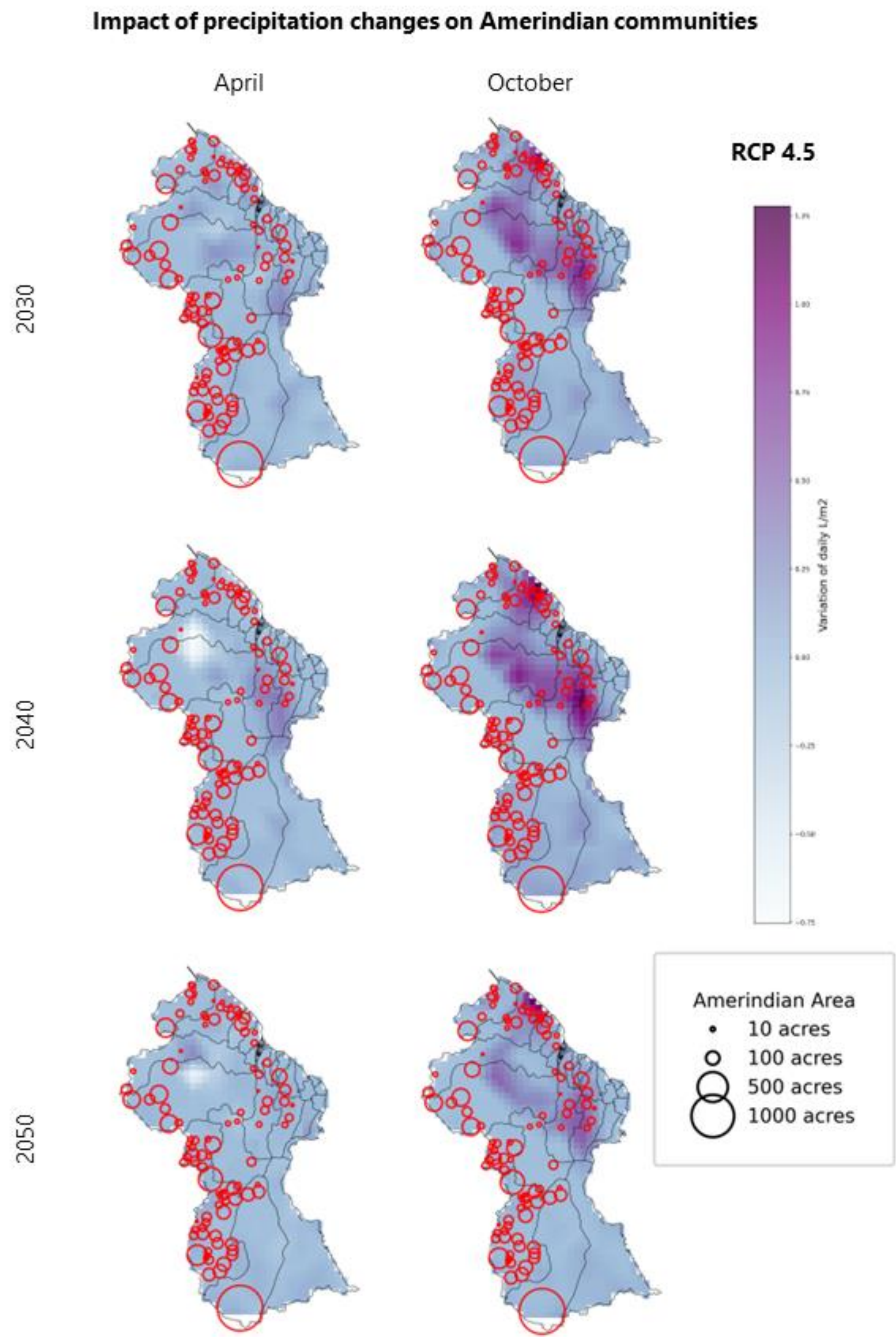

Figure 3.59. Impact of mean daily precipitation (mm) on Amerindian communities RCP 4.5.

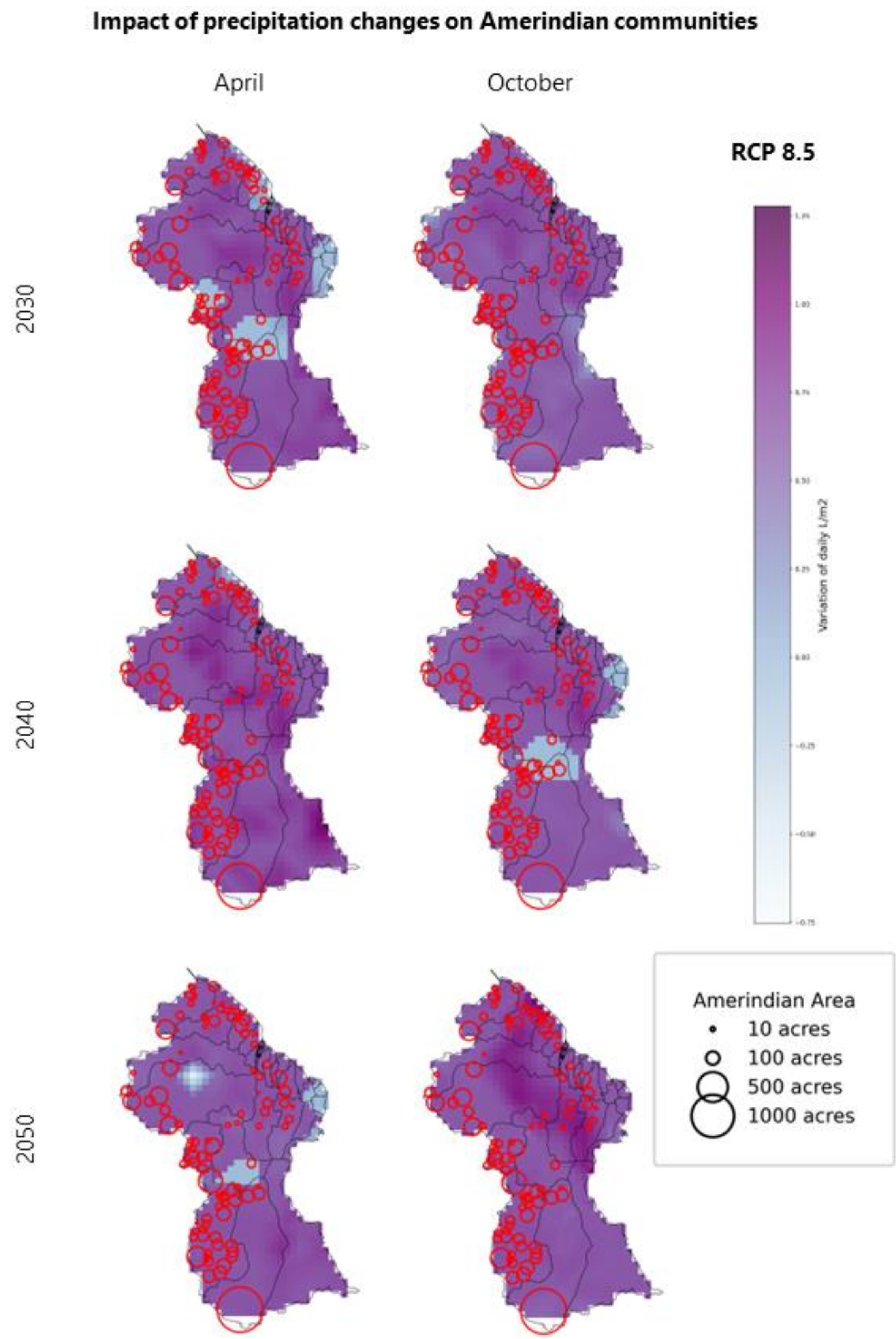

Figure 3.60. Impact of mean daily precipitation (mm) on Amerindian communities RCP 8.5.

4. National adaptation overarching policy frameworks

Guyana has a robust strategic adaptation planning framework seeking to both detect and address key vulnerabilities to the various risks posed by climate change, comprised of policies, strategies, and plans at the national and sectoral level which are both explicitly dedicated to climate change adaptation, and mainstream adaptation considerations into development priorities.

4.1. National adaptation frameworks

The initiation of Guyana´s comprehensive and structured nation-wide strategic planning of climate change adaptation could be attributed to Guyana´s **Climate Change Action Plan** elaborated in 2001, which also enables Guyana to meet commitments to the United Nations Framework for Climate Change Convention (UNFCCC). The plan establishes climate change adaptation as a priority due to the economic value of Guyana´s low-lying coastal zone that is expected to be affected by sea level rise, setting our adaptation options for six sectors, namely: coastal zone, agriculture and fisheries, water resources, energy, forestry and land use, and waste.

Originally developed in 2009, Guyana´s **Low Carbon Development Strategy (LCDS)** was later updated in 2013, and subsequently updated in 2022, acting as the principal framework for climate change adaptation in the country. The updated LCDS 2030 advances Guyana´s unique world-class financing model to support climate resilient development and expanding vision to include Guyana's other globally significant ecosystem services taking into consideration the new national circumstances. The LCDS therefore stands as the primary guiding document for climate change adaptation in Guyana.

Climate adaptation and resilience is one of the four inter-linked objectives of the LCDS 2030, comprised of the following priority areas:

- Building climate resilient agriculture systems.
- Conducting climate risk assessments and insurance.
- Coastal green-grey infrastructure enhancement and maintenance.
- Mangrove restoration and expansion.
- Drought and flood management.
- Building a more reliable, affordable, and resilient energy mix.
- Building an education system resilient to the impacts of climate change.
- Adapting public health to climate change.

- Strengthening emergency response to extreme events.

In 2016, Guyana submitted its **first nationally determined contribution (NDC)** with the overarching goal to transition towards a resilient, low-carbon, socially inclusive economy that provides a better quality of life for all within the ecological limits of the planet. Guyana´s first NDC establishes the country's international conditional and unconditional commitments for climate change adaptation to 2025.

A central element of the NDC is the preparation and implementation of the Climate Resilience Strategy and Action Pan (CRSAP) acting as the key comprehensive framework for adaptation and resilience building in Guyana. Table 3.9 outlines the more specific NDC adaptation commitments which Guyana has actively working towards achieving.

Table 3.9. Overview of the adaptation commitments set out in Guyana´s first NDC.

Type	Unconditional	Conditional
Policy Planning	• Mainstreaming of climate change considerations in all national development sectors. • Developing the CRSAP.	• Implementing the CRSAP.
Action	• Continuation of basic work on integrated water management infrastructure, which includes the construction, rehabilitation and maintenance of conservancies, canals, and sea defences, as well as water supply and sanitation infrastructure. • Introduction of new agricultural techniques such as hydroponics and fertigation.	• Upgrading infrastructure and other assets to protect against flooding. • Mangrove restoration. • Hinterland adaptation measures. • Development and implementation of Early Warning Systems. • Enhanced weather forecasting including microclimate studies and localized forecasting. • Development and introduction of crop varieties which are flood resistant, drought tolerant, and disease resistant. • Development of environmental and climate change awareness programmes at all levels. • Development of innovative financial risk management and insurance measures.

With resources from the Guyana-Norway Partnership, in 2016 Guyana concluded a comprehensive **Climate Resilience Strategy and Action Plan (CRSAP)**, which presents a comprehensive national framework for adaptation and resilience building built in five cross-cutting pillars of adaptation, namely:

1. Information, research, and systematic observation.
2. Institutional framework and capacity building, education, and awareness.
3. Policy, legal framework, and tools to integrate climate change adaptation into development planning.
4. Generation and application of technologies.
5. Innovative financing instruments.

The CRSAP was developed through a thorough stakeholder consultation process, consistent with the methodology set out in the UNFCCC Least Developed Countries Expert Group (LEG) Technical Guidelines for the National Adaptation Plan Process (Least Developed Countries Expert Group, 2012), adapted to the specific needs and situation in Guyana. The CRSAP builds on the work carried out in Guyana over previous years and identifies key climate risks and priority resilience actions, across four sectors, namely: health, agriculture, drainage and irrigation, and sea defence. The CRSAP consists of the following twin-track process as described below:

- **Track 1 (2016-2020)** focused on the development of four early-start resilience project concepts designed for sectors where there is an existing robust evidence base, and includes their supporting appraisal documentation, allowing them to be assessed by bilateral and multi-lateral partners/funds.
- **Track 2 (2020 and beyond)** recognizes the needs of the country to continue building resilience to climate change across all key sectors. It focuses on gathering the evidence on climate vulnerabilities, impacts, risks, and their associated uncertainties needed to design new interventions.

In 2021, work commenced to implement the CRSAP through the update of its most important elements, the allocation of funding to priority climate resilience programmes asset out in the LCDS 2030, and the launch of a finance strategy to finance the remainder of the CRSAP. The priority climate change resilience programmes include:

- **Sea Defence Enhancement and Maintenance:** Protecting coastal communities against coastal flooding by increasing Guyana´s sea defence system´s resilience to climate change through restoration and retrofitting of grey infrastructure and empowerment, restoration, and protection of mangroves.
- **Strengthening Drainage and Irrigation Systems:** Improving the dual role of drainage and irrigation for flood control and water drainage, as well as provision of water for agricultural, domestic, and other purposes.
- **Building Climate-Resilient Agriculture Systems**: Implement climate-smart agricultural initiatives improving water management for both flood control and drought preventions, while improving response capacity for climate events and strengthening inter-institutional cooperation.

- **Public Health Adaptation to Climate Change:** Improving the risk preparedness, management, and recovery capacity of the health sector, improving access to clean water, sanitation, and hygiene, reducing incidences of water and vector-borne diseases, and improving the knowledge and capacities of the public and health practitioners on the risks imposed by climate change.
- **Emergency and Extreme Events/Flood Control and Management:** Undertaking comprehensive water resource management and developing early-warning systems.

In 2016, Guyana commenced its **adaptation technology needs assessment** process for three priority sectors, namely: agriculture, water resources, and coastal zones. This was a country-driven process leading to the identification, prioritisation and diffusion of environmentally sound technologies for adaptation to climate change. The process culminated with the production three consecutive documents, namely, the Technology Needs Assessment (TNA), the Barrier Analysis and Enabling Framework (BA&EF), and Technology Action Plan (TAP), which were submitted to the UNFCCC in 2016, 2017, and 2018, respectively. The following Table 3.10 summarizes the resulting priority technologies and proposed project concepts identified in the TNA process for enhancing climate resilience in Guyana's agriculture, water resources, and coastal zones sectors.

Table 3.10. Priority technologies for agriculture, water resources, and coastal zones sectors.

Sector	Priority technology	Proposed project concept
Agriculture	Freshwater Harvesting: Empoldering of Water Collection Areas	Rainwater Harvesting for Sustainable Crop Production and Domestic Consumption
	Agrometeorological Systems for Forecasting and Early Warning	Institutional Strengthening: Establishment of a National Agrometeorological System (NAS)
Water resources	Mapping and Modelling of Groundwater	Integrated Water Resource Management: Ground and Surface Water Mapping and Modelling
	Mapping and Modelling of Surface Water	
	Geographic Information System (GIS) Mapping for Water Catchment Protection	Integrated Water Resource Management: Capacity-Building in GIS and Development of Integrated Water Resource Management Policy and Action Plan
Coastal zones	Mapping and Modelling of Coastal Processes	Development and Mainstreaming of Integrated Coastal Zone Management (ICZM) Policy & Action Plan
	Early Warning Systems (EWS) for Flood and Drought	Capacity Strengthening of EWS and Disaster Management
	Energy-efficient Mobile Pumps	-

Building upon the CRSAP and the results of the TNA process, in 2019, the GoG produced a **Draft National Adaptation Plan (NAP)** in collaboration with the United Nations Development Programme's (UNDP) Japan-Caribbean Climate Change Partnership (J-CCCP) following the UNFCCC´s NAP process defined in the UNFCCC Least Developed Countries Expert Group (LEG) Technical Guidelines for the National Adaptation Plan Process (Least Developed Countries Expert Group, 2012).

The Draft NAP is a 10-year roadmap from 2020-2030 seeking to:

- Reduce the vulnerability to the impacts of climate change, by building adaptive capacity and resilience.
- Facilitate the integration of climate change adaptation, in a coherent manner, into relevant new and existing policies, programmes and activities, development of planning processes and strategies within all relevant sectors and at different governing levels, as appropriate.

The Draft NAP assesses the risks and proposes and prioritises adaptation actions for a total of 14 sectors including: water, agriculture, fisheries, forestry, mining, energy, tourism, community and regional development, education, health and well-being, land-ecosystems-biodiversity, equity and equality, indigenous peoples, and resilient infrastructure. This document is currently being updated for submission to the UNFCCC.

4.2. Sectoral adaptation frameworks

Within the overarching directive stipulated in the national adaptation policy framework, Guyana has undertaken profound efforts to mainstream climate change risks and priority adaptation measures within sectoral planning frameworks.

The following set of tables encompass the key strategies, policies, and plans steering adaptation measures across Guyana´s ten adaptation sectors, namely: agriculture and food security; water resources; coastal zones; health; education; ecosystems and biodiversity; energy security; disaster risk management; land use, infrastructure, settlements, and services; and Amerindian and Hinterland development.

4.2.1. Agriculture and food security

Name	National Strategy for Agriculture
Period	2013-2020
Description	This national Strategy seeks to position agriculture as Guyana´s vehicle for sustained economic and social prosperity, outlining 25 priority areas linked

	to enhanced climate action and resilience. Among these include the contribution of the agriculture sector to water security, food security, bio-fuel production, environmental sustainability, risk reduction and disaster management, enhanced land management, innovation and enhanced practices, and access to hydrometeorology and weather forecasting.
Name	Disaster Risk Management (DRM) Plan for the Agriculture Sector
Period	2013-2018
Description	The Agriculture Sector DRM Plan seeks to achieve sustained economic and social prosperity through improved agriculture risk reduction and disaster risk management through the following four key result areas: • Strengthen technical capacities and institutional frameworks to prevent and mitigate the impacts of disasters on agriculture. • Improve informed decision-making and coordination through risk identification, information systems, and early warning. • Build resilience for sustainable livelihoods in the agriculture sector. • Articulate preparedness response and rehabilitation.
Name	National Adaptation Strategy and Action Plan to Address Climate Change in the Agriculture Sector
Period	2009-2018
Description	The goal of this Strategy is to more effectively reduce the risks posed by climate change and position the agricultural sector to adapt through technical innovation and diversification to increase its competitiveness and sustainability. The Strategy seeks to mainstream adaptation, foster research and development, build awareness communication, enhance coordination, and mobilize public-private partnership for adaptation.
Name	Food and Nutrition Security Strategy
Period	2011-2020
Description	The Guyana Food and Nutrition Security Strategy offers a plan of action directed at ensuring the people of Guyana always have access to enough food that is; affordable, safe, healthy, culturally acceptable, meets specific dietary needs, obtained in a dignified manner, produced in ways that are environmentally sound and socially just. The overall aim is to improve the health and well-being of all persons living in Guyana through enhanced food and nutrition security, to be achieved through the following three defining goals: • Facilitate sustainable and stable employment-generating opportunities that would increase availability of and accessibility to food, especially among more vulnerable groups. • Promote systems (information, education and communication/dissemination) for use and consumption of healthy

	foods for increased nutrition of all Guyanese, and especially vulnerable groups. • Promote increased institutional coordination and functioning for improved food and nutrition security. The Strategy recognizes that climate change impacts the four key dimensions of food security (availability, stability, access, and utilization), for which agriculture is seen both as part of the climate problem itself, and as part of the solution to the problem of hunger.
Name	Draft Agri Vision 2025
Period	2021-2025
Description	The Draft Agri Vision 2025 seeks to establish the Agriculture Development Strategy for the period 2021-2025, to build a competitive, dynamic, and diversified, socially inclusive and environmentally sustainable agri-food system in Guyana. It provides an overarching vision for the longer-term development of the agriculture sector, contributing to (1) economic growth and diversification, (2) employment and poverty reduction (3) food security and improved nutrition and (4) climate resilient ecosystem sustainability, including climate change mitigation
Name	Guideline for Incorporating Integrated Disaster Risk Management in Agricultural Planning
Period	2013-2020
Description	This Guideline defines integrated disaster risk management (IDRM) and establishes a comprehensive approach to integrate IDRM in agricultural planning following six policy elements, namely risk identification, risk reduction, risk adaptation, financial protection and risk transfer, preparedness and response, and rehabilitation and reconstruction. The Guideline sets climate change as an integral part of IDRM for the agriculture sector, in terms of both assessing increasing risks and incorporating adaptation approaches.
Name	Draft National Pathway for Food Systems Transformation
Period	2021-2025
Description	Guyana's position on food systems transformation is to adopt a "food systems approach" rather than an individual sector approach, in order to become be more productive, more inclusive of the poor, more environmentally sustainable and resilient against climate change, and better equipped to deliver healthy and nutritious diets to all Guyanese. The Pathway seeks to: • Promote de-risking of the agriculture sector to withstand any climate change risks, including through innovation and technology. • Maintain and increase the genetic diversity of crops and livestock. • Ensure national food systems are regenerative and circular. • Develop climate smart agricultural practices.

	• Disaster preparedness against long-term and structural causes and rapid shocks.

4.2.2. Water resources

Name	National Drought Mitigation and Adaptation Plan (NDMAP)
Period	2013-2020
Description	The NDMAP seeks to facilitate proactive, coordinated, and effective planning, preparedness, mitigation, adaptation, response, and recovery activities in Guyana in response to drought risks and impacts. It focuses on three key pillars: • Drought monitoring and early warning systems. • Assessment of drought vulnerability and risk. • Measures to limit impacts of drought and better response to drought.
Name	Draft National Integrated Water Resources Management (IWRM) Policy and Roadmap
Period	2013-2030
Description	The Draft IWRM Policy and Roadmap were prepared to ensure that Guyana's water resources are managed with concern for safeguarding the health, safety and welfare of Guyanese. Additionally, it seeks to secure the country's ecosystems and ensure effective, efficient, and equitable use of water resources, consistent with the sustainable development goals of the country.
Name	Guyana Water Incorporated (GWI) Strategic Plan
Period	2021-2025
Description	GWI has the mission to deliver safe, adequate, and affordable water and ensure safe sewerage systems for improved public health and sustainable economic development. The GWI 2021-2025 Strategic Plan establishes accounts for the impact of climate change in enhancing quality of services, improving operational efficiency and productivity that ensures a safe and reliable water supply, supporting social and economic growth, and investing in future sustainability.
Name	Water Utility Adaptation Plan
Period	2020-2030
Description	The Water Utility Adaptation Plan provides a 10-year mechanism for achieving long-term sustainability and resilience of water supply services in Guyana. The strategic objective is to ensure citizens of Guyana are provided with water services which can supply the agreed water quality levels of service in the face of existing climate variability and future climate change. The Plan is structured into five adaptation programmes, namely:

	• Resilient water services in coastal regions. • Access to resilient water services in the hinterland regions. • Integrated water resources management. • Flood risk management and early warning. • Strengthened GWI business functions for climate adaptation.

4.2.3. Coastal zones

Name	Maritime Economy Plan
Period	2021-2030
Description	The Maritime Economy Plan identifies coastal development as an urgent priority for its critical contribution to the national economy and dire need for climate change adaptation. It seeks to establish a strategic approach to coastal flood and erosion risk management is needed that incorporates traditional engineering approaches, natural defences (such as mangroves), the application of planning and development control measures and takes account of climate change predictions. The desired outcome is the protection of life and property from sea level rise and climate change and all supporting marine ecosystem services.
Name	Draft National Mangrove Restoration Action Plan
Period	2022-2032
Description	The Draft National Mangrove Restoration Action Plan seeks to sustainably manage and protect marine and coastal mangrove ecosystems and the services they provide, to avoid significant adverse impacts – including those posed by climate change – by strengthening the ecosystems' resilience, and act for their restoration in order to achieve healthy and productive ecosystems. The specific objectives by 2030 include: • Conserve at least an additional 15 - 20% of coastal and marine ecosystems. • Increase the economic benefits from the sustainable use of coastal and marine resources through sustainable management of aquaculture, tourism and mangrove utilization. • Place all remaining mangrove forests under an effective integrated management regime to maintain and enhance their biological productivity and maintain a zero net loss. • Have a net overall increase in hectarage of mangrove forests through reforestation and afforestation. • Enhance institutional arrangements for sustainable mangrove management.
Name	Updated Sea and River Defence Bill 2023

Period	2023
Description	The Updated Sea and River Defence Bill 2023 has had its first reading in the National Assembly, aiming to make enhanced provisions for the protection of inundation from the sea or rivers and to provide for the establishment, construction and maintenance of sea and river defences using both green and grey infrastructure.

4.2.4. Health

Name	Ministry of Health Technical Plan on Climate Change and Health
Period	Current
Description	The Technical Plan on Climate change and Health sets a proposed framework to protect health in Guyana from climate change through four strategic objectives as follows: • Ensure public health concerns and health protection from climate change are at the centre of national, regional, and international action on climate change. • Implement adaptive strategies at local and national level to minimize impacts of climate change on population´s health. • Support "healthy" development strategies in other sectors that protect and promote health and mitigate climate change. • Strengthen the institutional capacity of public health systems for providing guidance and leadership on health protection from climate change.

4.2.5. Education

Name	National Risk Management Policy for the Education Sector
Period	2021-2030
Description	This Policy seeks to is to improve risk management measures within the education sector, including risks posed by climate change such as floods, drought, erosion, disease outbreak, water pollution, forest fires, high winds, sea level rise, and heat waves. The three strategic objectives include: • Ensuring equitable access to education and a safe and protective learning environment to all children and youth affected by crises. • Improving teaching and learning processes and modalities in crises. • Improving capacities for managing crises. Among the approaches undertaken, the policy seeks to:

	• Establish climate-adaptive disaster management procedures • Enhance the education management information system. • Improve climate-adaptive school construction specifications. • Integrate climate change as part of school curriculums.
Name	Education for Sustainable Development (ESD) Policy
Period	2016-2020
Description	The ESD Policy aims to introduce the principles of sustainability in all aspects of the formal, non-formal and informal education system in Guyana, such that everyone has the opportunity to the acquire knowledge, skills, values and attitudes necessary for a sustainable future and for positive societal transformation. The policy highlights the critical importance climate change education for sustainable development and its convergence with disaster risk reduction, energy, and waste management.

4.2.6. Ecosystems and biodiversity

Name	Aligned National Action Plan to Combat Land Degradation
Period	2015-2025
Description	The Aligned National Action Plan to Combat Land Degradation presents a strategic medium- and long-term national approach and plan for reduction and mitigating land degradation impacts and promote sustainable land management, highlighting the intrinsic interrelationships between land degradation, desertification, climate change, and biodiversity. The Plan sets out four strategic objectives, namely: • Improve the living conditions of affected populations. • Improve the condition of affected ecosystems • Generate global benefits • Mobilize resources through partnerships.
Name	National Biodiversity Strategy and Action Plan (NBSAP)
Period	2015-2030
Description	The NBSAP establishes a framework of priority objectives in Guyana such that: • By 2020, biodiversity is valued, effectively conserved, protected and restored where appropriate, delivering significant benefits and contributing to climate change mitigation and adaptation in a way that is acceptable nationally and globally. • By 2030, biodiversity is sustainably utilized, managed and mainstreamed into all sectors contributing to the advancement of

	Guyana's biosecurity, and socio-economic and low carbon development.
Name	Action Plan for Implementing the Program of Work on Protected Areas of the Convention on Biological Diversity
Period	2012-2020
Description	This Action Plan seeks to empower Guyana´s Protected Areas System in the role to support the conservation of the country´s biological diversity, safeguarding and maintenance of eco-system services, and assisting in climate change adaptation. As such, the Action Plan seeks to : • Establish and strengthen the institutional framework for establishment and management of protected areas. • Improve capacity building for the planning, establishment, and management of protected areas. • Ensure that protected areas and national and regional systems of protected areas are financially sustainable. • Evaluate and improve the effectiveness of protected areas management.
Name	Revised National Forest Policy Statement (NFPS)
Period	2018-2028
Description	The Revised NFPS positions forests as a cornerstone of the country's national patrimony; providing a host of products and services necessary to achieving the good life. The Revised NFPS´s overall objective is conserve, protect, and sustainably use the state's forest by ensuring it's social, economic, and environmental attributes and benefits are sustained and enhanced for the benefit of current and future generations of Guyanese, whilst fulfilling Guyana's commitments under international agreements and conventions. Sustainable forest management is stipulated as a key adaptation objective, focusing on managing and enhancing the ecological integrity of Guyana's forests, through preventative and restorative measures. The Revised NFPS this seeks to understand, prevent, and recover from climate change as a priority growing threat to local livelihoods and Guyana's macro- economic and social development.
Name	National Forest Plan (NFP)
Period	2018-2028
Description	Guyana´s NFP seeks to operationalize the overarching adaptation goals set out in the revised NFPS by establishing a roadmap for the four key specific objectives: • Economics: Deriving development benefits from the forest. • Conservation: Conserving, protecting and sustaining the forest.

	• Governance: Governing the forest to ensure current and future benefits. • Capacity: Building human and institutional capacity for management of activities in the forest.
Name	Guideline for Incorporating Integrated Disaster Risk Management in Environmental Management
Period	2013-2020
Description	This Guideline defines integrated disaster risk management (IDRM) and establishes a comprehensive approach to integrate IDRM in environmental management planning following six policy elements, namely risk identification, risk reduction, risk adaptation, financial protection and risk transfer, preparedness and response, and rehabilitation and reconstruction. The Guideline sets climate change as an integral part of IDRM for environmental management, in terms of both assessing increasing risks and incorporating adaptation approaches.

4.2.7. Energy security

Name	Guyana Energy Agency (GEA) Draft Strategic Plan
Period	2016-2020
Description	The Draft Strategy Plan directs the activities of the GEA to ensure that stable, reliable and affordable energy is provided to all persons in Guyana within an economically, environmentally and socially sustainable framework. The Strategic Plan highlights the importance of considering the potential risks of a warmer climate and its effect on the energy sector, and therefore seeks to: • Collect and analyse available data on past climate impacts on the energy sector and encourage adaptation measures to enhance the country's resilience. • Promote education and awareness of key concepts such as sustainable energy, energy management and energy conservation as well as the impact of climate change on energy systems and how to manage these impacts.
Name	Guyana Power and Light (GPL) Development and Expansion Programme
Period	2024-2028
Description	The Development and Expansion Programme intends to support the LCDS 2030, cognizant that access to affordable, reliable, clean, and sustainable

	energy remains a priority among the several supporting pillars of the economic development trajectory of Guyana. Among other elements, this strategic planning document assesses major risks posed by climate change – including extreme weather events, flooding, sea level rise, droughts, heatwaves, and strong wind gusts – and incorporates contingency measures to support the resilience of efforts to expand and diversify the power sector.

4.2.8. Disaster risk management

Name	National Integrated Disaster Risk Management Plan (NIDRMP) and Implementation Strategy
Period	2013-2023
Description	The NIDRMP seeks a more sustainable and safe Guyana with reduced risk and enhanced resilience to impacts and consequences of key hazards through the implementation, improvement, and mainstreaming of an integrated disaster risk management framework across all sectors and at all levels in the country to minimize potential death, injuries, loss of property, livelihoods, socio-economic loss and damage to the environment, and underpinning sustainable development in the face of additional challenges imposed by climate change. The NISRMP is based on five-fold objectives focusing on the impacts of floods and droughts, including: (1) risk identification, (2) risk prevention and mitigation, (3) risk transfer and financial protection, (4) risk preparedness and response, and (5) risk recovery. The implementation strategy sets out a 10-year roadmap of key activities, projects, and financing options to attain the goals set out in the NIDRMP.
Name	Early Warning Systems (EWS) Framework
Period	2015-2025
Description	The EWS Framework sets the overarching guiding principles and approach, for Guyana´s EWS structure and mechanism at the various levels, detailing functions and operational guidance, providing guidance on synergies with other disaster risk management areas, and outlining actions to be undertaken for implementation. The EWS framework serves as a cornerstone for Guyana's climate change adaptation efforts at all levels by establishing communities and institutions to make informed and timely decisions so they may time their activities with the expected impacts and facilitate rapid and effective response to climate hazards.
Name	National Multi-Hazard Disaster Preparedness and Response Plan (NMHPRP)
Period	2013-2023

Description	The purpose of the NMHPRP is to enhance the country's ability to manage all disasters using a comprehensive disaster management approach, accounting for the exacerbated impacts of climate change, while ensuring the timely and effective assistance to the affected in a coordinated manner, ensuring the greatest protection of life, property and health. The NMHPRP defines the administrative structure in times of disaster and sets our strategic actions over the next ten years to tackle disaster risks.
Name	Disaster Risk Management Policy (DRMP)
Period	2013-2025
Description	The DRMP establishes the guiding principles and architecture for disaster risk management in Guyana, by presenting the institutional structures, roles, responsibilities, authorities and key processes required to achieve a coordinated, coherent and consistent approach to disaster risk management that is multi-faceted, multi-hazard, multi-disciplinary, multi-sector, and multi-stakeholder, while being both corrective and prospective. Building resilience and reducing vulnerability to climate change are elemental organizing principles of the DRMP. One of its strategic objectives is the mainstreaming of disaster risk management into developmental policies, planning processes, land management and financials, and formal and non-formal education systems.
Name	Draft Disaster Risk Management Bill
Period	Current
Description	This Draft Bill aims to provide the legal basis for the development of disaster risk management policies and plans in Guyana while improving the institutional and policy framework for the management of disaster risk. Among its objectives is to encourage the mainstreaming of disaster risk reduction and climate change in development processes including policy formulation, socio-economic development planning, budgeting, and governance, particularly in the areas of environment, agriculture, water, energy, health, education, poverty reduction, land-use planning, and public infrastructure and housing, among others.
Name	National Flood Preparedness and Response Plan (NFPRP)
Period	2012-2020
Description	The NFPRP of the Civil Defence Commission of Guyana provides strategic guidance in a systematic and sequential manner for preparing and responding to a flood in a coordinated manner, including the roles and responsibilities, response mechanisms, and coordination arrangements. The purpose of the NFPRP is to enhance Guyana's ability to manage all flood-related disasters using a comprehensive disaster management approach, accounting for the impacts of climate change.

Name	Country Work Programme for Comprehensive Disaster Management (CWP-CDM)
Period	2021-2025
Description	The results-based, climate-smart 2021-2025 Guyana Country Work Programme (CWP) is a systematic way to address Comprehensive Disaster Management (CDM) and Disaster Risk Reduction (DRR) at the country level. This multi-sectoral approach aims to foster a whole of government approach while reinforcing linkages among disaster risk, climate change, and sustainable development. The CWP is based on five priority areas, namely: • Institutional strengthening for comprehensive disaster management. • Preparedness and response capacity. • Strengthening capacity for disaster risk reduction. • Knowledge management systems. • Recovery, rehabilitation, and reconstruction.

4.2.9. Land use, infrastructure, settlements, and services

Name	National Land Use Plan (NLUP)
Period	2013-2030
Description	The NLUP provides an overarching policy framework in Guyana to enhance land use decision-making coordination between national and regional levels, while using a rational adaptive approach for resilient land use development and investment in infrastructure that is responsive to climate change and sea level. The main output of the NLUP is a series of suitable land management options and investments in infrastructure for diverse land use types, including productive landscapes and settlements.
Name	National Land Transport Strategy (NLTS)
Period	2016-2026
Description	The NLTS in intends to contribute to the development of an efficient, effective and sustainable land transport network across Guyana. It is guided by the 2021 Climate Resilient Investment Plan for the Road Transport Sector, which seeks to increase the resilience of Guyana's road transport sector, so as to ensure that services remain operational for longer and are resilient in the face of extreme natural hazards and climate variability and change.

4.2.10. Amerindian and hinterland development

Name	Amerindian Act
Period	2006-ongoing
Description	The Amerindian Act provides for the recognition and protection of the collective rights, the granting of land, and the promotion of good governance within Amerindian Villages and Communities. It serves as the legal basis supporting the recognition and protection of collective rights of Amerindians in Guyana, including throughout all climate change adaptation resilience, and sustainable development efforts in the country. Among other elements, it is worth highlighting outlines the mandate for the National Toshaos Council (NTC) to prepare strategies and plans for reducing poverty, improving access to health & education, and to protect, conserve and sustainably manage village lands and resources.

5. Adaptation actions and their effects

Over the past decade, Guyana has been actively engaging in a variety of initiatives, projects, and programmes to reduce vulnerability and enhance resilience against climate change, both on a nationwide scale and in particular regions of the country for each of the ten priority adaptation sectors of Guyana, as follows:

Agriculture and food security: Enhancing the resilience of low-income and indigenous small-scale farmers in rural and coastal communities, promoting the links between increased productivity, environmental protection, and family nutrition.

Water resources: Investing in drainage control infrastructure for flood prevention in low-lying areas and empowering integrated water resource management.

Coastal zones: Investing in sea defence mechanisms using both green (mangrove) and grey (sea wall/dike) infrastructure.

Health: Expanding a climate-smart healthcare service delivery network.

Education: Building climate-compatible education facilities to promote energy and water security, while withstand extreme weather events.

Ecosystems and biodiversity: Improving gold mining techniques to protect biodiversity and maintaining ecosystem functionality and improving the bioeconomy and ecosystem services in the Amazon rainforest.

Energy security: Finding the right balance between energy security and climate security through the climate-resilient expansion and diversification of Guyana´s electricity generation, transmission and distribution system.

Disaster risk management: Operating the national and regional integrated multi-hazard disaster risk management systems and enhancing early warning systems.

Land use, infrastructure, settlements, and services: Actively mainstreaming land use management, transport infrastructure, and urban development components supporting the ongoing biggest infrastructure transformations in Guyana´s history.

Amerindian and Hinterland development: Supporting communities in planning and implementing their sustainability plans contributing to self-defined resilient development priorities.

These actions are all framed within the goals, objectives, and strategic direction stipulated the above-mentioned national and sectoral climate change adaptation frameworks.

The following sections offer an overview of the progress and intended contributions of completed, ongoing, and planned adaptation projects and programmes for each of the ten priority sectors of Guyana. A more detailed description of each action is provided in Annex III.

5.1. Agriculture and food security

Small farmers produce most of the fruits and vegetables grown in Guyana, for which agriculture remains largely a subsidence activity highly vulnerable to climate change. Over the last decade, Guyana has taken significant action to **enhance the resilience of low-income and indigenous small-scale farmers in rural and coastal communities, promoting the links between increased productivity, environmental protection, and family nutrition**.

Emphasis have been placed in Regions 1, 5, 9, and 10 where agricultural potential and availability of natural resources is greater, yet face increased levels of exposure to climate hazards and are particularly vulnerable to its effects due to decreased socioeconomic adaptive capacities. Within these communities, women and population groups affected by poverty are being most supported.

These objectives are being achieved through a combination of:

- Institutional strengthening and support for local and regional councils as they plan and prioritize climate-resilient investments in local value chains.
- Research, monitoring and communication to produce high-quality data for the agriculture sector.
- Climate-resilient technology adoption, including improving farmers' access to public services.
- Climate-resilient skills development, including planning and natural resources management (water, soil, renewable energy, agro-diversity, etc.).
- Nutrition education and crop diversification for food security.

For instance, the **Sustainable Agricultural Development Programme** has supported more than 3,500 farmers, including Amerindian communities, which represent more than 89% of the population of Region 9. Further, the **Hinterland Environmentally Sustainable Agricultural Development Project** is supporting 6,000 families from 80 indigenous and rural communities whereby 15% are headed by women and 75% are Indigenous. Both projects are nearing completion, initiated in 2017 and 2016, respectively. On the other hand, under the 2012-2020 **Sustainable Livelihoods and Community Economic Growth Project**, small-scale producers were engaged in hydroponic and natural/organic cultivation of vegetables for domestic and export markets. Furthermore, under the **Caribbean Small Island Developing States (SIDS) Multicounty Soil Management Initiative for Integrated Landscape Restoration and Climate-Resilient Food Systems**, three locations in Guyana, namely Arakaka, Little Biabu, and Kimbia are building the necessary tools for adopting policies, measures and reforming legal and institutional frameworks to achieve climate resilience through land degradation neutrality, climate-smart agriculture, drought risk management, all while enhancing resilient food systems and alternative livelihoods by mobilizing the private sector.

Over a decade ago, the Agrometeorology Section within the Hydrometeorological Service was reactivated. Under the guidance of the Caribbean Institute for Meteorology and Hydrology (CIMH), the Section has been actively developing products to support agricultural development, including the production of monthly Farmers' and Drought Bulletins. It has also been rolling out the **Participatory Integrated Climate Services for Agriculture (PICSA)** initiative across Guyana to bring awareness to local farmers on their historical and local climate so that they can plan smart for the next crop and future, taking into consideration local climate situations.

Beyond these overarching projects, several **community-based initiatives** have also been under the Global Environment Facility (GEF) Small Grants Program, including:

- Capacity Building and Protected Agriculture Demonstration for Farmers in Guyana.
- Climate Resilient Actions for Food Security for Persons with Disabilities.
- Grow Up Internship through Sustainable Agricultural Practices in Region 10.
- Restoring the productivity of cash crop farmers in Fyrish/Gibraltar, Region 6 to their pre-flood levels.
- Climate Smart Agriculture for Food Security- Vertical Farming in Plaisance Village.
- Improving farming in Mahaicony River by Adapting to Climate Change and the Environment.
- Building Resilience through climate SMART agriculture while promoting a healthier environment.
- Safeguarding food security in Kwakwani by adopting climate-smart agricultural practices.

It is expected that higher productivity from these combined efforts will support food security in the face of risks posed by climate change, reduce pressure on forest and fragile ecosystems, all while increasing incomes for small and medium-sized farmers. Building agricultural technical adaptive knowledge capacity and access to climate-resilient infrastructure will further enhance the resilience of the sector.

Going forward, under the **LCDS 2030** Guyana plans to dedicate resources from the sale of ART-TREES credits to continue building climate-smart agriculture systems in the Interior Regions 8 and 9 and the Coastal Regions 5 and 6. Guyana also has a concept note for the **RE-ACT (Resilient Action Guyana) Project**, seeking to increase resilience in highly vulnerable agricultural communities along Guyana´s productive coastal zones by building technical capacities and technology transfer among farmers, as well as building institutional capacities to improve information availability and dissemination of good practices for climate-resilient agricultural production and agricultural water resources management at farm and landscape scale.

5.2. Water resources

Adaptation efforts in the water resources sector in Guyana have been focused on two priority areas. First drainage control for flood prevention in low-lying areas, and second, integrated water resource management (IWRM).

Concerning **drainage control for flood prevention**, over three-quarters of the Guyanese population live in a 30km coastal band along the Atlantic coast spanning Regions 4, 5, 6, and parts of Region 3, all transacted by a dense network of drainage and irrigation canals, as reported by the Guyana Land Surveys Commission (GLSC). This is an area of reclaimed lands below the regional mean sea level, situated between a water storage basin – namely, the East Demerara Water Conservancy (EDWC) – and a protective seawall complex. The EDWC plays a key two-fold role of water supply and flooding control for the low-lying metropolitan sphere around Georgetown. On one hand, the EDWC is a water storage system that provides regional agricultural lands and urban areas with irrigation and drinking water. During times of heavy rainfall, this system also functions as a regional drainage and flood control mechanism. This metropolitan coastal area is therefore highly susceptible to flooding from two combined phenomena: pluvial drainage and sea level rise.

While the EDWC dam is a crucial component of Guyana's protection against flooding, it has been at a critical risk of breaching due to increased precipitation from climate change and a lack of development and maintenance across its drainage system. The GoG has therefore undertaken a series of sequential and complementary projects specifically seeking to enhance climate adaptation and reduce pluvial flood risk in urban and rural areas in the coastal plain of Guyana (Regions 3 through 6) by improving water drainage infrastructure in the EDWC.

This series of projects include the following pluvial flooding management initiatives at the EDWC:

- 2007-2013: The **Conservancy Adaptation Project** was the first step undertaken to conceive a master plan for upgrading the EDWC, including the necessary infrastructure investments aimed at increasing the conservancy´s drainage capacity in light of projected climate change. The project consisted of a series of studies strengthening Guyana´s understanding of the existing EDWC system and coastal plain drainage regimes and the increased drainage demands imposed by climate change, identifying key intervention areas to enhance adaptive capacity. The project also strengthened institutional capacity of the GoG to manage water levels in the EDWC and to guide interventions aimed reducing the country's vulnerability to floods.
- 2012-2016: The **Rehabilitation of the EDWC Dam** project was a two-phase initiative that procured equipment and conducted the construction and rehabilitation of 6 of the EDWC Dam´s 33 intake and relief structures to protect the EDWC Dam from overtopping and collapse during rainy seasons, namely the Shaks, Hope, Nancy, and Annandale intakes, and the Sara Johanna and Maduni sluices.
- 2014-2024: The **Flood Risk Management (FRM) Project** is the ongoing most comprehensive initiative to reduce the risk of flooding in the low-lying areas of the East Demerara. The project has two interrelated components. First, the project involves priority infrastructure rehabilitation and development work to upgrade critical sections of EDWC dams, as well as carrying out priority flood risk reduction investments in the EDWC drainage system network. The second component involves institutional strengthening for flood risk reduction by enhancing access to quality data, skills, tools, and sensing technologies for flood (hydraulic and hydrological) modelling to best

monitor and plan for flood control. Guyana therefore benefited from technical assistance aimed at strengthening the legal and regulatory framework for managing flood risk financing as well as enhancing financial management controls and processes for flood recovery and resilience building. This also included routine inspection and maintenance of existing drainage systems while strengthening Guyana's hydrometeorological, flood forecasting and early warning systems, as well as Guyana's overall disaster risk management capacities.

- 2015-2017: Further enhancing the infrastructure work, the **Cunha Canal Rehabilitation Project** increased the canal´s discharge capacity to reduce the risks of the embankment overtopping and flooding to improve dam stability in the south-western section of the EDWC, as well as to support enhancing productivity of local agricultural areas surrounding the canal. The sluices at the outlets of the Cunha Canal and the East Demerara Water Conservancy were both rehabilitated, a public road bridge across the canal was constructed, the canal was widened and deepened and rerouted along its original alignment.
- 2019-2021: **Fixed and mobile pumps** and associated structures and spares were also acquired and installed throughout the EDWC including Hampton Court, Devonshire Castle, Den Amstel, Hope, Nootenzuil, Mora Point, and Rose Hall to further increase the efficacy of drainage capacity.
- 2019-2024: The **Resilient, Green and Inclusive Flood Investment Baseline for Georgetown Project** was launched to assist the GoG in designing a new master plan to guide future investments in climate-resilient flood-risk management infrastructure based on natural solutions for the Georgetown Metropolitan Area (GMA), considering its continuing growth. As such, Guyana is developing a comprehensive mapping of the GMA's current and future hydrological regime and planning priority resilient, green, and inclusive interventions for the GMA based on these results. Relevant stakeholders are also undergoing training and operational capacity-building to better manage existing and future flood-risk infrastructure in the GMA.

Going forward, the **Guyana Coastal Adaptation and Resilience (CARe) Project** is in its final planning stages to further advance climate change adaptation progress made in reducing pluvial flood risks in Guyana´s coastal area. The approach is three-fold as follows: First, infrastructure investments for the replacement, and construction of drainage structures. Second, the elaboration of guidelines for preventive flood risk reduction measures in new developments. Lastly, training Ministry of Agriculture's National Drainage and Irrigation Authority (NDIA) on flood prevention infrastructure operation and maintenance.

Furthermore, Guyana is prioritising aggressive future plans for upgrading and rehabilitating drainage and irrigation infrastructure in all regions of Guyana beyond the EWDC to adapt to increased pluvial flows caused by climate change. Under the **LCDS 2030**, Guyana is planning to dedicate approximately US $63 million in 2024 from the sale of ART-TREES credits towards strengthening drainage and irrigation system in Georgetown and the immediate surrounding parts of the Demerara Coast, as well as expanding the capacity of the drainage network through the construction of three new major outfalls, one each in Regions 3, 5 and 6.

Concerning **integrated water resource management**, the LCDS 2030 recognises that planning and managing water resources necessitate a complete and integrated approach of all relevant hydrological, topographical, socio-cultural, economic, political, environmental and institutional factors across all related water-using sectors in Guyana for better management of each aquifer. As such, Guyana is undertaking steps to:

1. Develop and update Water Management Plans for each aquifer administrative region; adopting a cross-sectoral approach valuing the multi-purpose of water for irrigation and drinking, sanitation, environment, agriculture, and energy, all to ensure integration, stakeholder participation and representation of interests at all levels of society, including water rights, governance, and public and private partnerships.
2. Undertake periodic assessments of both surface and ground water resources.

Regarding progress under the first objective, Guyana has been working with the Amazonian Countries Treaty Organization (ACTO) since 2019 to enhance **Water Resource Management in Hinterland Communities to Protect Aquifer Recharge Zones in the Upper Takatu Region**, seeking to ensure integrated and sustainable management of the transboundary water resources of the Amazon River Basin between Guyana and Suriname, considering climate variability and climate change. This will be achieved by improving governance models and monitoring and evaluation schemes for IWRN, while building local capacities for community resilience to address the impacts of floods and droughts in the Amazon Basin in order to reduce socio-economic and ecosystem damages from extreme climactic events.

Regarding progress under the second objective, the Hydrometeorological Service of Guyana (Hydromet) reinstated a dedicated groundwater section, in 2017 and is developing a **roadmap seeking to build a fully functional groundwater monitoring network with nation-wide coverage**. To further improve water management, the GoG also established a **water quality monitoring laboratory** within the structure of Hydromet. This facility has commenced the systematic monitoring of the quality of water resources across the country.

5.3. Coastal zones

Guyana´s ongoing adaptation efforts for coastal zones encompass **investment in sea defence mechanisms using both green (mangrove) and grey (sea wall/dike) infrastructure** to protect Guyana´s low-lying population from coastal erosion and inundation caused by climate-induced sea level rise.

Regarding grey infrastructure, the **Sea and River Defence Resilience Project** reconstructed and improved approximately 5.4 kilometres of sea and river defences, enhanced shoreline change monitoring and analysis, and implemented a coastal flooding defence community awareness and education programme between 2014and 2020. Going forward, under the **LCDS 2030**, Guyana is planning to dedicate US $51 million in 2024 from the sale of ART-TREES credits towards enhancing and maintaining sea defences in Region 6 along East Bank Berbice, as well as to develop and apply climate-resilient enforcement regulations in all future public and private coastal developments.

In the area of green infrastructure, Guyana has prioritized the restoration and expansion of mangrove forests through a community-based mangrove management approach seeking to mitigate coastal hazards while fostering climate-adaptive ecosystem services. Between 2010 and 2014, Guyana's National Agricultural Research and Extension Institute (NAREI) spearheaded the **Guyana Mangrove Restoration Project**. This project allowed for the establishment of national administrative capacity to manage mangroves in Guyana and focused efforts on mangrove restoration, community-based mangrove management, as well as public awareness, whereby women were empowered to be environmental leaders through the establishment and operation of sustainable businesses benefitting from mangrove ecosystem services. The initiative made commendable achievements, including the monitoring and protection of 36.5 kilometres of mangroves, the planting of 420,000 black mangrove seedlings through a community-based management approach, and the restoration of 5 kilometres of mangroves along the East Coast of Demerara, West Coast of Berbice, and Corentyne Coast.

Following the project, mangrove restoration efforts were continued by NAREI, for which, between 2020 and 2023 alone, the GoG has **invested more than US $500 million to the restoration and expansion of the country's mangrove ecosystem**, helping to protect coastlines from flooding and coastal erosion while providing sustainable climate-resilient business opportunities from community-based mangrove management schemes. The government is actively working to restore mangroves in about 12 areas and conducting training across the country. Cumulative restoration since 2010 spans 500 hectares of mangrove forests.

In 2022, the **Securing the Future of the Barima Mora Passage Mangrove Ecosystems and its Peoples Project** launched to develop a framework to protect the Barima Mora's unique mangrove ecosystem while working with Indigenous communities to empower mangrove for climate resilience, in addition to providing training to engage in connected climate-resilient sustainable livelihoods and green jobs. Further small-scale community-based mangrove adaptation initiatives are ongoing, such as the **Conservation of Coastal Mangrove Forest Resource to Support Brackish Water Aquaculture for Enhancement of Community Socioeconomic Benefit and Food Security**.

Going forward, Guyana foresees further efforts in addressing gaps in understating mangrove contribution for strengthened coastal zone management to address threats from rising sea level through an active concept nope for a project aimed at **Unlocking the Potential of Guyana's Mangrove Forests to Build Resilience to Climate Change**.

Furthermore, under the **LCDS 2030**, Guyana is planning to dedicate financing from ART-TREES credits towards further mangrove protection initiatives combining green-grey solutions while capitalizing on indigenous traditional knowledge to build sustainable frameworks for coastal environment.

5.4. Health

Under the **LCDS 2030**, it is planned to channel revenues from ART-TREES credits towards public health adaptation to climate change programmes in interior (Regions 1, 7 and 9) and coastal (Region 6) Guyana in the upcoming years. The **Climate Resilience Strategy and Action Plan (CRSAP)** further identifies the following priority resilience objectives that are planned to be implemented by the Ministry of Health (MoH) over the upcoming decade as follows:

- Improve knowledge on climate vulnerability of the health sector, particularly climate-related diseases and appropriate prevention and treatment.
- Enhance monitoring and evaluation of climate impacts on health.
- Promote adaptation good practice and develop innovative solutions.
- Develop national early warning systems for the health sector based on short-and medium-term climate forecasts and strengthen the capacity of the health sector to respond effectively to the climate-related risks.
- Develop climate smart health facilities, especially in the interior, which incorporate design features – such as renewable energy sources and water harvesting capacity – to ensure effective functioning during times of climate-induced stress.
- Reduce the exposure of communities to health-related risks associated with flooding.
- Establish a line item on the national budget for climate change activities for health.
- Promote community-based climate action to improve health conditions.
- Expand the healthcare service delivery network to enhance access to meet increased climate-induced demand for healthcare services.

Insofar, **solar PV infrastructure has been installed** at Arakaka Health Centre, Barima Kariabo Health Centre, and Moruca Health Centre in Region 1, as well as the Quebenang Health Centre in Region 7. Under the **SMART Health Care Facilities Caribbean Project** a total of five healthcare facilities were retrofitted across Guyana to become safer, greener, and more resilient to natural disasters and climate change, namely the Paramakatoi Health Centre, the Diamond Diagnostic Centre, the Lethem Regional Hospital, the Leonora Cottage Hospital, and the Mabaruma District Hospital. These retrofits included the installation of more efficient cooling methods, repairs and upgrades to rainwater harvesting systems and stormwater drainage, introduction of LED lighting, and installation of solar water heaters and PV electricity generation with battery back-up. The aim of both initiatives is to improve resilience of existing healthcare facilities by enabling undisturbed access to energy and water to ensure self-sufficiency during extreme weather events which ensures continued provision of healthcare services in times of crisis.

Further, Guyana has mobilized resources to **increase the healthcare service delivery network by constructing seven new hospitals** across the country by the end of 2024. The aim is to meet increased climate-induced demand for healthcare services throughout Guyana. Hospitals are being constructed at Anna Regina in Region 2, De Kinderen in Region 3, Diamond and Enmore in Region 4, Bath in Region 5, New Amsterdam and Skeldon in Region 6.

5.5. Education

The LCDS 2030 aims to build **climate-compatible education facilities**, such that, on one hand, educational establishments promote the self-sufficient and efficient use of energy and water so as to ensure to **energy and water security** in light of climate variability and climate change. On the other hand, they are also robust enough to **withstand extreme weather events**. Guyana has engaged in initial planning processes to carry out robust rehabilitation efforts of the existing education infrastructure throughout the country to ensure it meets both criteria for climate-compatibility.

The Ministry of Education has recognized the need for educational facilities to be designed and built in a manner that increase resilience to the impact of climate change, such as flooding. Specific measures to be implemented in the future are set out in the **National Risk Management Policy for the Education Sector**, which conducts region-specific comprehensive analysis of the risks posed by climate change to schools (including floods, drought, erosion, disease outbreak, water pollution, forest fires, high winds, sea level rise, and heat waves), as well as an assessment of the current and needed risk management capacities in the education sector. Adaptive capacities will be increased through a combination of climate-resilient infrastructure improvements/rehabilitations, improvement of management systems, and enhancing professor/teacher/staff capacities for enhancing resilience in times of climate-induced emergencies.

This Policy also aims to reinforce the Ministry of Education (MoE) capacities at central and sub-national levels to be prepared for and prevent the impacts of crises and ensure educational continuity during and after a crisis hit. Further anchored in the **Education Strategic Plan (ESP) 2021-2025 – Vision 2030**, work will be conducted to improve governance, accountability, and efficiency of the education system and reducing inequities in education, all contributing to reducing climate vulnerability.

5.6. Ecosystems and biodiversity

Driven by the Environmental Protection Agency (EPA), The primary focus of adaptation efforts implemented insofar in the ecosystems and biodiversity sector has been two-fold: improving gold mining techniques to protect biodiversity and maintain ecosystem functionality and improving the bioeconomy and ecosystem services in the Amazon rainforest.

On one hand, a series of synergic projects are being implemented since 2014 seeking to **improve gold mining techniques to protect biodiversity and maintain ecosystem functionality** for the benefit of all Guyanese livelihoods and health by shifting towards a mercury-free gold mining sector by 2025 under the Minamata Convention through a strengthened regulatory framework and institutional capacity-building, with a particular focus on artisanal, small and medium-scale gold mining operations. The series of projects include:

- 2014-2017: Undertaking an **initial mercury assessment** to identify the national mercury challenges and the extent to which policy and regulatory framework can enable Guyana to implement obligations under the Minamata Convention.
- 2014-2018: **Strengthening monitoring, enforcement and uptake of environmental regulations** in Guyana´s gold mining sector, focused on biodiversity and ecosystem services protection.
- 2018-2023: **Adopting a supply chain approach** for eliminating mercury in the artisanal and small-scale gold mining sector by empowering profit-motivated business enterprises to engage in sustainable jewellery branding and supply chains.
- 2019-ongoing: **Developing National Action Plan for the Artisanal and Small-Scale Gold Mining (ASGM)** sector and building implementation capacities to adopt sustainable gold mining practices and reduce mercury use in the sector to achieve commitments under the Minamata Convention.
- 2020-ongoing: **Strengthening the regulatory framework and institutional capacity** for the management of small- and medium- scale gold mining and to promote greater adoption of environmentally responsible mining techniques in Guyana in order to protect globally significant biodiversity, reduce mercury contamination, enhance local livelihoods and human health."

On the other hand, five projects have recently begun to **improve the bioeconomy and ecosystem services in the Amazon rainforest located in Southern Guyana**.

Between 2009 and 2013, Guyana established a science-based research programme for the **Measurement of Climate Change Impacts and Ecosystem Services in Iwokrama** aimed at reducing this forest´s vulnerability to climate change, while demonstrating how it could continue to be used in a sustainable way to generate income for government and local communities, whose livelihoods depend on the forest.

Between 2012 and 2018, efforts were conducted towards **Leveraging Natural capital in Guyana´s Rupununi** to enhance community-based agricultural and tourism businesses to implement climate-resilient and environmentally sustainable best practices for the management and long-term safeguarding of ecosystems services sustaining sustainable socioeconomic growth in the region. Since 2020, the work has been continued by **Developing a Sustainable Tourism Circuit in South Rupununi** via formalized climate-adaptive tourism packages that foster sustainable community-based economic development while safeguarding ecosystem services and biodiversity.

In 2022, the **securing a Living Amazon through Landscape Connectivity in Southern Guyana** project was approved for implementation, seeking to address the cumulative negative ecological and hydrological impacts of unplanned land-use changes and unsustainable natural resource extraction activities in the Kanuku Mountains Protected Area and North Rupununi Wetlands, encompassing infrastructure development, logging, large-scale agriculture, and wildlife harvesting. The project builds management capacity against the consequential resource depletion and habitat fragmentation compromise the area´s ability to deliver ecosystem services which sustain livelihoods and provide economic and subsistence opportunities for the area´s local and Indigenous communities, notably biodiversity maintenance, water supply and quality maintenance, and ensure resilience to potential impacts from climate change.

Further, in 2021 the **Amazon Bioeconomy Fund** was launched by the Green Climate Fund aimed at unlocking private capital by valuing bioeconomy products and services with climate change adaptation results in the Amazon. Operating in six countries, namely Brazil, Colombia, Ecuador, Peru, Suriname, and Guyana, the fund is delivering sustainable solutions to reduce the impacts of climate change in the Amazon biome by prioritizing natural capital and delivering climate benefits, seeking to encourage private investment in six key areas of the bioeconomy: sustainable agroforestry, native palm cultivation, non-timber natural forest products, growing native species timber, aquaculture, and community-led nature tourism.

Going forward, under the **LCDS 2030**, Guyana is planning to dedicate US $110 million from ART-TREES credits towards enhancing the adaptive capacity of ecosystems by:

- Recovering mining areas and enhanced planning in the mining sector.
- Provide support to the maintenance of Protected Areas.
- Advancing biodiversity protection efforts.
- Research and development in biodiversity and broader ecosystem services.

5.7. Energy security

Guyana strives to find the right **balance between energy security and climate security**. While the LCDS 2030 envisions investment in clean energy primarily in the aim to achieve greenhouse gas (GHG) reduction targets, significant ongoing investments in **expanding and diversifying Guyana's electricity supply** through hydro, solar, and wind technologies also contribute to build resilience in terms of energy access and reliability.

Ongoing investments in reinforcing **climate-resilient transmission and distribution infrastructure** for the main public grids will help bring undisrupted power by enhancing tolerance levels to extreme weather events. Furthermore, the ongoing diversification of **isolated grids** introduces further redundancies to the energy system to provide reliable and back-up power to previously energy-insecure communities.

Lastly, the **rural electrification programme** and the **solar home system programme** and **mini grid programme** further enables previously unconnected homes and communities to reliably access clean and affordable energy. Extensive details on the completed, ongoing, and planned projects linked to energy security in Guyana is detailed in Chapter 4 – Mitigation.

5.8. Disaster risk management

Established under the Office of the President in 1992, the Civil Defence Commission (CDC) is the focal agency charged with Integrated Disaster Risk Management (IDRM) in Guyana and a full member of the Caribbean Disaster Emergency Management Agency (CDEMA). Guyana has achieved notable progress in the evolution of IDRM planning and implementation in the country championed by the **National Integrated Disaster Risk Management Plan and Implementation Strategy (NIDRMP)**, established in 2013. IDRM is built upon five components: risk identification, prevention and mitigation, financial protection and risk transfer, preparedness and response, and recovery.

The CDC coordinates the **National Disaster Risk Reduction (DRR) Platform**, which is a multi-stakeholder body established in 2015. The Platform underwent a reconstitution in 2018 which saw the identification of a Technical Advisory Committee and a Policy Level Committee, in a bid to position this body as the key technical and policy-driving entity for DRM planning and implementation across all sectors in Guyana.

In 2015, the CDC commenced the development of **Regional DRM Systems**, to build capacities at the local level and to achieve some amount of decentralisation in disaster preparedness and response across the country. To do so, **comprehensive regional risk assessments** were conducted for each of Guyana's 10 regions, identifying priority hazard linked to climate change, such as drought, flooding, water pollution, saltwater intrusion, fires, health epidemics, and pests and diseases, among others. This culminated in a comprehensive set of **regional multi-hazard preparedness and response plans** for each of the 10 regions of Guyana. At the National level, the National Emergency Operations Centre (NEOC) is activated by the CDC when necessary to ensure comprehensive and holistic response among stakeholders to large scale emergencies and/or disasters.

One of the key priorities for the country is risk identification through both vulnerability assessments and risk assessment and mapping, as well as the operation of a robust early warning system. In 2013, the **National Early Warning Systems (EWS) Framework** was developed, and Guyana is actively working towards rendering the framework operational through enhanced management mechanisms, as well as EWS technology acquisition and implementation for both risk monitoring and communication, combined with institutional strengthening and training for the operation and maintenance of such systems.

In this regard, Guyana has benefitted from several regional projects for the upgrade and further development of the **Hydrometeorological Service´s weather station monitoring network** with the provision of at least 25 automatic weather station for deployment across the country. The Hydrometeorological Service is also working to operationalize a national flood early warning system to complement existing products that support early warning in agriculture with respect to drought and flooding.

Guyana was also included in the World Meteorological Organization (WMO)-led **Climate Risk and Early Warning (CREWS) project** for the Caribbean region, aimed at streamlining capacities related to weather forecasting, hydrological services, multi-hazard impact-based warnings and service delivery for enhanced decision-making at regional, national, and local level. Under the CREWS Project, Guyana developed a national roadmap to strengthen and streamline multi-hazard early warning and hydrometeorological services. In addition to institutional strengthening, a Risk Information Exchange repository was also developed and piloted to support the transition to impact-based forecasting.

Guyana was also shortlisted for support under the WMO-led **Systematic Observational Financing Facility (SOFF)** for the establishment and maintenance of a basic observation network that would feed into the global system for meteorological observations.

Further, Guyana is partaking in the first batch of countries to pilot the **Early Warning for All (EW4A) Initiative**, which aims to ensure universal protection from hazardous weather, water, or climate events through life-saving early warning systems by the end of 2027. The EW4A is built on four pillars to deliver effective and inclusive multi-hazard early warning systems, namely:

- Collecting data and undertaking risk assessments to increase knowledge on hazards and vulnerabilities and trends.
- Developing hazard monitoring and early warning services for detection, observation, monitoring, analysis, and forecasting.
- Communicating and disseminating risk information to all those who need it.
- Building national and community response capabilities.

Capacity-building and awareness-raising activities have also been of priority to Guyana to build knowledge among the public, particularly vulnerable groups, on the risks posed by hazards, how to act in the event of an emergency, and how to use EWS and climate information to effectively respond in the event of an emergency. One such example is the 2018-2021 **Strengthening Disaster Management Capacity of Women Project**, which sought to support empower women and vulnerable groups in hazard-prone hinterland and coastal indigenous communities across Regions 5, 6, 7, 8, and 9 to use community-based EWS to strengthen disaster and climate risk resilience under a community-based DRM approach.

5.9. Land use, infrastructure, settlements, and services

Guyana is embarking on one of the biggest infrastructure transformations in the country's history, for which climate-resilient development is being actively mainstreamed in associated land use management, transport infrastructure, and urban development.

Since 2004, Guyana has undertaken significant strides for **mainstreaming sustainable land management (SLM)** seeking to streamline the provision of land services to land-users and decision-makers and to foster long-term economic, social and environmental development in the country. Two key subsequent institutional strengthening and capacity-building projects have been implemented to establish an enabling environment to combat and reverse land degradation while fostering sustainable climate-resilient territorial planning and urban development.

The GoG has embarked on a large investment effort to **upgrade and revamp transportation infrastructure** in the country, which consists of interventions to expand critical coverage and capacity and to rehabilitate and conserve the existing road network, as well as to strengthening the capacities of the authorities to reinforce climate-resilient mobility within the country.

In the largest urban area centred around Georgetown, but also including East and West Coast Demerara, East and West Bank Demerara, and Silica City, Guyana has started to construct an interlinked network of four-lane highways and associated infrastructure. Furthermore, since the turn of the century, Guyana has been in the process of constructing of a land transport link through Lethem to connect Brazil in the South and a new Deep-Water Port along Guyana's coast in the North. Further work is planned in North-Eastern part of Guyana, financing the rehabilitation and upgrade of selected road corridors to enhance mobility in the region. This new infrastructure will help to boost the economy, create jobs and boost revenues for both local and national government, while increasing connectivity, a predeterminant enabling factor for climate resilience.

Despite the recent increase in investment in Guyana's road sector, several problems persist which maintains an elevated degree of vulnerability of road transport infrastructure to the impacts of climate change, including:

- Low density and lack of availability of climate resilient road infrastructure in good condition, as well as limited land connections with cities along the coast and in the interior of the country, which affect access to/from the various production centres and raise transport costs.
- Increased losses and need of maintenance in aging networks over their life cycle.
- Limited institutional capacity to coordinate the growing project portfolio.
- Challenges intrinsic to comprehensive road safety.

In this context, the GoG has actively undertaken several programmes to **Support Climate Resilient Road Infrastructure Development**. The objective of these programmes is to mainstream climate change risk assessments and integrate climate-resilient solutions and enhancements such that the expansion and rehabilitation of road networks is conducted in a climate-resilient manner, so as to advance Guyana's safe, efficient, and climate-resilient road and associated infrastructure. Further, these programmes are actively strengthening the capacity of the public sector to embed socio-environmental and climate resilience aspects in transportation infrastructure project planning and implementation processes, as well as to manage a growing public infrastructure investment agenda aligned with both climate resilience objectives and economic expansion.

As this economic expansion intensifies, Guyana is moving into a new phase of **low-carbon and climate-resilient urban development** to develop liveable, clean, affordable cities and towns that are resilient to the impact of climate change. Interventions are underway to upgrade the drainage and irrigation system across the capital, and major public and private sector investments are being made in new building stock across the area. Through the **Climate-Resilient Adequate Housing and Urban Accessibility in Georgetown** project, Guyana aims to improve the quality of life in urban and peri-urban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility services. This objective has two main components: First, the "Delivery of Housing and Basic Infrastructure Solutions" component aims to provide subsidies to cover the costs of basic home improvements and new core home construction for low-income households, as well as to construct and rehabilitate infrastructure and services of government-sponsored housing sites in the Georgetown area. The second component, "Enhancement of Urban Road Network and Road Safety," comprises the rehabilitation and expansion of Georgetown's main road axis, as well as the development of a National Road Safety Action Plan. In both cases, the GoG is committed to identifying and implementing climate-ready designs, and exploring the potential for complementary sustainable infrastructure solutions, including green infrastructure. To achieve this, the GoG needs updated and granular information on the vulnerability profile of Georgetown's territory, and to develop locally appropriate plans and design proposals based on this information. As such, under this project, the GoG is conducting urban growth and risk assessment studies and development planning proposals and associate technical studies for embedding climate change adaptation in the construction of housing and urban accessibility infrastructure in Georgetown.

Going forward, working closely with local administrations, the GoG will support development plans for Guyana's urban areas, including Georgetown, Silica City, and their environs, and the eight additional towns of the country, namely Anna Regina, Bartica, Corriverton, Linden, New Amsterdam, Rose Hall, Lethem and Mabaruma. The urban development plans will incorporate infrastructure work already in progress including transportation, housing, water, construction and drainage and irrigation networks and ensure that future developments complement these earlier investments while aligning with a climate-resilient vision for Guyana's towns and cities set out in the LCDS 2030. As plans are developed, expertise will be drawn from the University of Guyana, other educational and technical institutions, and the private sector. Principles for climate-resilient buildings will be identified, and perhaps standards for green design and construction.

5.10. Amerindian and Hinterland development

Under the LCDS 2030, Guyana embeds sustainable development at village level with clear strategy in a continuous, predictable, and sustained manner. 100% of revenues from the sale of forest carbon credits is invested in community, multi-community and national priorities identified during the national consultation on the LCDS 2030. Of this, a dedicated 15% of all revenues earned from forest carbon markets in Guyana (under the ART-TREES mechanism) are made available for bottom-up investments in the implementation of community-led low-carbon development programmes for Indigenous Peoples and Local Communities (IPLCs) who choose to opt in to access these funds through the development and implementation of their own **Village Sustainability Plans (VSP)** under the principle of free prior and informed consent (FPIC). Significant feedback was received back on the proposed revenue sharing approach, and the resulting opt in mechanism is anticipated to start in July 2022. The National Toshaos Council (NTC), the constitutional body representing Indigenous Villages in Guyana, passed a resolution at the July 2022 Conference, endorsing this approach.

As of September 2023, all 242 Amerindian villages in Guyana have submitted plans. While the structure and content of each of these plans vary, as they are self-determined by each community, these include climate change adaptation efforts such as:

- Climate-resilient community energy and water infrastructure and communications.
- Sustainable livelihood opportunities including ecotourism and climate-resilient agricultural opportunities to ensure both food security and income generation.
- Sustainable management of nature, environment, ecosystems, and biodiversity.
- Ensuring equal access to local climate-compatible education.
- Enhanced healthcare, encompassing access to safe, and affordable drinking water, access to adequate and equitable sanitation and hygiene for all, and access to sexual and reproductive health care services.

To date, US $237.5 million has been received thus far from the sale of Guyana's first commercial sale of carbon credits, which a total of US $22.5 million was disbursed to Amerindian communities in 2023 to implement their VSP as outlined above.

Going forward, the GoG, in collaboration with the National Toshaos Council, aim to support IPLCs in Guyana to successfully implement, monitor, evaluate, and improve their recently elaborated VSPs to achieve community-driven sustainable development that maintains and enhances the value of their resources while fostering environmental integrity and building climate resilience. As such, the GoG and the NTC currently have the project proposal **Support to Village Planning and Implementation as part of Guyana's REDD+ Programme**, seeking financing from payments earned under the Guyana-Norway Bilateral Cooperation Agreement. The proposed project also seeks to build institutional capacities of the NTC and the Ministry of Amerindian to fulfil their mandate and to support IPLCs across the country to effectively plan, implement, and monitor their VSPs.

6. Challenges and barriers for adaptation implementation

Guyana´s ability to respond to climate change impacts and maintain a strong position with respect to managing the implications depends on several factors:

- Commitment to address projected impacts, even when presented with uncertainty (i.e. precautionary principle to protect future generations).
- Ability to detect change through data collection and evaluation systems and communicate the results out in a meaningful and consistent manner to support desired behavioural changes.
- Having systems and processes in place to identify high priority risks and implement pre-emptive strategies at the right time and place.
- Gaining access to sufficient funds to mitigate impacts from natural disasters and longer-term climate impacts without hampering the national economy and global competitiveness.

- Ensuring sufficient training and human capacity to support longevity of resiliency strategies.
- Maintaining a strong stand on GHG emission reductions, and alignment with national commitments, to provide a positive example to the international community.

Adaptation is the essence of resiliency, and it is clear that Guyana is making efforts to ensure the future of the country even when presented with numerous challenges and barriers at the national and sectoral level which impede the country´s adaptive capacity. These translate into capacity support needs across six critical dimensions, namely:

Informational **Institutional** **Human** **Financial** **Technological** **Regulatory**

Overall, Guyana can be considered to be progressing well in development in terms of building adaptive capacity to address climate variability and change. The following sections explore each of these barriers, challenges, and support needs for building adaptive capacity across the country and within each of the ten priority adaptation sectors.

6.1. Cross-cutting challenges and barriers for adaptation

Although there is no shortage of ideas and recommendations to deal with climate change in Guyana, it is always important to employ the right solutions at the right time to ensure alignment with changing national priorities through:

- Pro-active data collection, evaluation, management, and reporting.
- Robust coordination, institutions, and collaboration schemes with community support mechanisms to preserve important activities.
- Capacity building to ensure success and longevity.
- Financial risk management to avert long-term economic impairment.
- Access to cutting-edge technology driving innovation and efficiency.
- Progressive policy and regulation to ensure sustainable and adaptive management to address unknown or unanticipated impacts.

Achieving adequate adaptive capacity in each of these six dimensions at the national level in Guyana requires surpassing several challenges and barriers. Guyana has explored these challenges in a participatory stakeholder consultation approach part of its **NAP Process** in 2019, as well as through a **National Capacity Self-Assessment of the Rio Conventions** completed in 2020 (Williams, 2020).

6.1.1. Informational capacity

Currently, there are several institutions in Guyana that are responsible for generating and providing climate change data and there is work in progress to have the compilation of data be done in a centralised manner. This will include a comprehensive suite of vulnerability, risk and adaptation assessments across the country. There is also need for a comprehensive Monitoring and Evaluation (M&E) system for climate change adaptation. Due to resource constraints, such assessments are conducted when Guyana prepares its National Communications to the UNFCCC.

There is a growing need for a comprehensive database for change adaptation, which will in the future enable reliable, centralized, and updated information for adaptation planning and mainstreaming. At the local level this challenge also exists where technical resources and equipment to carry out the task of data compilation, analysis and dissemination need to be bolstered.

6.1.2. Institutional capacity

In Guyana, there are several government organisations and committees that have an official mandate related to climate change management. Three of these agencies were established to implement the Low Carbon Development Strategy, namely the Office of Climate Change (OCC), now called the Department of Environment and Climate Change (DECC). Other governmental, as well as non-governmental, organisations also have climate-related mandates; however, these may not be their primary function.

It needs to be recognised that the successful deployment of climate change adaptation will require broad-based institutional action, for which robust collaboration and coordination mechanisms are fundamental. Currently, many of the institutions carry out their functions in a decentralised manner. This includes assessing and delineating clear roles and responsibilities with explicit mandates that bridge current gaps and identify main roles for the regulatory authority.

Mainstreaming of climate change into national and sectoral policies, programmes, projects and budgets was also identified as an area of improvement, underscoring the intrinsic interrelationships between development, vulnerability, resilience, and maladaptation, as well-as the multidisciplinary nature of adaptation action.

Furthermore, the role and involvement of the private sector should be mainstreamed to reflect priorities in the overall climate resiliency planning process. This aspect has been gaining more attention with the increasing access to privately funded investments in utilities and services or public-private-partnership models. Increasing consideration of this strategy, and exploration of these opportunities needs to be integrated into the adaptation process to reduced future vulnerability to food, water, energy, and health security. Success has been gained through well-conceived and properly designed incentive programs that benefit both parties.

6.1.3. Human capacity

Trained and skilled personnel is required for climate change adaptation management, including the implementation of adaptation actions. Specifically, human capacity is needed to:

- Undertake and interpret regional climate change projections;
- Conduct research on the vulnerability of key sectors and regions to the impacts of climate change;
- Implement and maintain the technologies and equipment necessary to monitor climate and climate-related impacts; and
- Develop technologies, such as sea defences, irrigation systems and early warning.

Human capital flight in Guyana (especially over the past five decades) that has resulted in shortages in managerial and technical capacity, in key institutions involved in development and climate planning, implementation, and monitoring, reporting, and verification processes. This human capacity gap also exists in areas of specialized knowledge on climate change issues in the country.

6.1.4. Financial capacity

Access to economic resources (or the lack thereof) is a key determinant of effective adaptive capacity and an enabling factor for implementation of adaptation measures. The estimated cost for adaptation and resilience efforts contained within the Climate Resilience Strategy and Action Plan, up to 2025 is approximately US $1.6 billion, far exceeding the limited public resources currently available in Guyana.

6.1.5. Technological capacity

Technological capacity is closely linked to financial capacity in Guyana, with high initial investment costs being the main barrier for technology adoption, coupled with a lack of in-country availability and reliance on external markets for innovation and manufacturing of climate-resilient technologies.

6.1.6. Regulatory capacity

While Guyana has a robust overarching adaptation policy framework, in a few instances, there are policy overlaps in requisite policies at the sectoral and sub-national level that prevent institutions from attaining their climate change adaptation objectives. Several sectoral policy and strategic planning frameworks in some cases require formalization, updating and harmonization with the LCDS, the Climate Change Resilience Plan and the NAP, ensuring robust mainstreaming of adaptation risks, opportunities, and priorities therein.

6.2. Sectoral challenges and barriers for adaptation

The following tables summarise sectoral-specific challenges and barriers limiting Guyana´s adaptive capacity.

6.2.1. Agriculture and food security

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Knowledge about the projected impacts of climate change over the water cycle, rainfall patterns and the availability and quality of both surface and groundwater, agricultural production and associated ecosystems needs enhancement	(NCC, 2019)
	Capacity for national agrometeorological and agroclimatological systems to support ecosystem-based climate resilient agriculture needs enhancement.	(NCC, 2019)
	There currently limited crop risk mapping based on projected spatial and temporal changes to temperature and precipitation patterns (including drought and flood) as well as saltwater intrusion and inundation in coastal areas.	(GoG, 2019)
	There is a need to identify key indicator species to monitor and detect impacts of climate change and develop monitoring and evaluation program for assessment and management response.	(GoG, 2019)
Institutional	Enhanced vertical integration is fundamental to ensure adaptive capacities are built and implemented at the regional and community levels, where the majority of agricultural activities occur.	(GoG, 2019)
Human	Farmers require expanded access to skills, training, knowledge and tools to understand and manage climate change risks.	(GoG, 2019)
Financial	There is a need to engage the private sector and encourage large scale financing from foreign investors, as agriculture remains largely a subsistence and small- to medium-scale industry in Guyana with severe financial barriers.	(GoG, 2019)
Technological	Food and agricultural climate-resilient production and processing technologies and techniques need enhancement through capacity building and adoption of green solutions.	(NCC, 2019)

	Freshwater harvesting technologies through empoldering of water collection areas has been identified as a key technology need.	(OCC, 2016b)
	Agrometeorological systems for forecasting and early warning have been identified as a key enabling technology.	(OCC, 2016b)
Regulatory	There is a need to embed climate change adaptation responses into agricultural policies and update appropriate climate change regulations for the sector.	(GoG, 2019)

6.2.2. Water resources

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Limited hydrologic data is available in Guyana, given that, since the late 1960's, data collection decreased dramatically, for which climate change projections related to precipitation, flooding, and droughts	(CDC, 2021)
	Public perception of the water resources being "plentiful" in Guyana has influenced public practices that sometimes defy the principles of conservation, requiring therefore a process for public "buy-in" of climate adaptive measures promoting collective and social responsibility over water resources.	(GLSC, 2020)
Institutional	The National Drought Early Warning System Protocol outlines the establishment of a Drought Committee to oversee the monitoring and early warning components of the country's drought protection plans to ensure that timely decisions can be made by decision makers at all levels; there is no evidence to suggest, however that this Committee has been formed and/or is currently functioning.	(CDC, 2021)
	While the Hydrometeorological Division of the Ministry of Agriculture is the regulatory body for water resources management, there is need for more capacity and resource support to strengthen work on data collection on ground water resources, among other areas.	(GLSC, 2020)
	Increased coordination between the Ministry of Agriculture, including the National Drainage and Irrigation Authority and Hydrometeorological Service, the Civil Defence Commission (for flood and drought risk response and management), and the Ministry of Housing & Water for potable water supply, including Guyana Water Incorporate, is critical for integrated water resource management.	(GoG, 2019)

Human	Hydrometeorological Division of the Ministry of Agriculture faces shortages in experienced personnel for integrated water resource management.	(GLSC, 2020)
Financial	The costs of rehabilitating and maintaining Guyana´s conservancies and associated drainage and irrigation network is high, necessitating significant financial support for implementation.	(GLSC, 2020)
	Hydrometeorological Division of the Ministry of Agriculture faces gaps in resources availability to execute various activities that promote watershed management.	(GLSC, 2020)
Technological	Expanding monitoring equipment and geographic information system (GIS) technologies is critical for mapping and modelling of groundwater, surface water, and water catchment protection in Guyana to support integrated water resource management.	(OCC, 2016b)
	Guyana´s drainage and irrigation system is over 100 years old and at various stages of despair, requiring access to energy-efficient stationary and mobile pumps, as well as enhanced dams, sluices, and canals.	(GLSC, 2020)
	Guyana requires extensive investment in water wells, sanitation equipment, and distribution networks to bridge the growing gap in access to safe potable water across the country due to pressures of migration and rapid urbanization.	(GLSC, 2020)
	Improper solid waste management and wastewater treatment and discharge practices have been identified as a risk factor affecting water quality.	(GLSC, 2020)
Regulatory	The National Flood Preparedness and Response Plan has not yet been reviewed or updated and this is necessary to effectively inform work on flood risk and projections.	(CDC, 2021)
	The Draft National Integrated Water Resources Management (IWRM) Policy and Roadmap requires finalization and adoption.	(CDC, 2021)
	Freshwater resources need to be accompanied by regulatory measures regarding fertilizer and pesticide application in agricultural fields, as well as chemical and mercury use in mining operations and tailings.	(CDC, 2021)

6.2.3. Coastal zones

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Enhanced and regular mapping and modelling of coastal processes is required, including regular assessments of the progression of sea level rise, coastal erosion, and the inventory of the state of green and grey sea defence infrastructure.	(OCC, 2016b)
	Need for improved knowledge of flood exposure and vulnerable locations to inform investment in sea and river defences.	(GoG, 2019)
	Need for a public campaign covering climate change, sea level rise, and the importance of mangroves.	(GoG, 2019)
Institutional	Due to the multi-purpose of mangroves, there is a need for strengthened coordination among related entities associated with mangrove monitoring and restoration to serve both carbon sequestration, coastal defence, biodiversity, and livelihood support function.	(GoG, 2019)
Human	Need for specialized knowledge to monitor and evaluate climatic impacts with a link to the design of projects through improved technologies and data collection.	(GoG, 2019)
Financial	The cost of rehabilitating, expanding, and maintaining of Guyana's sea defence system is astronomical, while Guyana´s LCDS has committed US $30 million funds for the maintenance and repair of sea walls, international finance is critical.	(GoG, 2019)
Technological	Need to acquire energy-efficient mobile pumps, both to rehabilitate and expand the current conservancy drainage network over 100 years old.	(OCC, 2016b)
Regulatory	There is a gap between the policy framework associated with sea and river defence and its implementation.	(GoG, 2019)

6.2.4. Health

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Hazard specific maps outlining locations with high vulnerability for climate-related disease outbreaks and spread are not routinely developed and updated. There is need for a comprehensive assessment of health vulnerability	(CDC, 2021)

	to climate change, aimed at formulating a national health vulnerability profile with two distinct objectives: a) discerning additional direct and indirect threats to health resulting from climate change; and b) evaluating the preparedness of health systems to manage the augmented burden of climate change on health and healthcare systems.	
	There is a need to develop national early warning systems for the health sector based on short to medium term climate forecasts and strengthen the capacity of the health sector to respond effectively to the climate-related risks.	(GoG, 2019)
	There is a need to complete scenario exercises regarding outbreaks resulting from climate-related impacts to inform disaster risk management plans.	(GoG, 2019)
Institutional	Strengthening cooperation among public agencies is critical to improve public sanitation, raise awareness, and enhance health-related adaptation efforts.	(MoH, n.d.)
	There is a need to institute a designated national focal point on climate change and health within the formal health sector to enable effective leadership and collaboration.	(MoH, n.d.)
	There is a need to Formulate a health and climate change task force within the ministries of health.	(MoH, n.d.)
Human	Needs for building the capacity of public health leaders to be proactive in providing technical guidance on health issues, and adapting to, climate change and show leadership in supporting the necessary rapid and comprehensive action.	(MoH, n.d.)
Financial	Need for establishing a line item on the national budget for climate change activities for health and disaster preparedness.	(GoG, 2019)
Technological	There is a need to promote adaptation good practice and promote innovative solutions.	(GoG, 2019)
	Research is critical on building strategies for climate smart health facilities.	(GoG, 2019)
	Research is needed on natural deterrents to proliferation of vector insects as opposed to chemical-based products.	(GoG, 2019)

6.2.5. Education

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	The curriculum needs to provide specific knowledge and practices to be used in the case of a climate-induced emergency.	(MoE, 2021)
	Risk coordination and communication strategies need to be developed and functioning to withstand climate change hazards at regional and school levels and ensure access to and continuity of quality education.	(MoE, 2021)
	Risk management data and information systems needed for the education sector, and need to be developed and instituted at central, regional and school levels, to support reporting and monitoring of climate change impacts.	(MoE, 2021)
Institutional	Enhanced collaboration between the Ministry of Education and other collaborating ministries, public and private sector agencies and non-profits in regions and towns has been deemed as a critical enabling condition.	(GoG, 2019)
Human	Principals and teachers require training to effectively consider relevant climate change hazards or disaster risk management.	(MoE, 2021)
	Officials from the MoE at national and regional levels are to some extent, trained to take natural hazards into account, and also need to be trained on the effects of climate change and climate-induced crisis.	(MoE, 2021)
	Educational planners need to be systematically trained in integrating climate change risk reduction, forced displacement or social cohesion into education sector planning.	(MoE, 2021)
Financial	The Education Sector Plan should include costs and financing for climate change risk prevention and management.	(MoE, 2021)
Technological	There is a critical need for improving the designs, facilities and access to schools, classrooms, and dormitories to ensure that education buildings are climate resilient.	(GoG, 2019)
	A lack of equitable provision of digital infrastructure to vulnerable communities hinders online learning and education continuity in times of climate-induced crisis.	(GoG, 2019)
Regulatory	Specific disaster-related construction and design standards need to be developed and implemented for schools.	(MoE, 2021)

6.2.6. Ecosystems and biodiversity

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	There is need for protected area valuation assessments nor climate change resilience and adaptation assessments for protected areas in Guyana.	(EPA, 2012)
	There is also need for updated spatial data and/or central repository on ecosystem richness, biodiversity hotspots, biodiversity sensitivity, protected species, sensitive ecosystems, nor at-risk species, etc. As such, there is a need to create a central repository of all research on biodiversity and ecosystem services that is freely accessible but tamper proof.	(EPA, 2014)
	Biodiversity research activities at Guyanese universities should be strengthened, particularly focusing on the impacts of climate change.	(EPA, 2014)
	There is a need to improve knowledge on climate vulnerability of ecosystems and biodiversity, particularly the associated impacts on livelihood, economy and society.	(GoG, 2019)
	Disseminate information through targeted outreach and awareness sessions for groups such as teachers, youth, media, Indigenous peoples, farmers and law enforcement agencies	(GoG, 2019)
Institutional	Institutions responsible for ecosystems and biodiversity are sometimes challenged by gaps in institutional capacity.	(EPA, 2014)
	Partnerships with regional and international organizations should be pursued to enhance capacity.	(EPA, 2014)
Human	There is a shortage and loss of expertise in the sector, for which incentives to retain qualified, trained and experienced personnel should be explored, both within institutions and within the country.	(EPA, 2014)
	An assessment of existing skills available should be conducted within institutions, including regional and local government bodies and should include an analysis of skills requirements and gaps, and opportunities for linkages and sharing of skills amongst institutions.	(EPA, 2014)
	Training and capacity building should be a systematic built-in component of project development.	(EPA, 2014)
Financial	Some limitation in national funding requires maximising access to funds allocated through United Nations	(EPA, 2014)

	organizations, funds and programmes NGOs, foundation, and academic institutions.	
	Guyana needs a strong research base and there is sometimes a lack of finance to undertake research regarding ecosystems and biodiversity.	(GoG, 2019)
Technological	There is urgent need to encourage and expand the use of Geographic Information System (GIS) ready datasets and use of Geospatial technologies and spatial analyses in biodiversity research and related work.	(EPA, 2014)
	Improvement in laboratory facilities is needed.	(EPA, 2014)
	(EPA, 2014)	
Regulatory	Undertaking joint and synergistic programming across the three focal areas of climate change, biodiversity, and land degradation is critical.	(EPA, 2014)

6.2.7. Energy security

Dimension	Challenges, barriers, and capacity-building needs	
Informational	The latest feasibility studies of 67 potential hydropower stations were completed in the 1970's and require updating to include current conditions and projected climate change scenarios. As such, there is a need to develop hydrologic model scenarios to understand the risks to hydropower generation from reduced stream flows or extreme events to inform reservoir management strategies.	(GEA, 2024); (GoG, 2019)
	There is a need to promote the importance of freshwater resources to energy resilience as well as raising awareness on the importance of the energy decentralization strategy for energy distribution on the resiliency of communities to extreme events and increasing future needs.	(GoG, 2019)
Institutional	Enhanced collaboration between the Department of Energy, the Guyana Energy Agency, the National Drainage and Irrigation Authority and Hydrometeorological Service, as well as research institutions / academia, civil society and the private sector is critical to build the knowledge base and subsequently plan for the management of climate-related risk on energy security in Guyana.	(GoG, 2019)
Human	Guidelines for technologies, legislation and capacity building are needed to support the modernization of the	(GoG, 2019)

	national grid and ensuring its capacity to withstand climate-related risks.	
	Capacity-building among energy sector staff, entrepreneurs, rural and hinterland communities is needed to implement and manage energy projects by collaborating with technical and vocational institutes, tertiary and professional development institutions to develop training and educational programmes.	(GoG, 2019)
Financial	Agencies that address energy manners need to advance feasibility studies to help develop a strategic investment plan to guide investments that support the integration of decentralized renewable energy projects.	(GoG, 2019)
Technological	Access to hydro, wind, and solar technology is critical to advance Guyana´s approach for decentralized generation of energy.	(GoG, 2019)
Regulatory	More specific programmes are needed to advance climate resilience in energy sector.	(GoG, 2019)

6.2.8. Disaster risk management

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Community-based disaster risk assessment and management plans have only been conducted in certain communities of Region 5 and should be replicated in all areas across the country.	(CDC, 2021)
	Methodologies for conducting risk assessments should be updated to engage stakeholders and include a gender perspective.	(CDC, 2021)
	A disaster risk assessment and management plan has not yet been finalized for Region 4, although they are available for the rest of the country.	(CDC, 2021)
	Enhanced awareness and participation in early warning and disaster response among the population is needed, particularly the empowerment of women´s role in DRM.	(UNDP, 2018)
	Timely and effective communication of disasters and risks should be enhanced.	(CDC, 2021)
	A standard repository of event/disaster and risk information should be established as well as national standards for the systematic collection, sharing and assessment of risk information and data related to hazards, exposures, vulnerabilities, and capacities to assist with DRM activities.	(CDC, 2021)

Institutional	Greater coordination between entities is needed to streamline DRM processes between the national, regional, and community scales, enabling the shift towards community-based disaster risk management approaches.	(CDC, 2021)
Human	Gap in human resource capacity has been highlighted as a factor restricting analysis of characteristics of key hazards that would help guide future action.	(CDC, 2021)
Financial	While the CDC has seen constant increases in its approved budgets over the past five years for DRM activities, the lack of adequate funding was identified by DRM stakeholders as a significant barrier to support early actions and response options over time.	(CDC, 2021)
Technological	Guyana´s early warning system needs reinforcement through an updated and expanded network of weather monitoring and forecasting stations, hydrometeorological equipment, multi-hazard monitoring systems.	(UNDP, 2018)

6.2.9. Land use, infrastructure, settlements, and services

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Conducting climate change risk assessments of transportation infrastructure and mapping high-risk transportation corridors is deemed critical to accommodate future extreme events and potential damage to infrastructure and adjacent lands.	(GoG, 2019)
	Improving knowledge on social vulnerability to climate change has been identified as a priority for the housing sector.	(GoG, 2019)
Institutional	Guyana is facing some constrains in institutional capacity to coordinate the growing portfolio of projects concerning the construction and rehabilitation of the country's road network.	(MoF, 2023)
	There is a need to improve the coordination and collaboration between local, regional and international bodies to implement changes in the design of transport systems in a climate-resilient manner.	(GoG, 2019)
	Need for enhanced coordination between the Ministry of Public Works and the Hydrometeorological Service to integrate climate risk considerations into infrastructure,	(GoG, 2019)

	settlements, land-use, and service planning, provision, and rehabilitation.	
Human	There is a need to maximise efforts for capacity building of personnel in the transport sector with emphasis on climate change resilience, adoption of good practice and development of innovative solutions.	(GoG, 2019)
	Need for educating building designers and inspectors on implications of climate risks and the need to ensure proper construction standards, materials, and techniques.	(GoG, 2019)
Financial	The cost of rehabilitating and expanding Guyana's road network is high, particularly concerning the remote and difficult geography of the Hinterland, for which there is a critical need to foster international cooperation and funding (from private and public sector entities) with a key emphasis on climate change.	(MoF, 2023)
	Access to funding/financial resources for "climate smart" buildings is critical, considering the country´s ongoing challenge to combat housing availability and housing affordability.	(GoG, 2019)
Technological	Need for enhanced access to green and climate-resilient construction techniques and materials.	(GoG, 2019)
Regulatory	Building codes designed to protect households against flooding are not adhered to.	(CDC, 2021)
	A higher degree of effectiveness of the transport division's adaptation policy framework, with a workable link between development and implementation.	(GoG, 2019)
	Land use planning frameworks currently do not account for the impacts of climate change.	(GoG, 2019)
	There is a need to develop, implement and enforce housing-related laws, policies, regulations and national strategies for climate resilience.	(GoG, 2019)

6.2.10. Amerindian and Hinterland development

Dimension	Challenges, barriers, and capacity-building needs	Reference
Informational	Remote satellite communities need enhanced access to early warning systems for extreme events.	(GoG, 2019)
	Need for developing community-based monitoring programs.	

Institutional	Enhanced coordination and networking among the Village Councils and all relevant government agencies and stakeholders is needed to mainstream climate change considerations in the development and implementation of Village Sustainability Plans.	(GoG, 2019)
Human	There is a need to disseminate climate-related information through targeted outreach and awareness sessions for various groups of Amerindian peoples.	(GoG, 2019)
Financial	Noting that the ART-TREES mechanism dedicates 15% of all revenues earned from forest carbon markets in Guyana towards bottom-up investments for sustainable development efforts within Amerindian communities, further financing is required to propel adaptation actions.	(GoG, 2019)
Technological	Need for using traditional and scientific knowledge to inform decision makers, stakeholders and the younger generation in developing resilience and adaptation plans.	(GoG, 2019)
Regulatory	Continuing to advance land titling is important, particularly accounting for displacements and migration of Amerindian communities due to climate impacts.	(GoG, 2019)

7. Support mechanisms for effective adaptation implementation

In light of the above-mentioned challenges and barriers, international support for climate change adaptation is fundamental for Guyana in the form of financing, technology transfer, and capacity-building.

It is worth highlighting that most of the progress in climate change adaptation action in Guyana has been achieved through national revenues, climate financing earned under the bilateral agreement on climate financing and carbon credits revenues, as well as the technical cooperation support administered through the Global Environment Facility (GEF), the Green Climate Fund (GCF) and its small grants programme, and the Adaptation Fund (AF).. The World Bank (WB) and the Inter-American Development Bank (IDB) are two other fundamental sources of international technical, capacity-building, and financial support.

Guyana's home-grown LCDS set out an innovative payment for forest climate services scheme, with a bilateral agreement for the receipt of payments then integrating with voluntary and compliance carbon markets. This led to the innovative results-based agreement with Norway and unlocked Guyana´s access to ART-TREES credits, the sale of which will be a key funding source towards resilience objectives under the LCDS.

At the regional level, cooperative approaches under the Amazonian Countries Treaty Organization (ACTO) and CARICOM´s Caribbean Community Climate Change Centre (CCCCC) will also continue to play an important role in advancing climate change adaptation in the country, fostering interchange of best practices and knowledge between neighbouring countries facing similar challenges.

Early warning systems and hydrometeorological monitoring are systematically raised as a critical measure impacting adaptive capacity across all sectors in Guyana. Partnerships with the World Meteorological Organization (WMO) and Guyana´s inclusion in the United Nation´s Early Warning For All Initiative will therefore support significant strides for evidence-based adaptation planning and effective disaster risk management in the country.

Notwithstanding the central role of technical, capacity-building, and technology transfer support offered though multilateral and bilateral funding and cooperation agreements, non-governmental organizations (NGOs) have also supported climate change adaptation activities either directly or indirectly in Guyana. Among these NGOs are:

- World Wildlife Fund
- Conservation International Guyana

- Iwokrama Research Learning Centre
- North Rupununi District Development Board
- Guyana Youth Environment Network
- Caribbean Youth Environment Network-Guyana
- Guyana Marine Conservation Society
- South Rupununi Peoples Development Association
- South Rupununi Conservation Society
- Guyana Society for Biodiversity and Ecosystem

At the sub national level (regional/local) the Regional Democratic Councils and Neighbourhood Democratic Councils and Community Based Organizations, Indigenous Communities and Municipalities have also been playing their roles in natural resources management issues within their localities, whose local capacities are being optimised to achieve adequate vertical integration of adaptation action catering to Guyana´s rich geographical diversity.

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4 Measures to Mitigate Climate Change

This chapter presents a thorough analysis of Guyana's efforts to combat climate change through mitigation measures. It begins with an introduction outlining Guyana's commitments in this regard and proceeds to discuss national policies and frameworks guiding mitigation efforts, along with sector-specific mitigation policies and measures (PAMs) that have been implemented, are currently ongoing, or are planned for implementation. The chapter examines future greenhouse gas (GHG) emission projections and concludes by suggesting support mechanisms required for effective mitigation action, encompassing policy backing, capacity building, technical assistance, financial mechanisms, and international cooperation. Overall, the chapter offers a comprehensive overview of Guyana's mitigation efforts, including achievements, and necessary support for further progress.

1. National climate change overarching policy framework

Guyana´s nationally determined contribution (NDC) (Government of Guyana, 2016) and Low Carbon Development Strategy (LCDS) (Government of Guyana, 2022) constitute the country´s core climate change mitigation policy documents, establishing the vision and plan towards attaining the overarching goal of achieving a low-emission economic development pathway.

Guyana´s **Low Carbon Development Strategy** was originally developed in 2009, being the first developing country to publish a strategy of its kind based on a payment for forest climate services model enabling the country to earn and invest new revenues from ecosystem conservation in its emerging low carbon economy. Later updated in 2013, and subsequently updated in 2022 following an extensive national stakeholder consultation process, Guyana´s updated LCDS 2030 outlines the country’s plans to continue advancing Guyana’s payment for forest climate services model and expanding vision to include Guyana’s other globally significant ecosystem services taking into consideration the new national circumstances.

The LCDS 2030 therefore establishes a unique world-class financing model that seeks to avoid deforestation and maintain the country’s forest cover as a global asset in the fight against climate change, while at the same time growing the economy five-fold over 10 years and keeping energy emissions flat or decreasing; investing in urban, rural and Amerindian development; protecting the coast and hinterland through adaptation to climate change; creating jobs in a suite of low carbon sectors; aligning the education and health sectors with low carbon development, and integrating Guyana's economy with its neighbours.

The LCDS 2030's vision is articulated into four inter-linked objectives for Guyana, the first three of which were the basic objectives of the LCDS since 2009 and the fourth of which was added to reflect new local and global realities as shown in Figure 4.1(Government of Guyana, 2022).

Figure 4.1. Strategic objectives of Guyana´s LCDS 2030.
Source: (Government of Guyana, 2022).

As a developing country, a coastal low-lying small island developing state (SIDS), and one of few net carbon sink countries, Guyana submitted to the United Nations Framework for Climate Change Convention (UNFCCC) in 2016 its **nationally determined contribution** with the overarching goal to transition the national economy to realise improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. This includes the pursuit of a resilient, low-carbon, socially-inclusive economy that provides a better quality of life for all within the ecological limits of the planet.

Guyana´s NDC establishes the country´s international conditional and unconditional commitments to 2025 under the forestry and energy sectors, where the majority of the nation´s current and historic emissions are produced. Under the forestry sector, Guyana seeks to utilise a combination of conservation and sustainable forest management practices and enhanced governance to combat climate change, including efforts from the timber and mining industries as well as its national protected area system. Under the energy sector, Guyana seeks to eliminate the country´s near complete dependence on fossil fuels and fortify energy efficiency. Table 4.1 outlines more specific NDC objectives per sector. Guyana has been actively working towards achieving these commitments.

For the energy sector, the country has implemented various solar photovoltaic (PV) and hydroelectric actions to increase the coverage and penetration of renewable energy sources across the country. Furthermore, the country has developed several actions to increase energy efficiency and create a sustainable energy system for Guyana. For the forestry sector, Guyana has established a state-of-the art monitoring, reporting, and verification system (MRVS) enabling the access to international carbon markets pay-for-results mechanisms, helping to propel Reducing Emissions from Deforestation and Degradation (REDD+) activities set out under the LCDS 2030, including the empowerment of indigenous communities to participate in and benefit from such actions, in addition to fortified frameworks ensuring the legality of the timber industry. Further details on the mitigation actions undertaken by Guyana in the energy and forestry sector are respectively provided in Section 2.2 and 2.3 to this Chapter.

Table 4.1. Overview of first NDC commitments.

Type	Forestry Sector	Energy Sector
Unconditional	• Enhance sustainable forest management encompassing: – Compliance and monitoring the legality of the timber industry. – Improved added- value activities locally to assist in creating a higher potential for carbon storage in long-use wood products. – Strengthened support for indigenous communities as they continue the stewardship of their lands and accrue benefits from REDD+ activities.	• Rapidly expand the coverage and penetration of the renewable energy power supply through a mix of wind, solar, biomass and hydropower. • Reduce energy consumption and increase energy efficiency through standards, incentives, and education programmes.

Type	Forestry Sector	Energy Sector
Conditional	• Empower the Emission Reduction Programme for Forests by: – Fortifying the ongoing improvement and implementation of Guyana's MRVS. – Building institutional and private sector capacity to comply with international timber trade and supply conditions and implement reduced impact logging. – Implementing policy reforms, education, technologies, and incentives for integrated sustainable planning and management of the mining industry. – Expanding the National Protected Area System to conserve an additional 2 million hectares.	• Develop a 100% renewable power supply.

In accordance with commitments under the UNFCCC and the Paris Agreement, the Government of Guyana begun revising and updating its NDC in 2021 for an envisioned 2021-2030 implementation period. As the final stage in the NDC revision process, the Government released a revised draft NDC for public review and comments by September 29th 2023 (Government of Guyana, 2023). The revised version of the NDC, which will take into consideration comments received, will be submitted to the UNFCCC.

2. Mitigation policies and measures by sector

Over the past decade, Guyana has been actively engaging in a variety of strategies, actions and plans to address climate change, both on a nationwide scale and in particular regions of the country. As previously stated, these actions are primarily aligned with the goals and objectives outlined in the country's two main national climate change policies, Guyana's NDC and Guyana's LCDS.

The mitigation actions encompass activities within the energy sector, as well as the forestry sector, including some cross-cutting initiatives. This is in line with the sectoral coverage of Guyana's NDC, which solely focuses on the forest, which is a net carbon sink (absorbing approximately 154 $MtCO_2e$ a year and storing 19.5 GT CO2e) and energy sectors as this is where the majority of Guyana's current and historical emissions are produced. For these reasons, Guyana's energy transition and continued sustainable management of the forest as a national and global asset are at the centre of the LCDS 2030 and the country continues to actively participate in REDD+ and the latest developments in market-based mechanisms supported by the Paris Agreement.

Guyana is using Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs) as substitutes for phasing out Chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl chloroform, and, ultimately, hydrochlorofluorocarbons (HCFCs) under the Montreal Protocol. Guyana acceded to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer on August 12, 1993 and subsequently ratified the London Amendment, Copenhagen Amendment and Montreal Amendment on July 23, 1999. This commitment contributes to emission reductions in the Industrial Processes and Product Use (IPPU) sector by utilising HFCs and PFCs as substitutes for ozone-depleting substances.

The agriculture and waste sectors are also sources of GHG emissions and will in time be part of the mitigation agenda of Guyana – however, these sectors are not the major sources of GHG emissions and have therefore not been prioritised.

In the case of agriculture, domestic agriculture is critical to the country´s food security and rural livelihoods and is under threat from the adverse effects of climate change, including floods and droughts. For these reasons, Guyana's focus on agriculture is currently centred on adaptation measures and has not yet prioritised mitigation actions for the sector.

Concerning the waste sector, Guyana is partaking in significant investments to enhance solid waste management collection and disposal technologies, including the inauguration of the Haags Bosch Sanitary Landfill, the rehabilitation of open dumpsites, and the control of illegal and informal waste management techniques, coupled with community-scale composting and recycling initiatives. Substantial achievement has also been observed in improved sanitation infrastructure. In this sense, priority for the waste sector has been on improved sanitation concentrating on human and environmental health.

The following sections provide a comprehensive overview of the various mitigation actions that have been implemented, are currently ongoing, or are planned for implementation within the energy, forestry sector, and cross-cutting sectors. The GHG emission reductions are provided in metric tons.

Annex III to the third National Communication (TNC) outlines the mitigation actions categorised by sector, offering comprehensive information on their status, duration, implementing entity, GHG coverage, as well as their geographic and sectoral scope. Additionally, it includes detailed descriptions and objectives, quantitative goals, steps taken or envisaged to achieve the action, estimated outcomes and GHG emission reductions, methodologies, and assumptions, along with progress indicators actions.

2.1. Energy sector

The energy sector is the largest emitter and is at the forefront of national priorities to reduce overall GHG emissions. Guyana recognises this fact and thus, has planned substantial mitigation actions related to the energy sector. A total of 29 mitigation actions are included in this sector, comprising 18 completed, 9 ongoing, and 2 planned initiatives. Among these, 23 are categorised as projects, while 6 are considered enabling activities.

The transition towards a clean energy matrix from the current fossil-dependent matrix is one of the key priorities in Guyana's national policies. As a result, mitigation actions in the energy sector are predominantly focused on how energy is generated. Of the 29 mitigation actions, 15 focus on power generation, 4 on energy efficiency, 5 on rural electrification, 1 on transport, and 4 on training and development.

For 3 of the mitigation actions in the energy sector, GHG emission reductions could not be estimated due to insufficient information, and 9 actions do not directly reduce GHG emissions.

Table 4.2 offers a concise summary of the various mitigation actions within the energy sector, along with their associated mitigation potential. A more detailed description of each action is provided in Annex III to the TNC.

Table 4.2. Overview of mitigation actions in the energy sector.

Number of mitigation actions	29	
Total estimated GHG emission reductions	782,947.75 tons CO_2e/yr	
Description	**Status (planned, ongoing, completed)**	**Estimated GHG emission reductions**
Guyana Utility Scale Solar Photovoltaic Program (GUYSOL)	Ongoing	37,500 tons CO_2e/yr
Sustainable Energy Program for Guyana	Ongoing	842 tons CO_2e/yr
Electric Vehicle Supporting Infrastructure	Completed	Not Applicable
Pilot Rice Husk Biogas Power Plant	Completed	101 tons CO_2e/yr
Leguan 0.6MWp Solar PV Farm	Planned	841 tons CO_2e/yr
EcoMicro Guyana	Completed	Not Estimated
Energy Matrix Diversification and Institutional Strengthening of the Department of Energy (EMISDE)	Ongoing	3.67 tons CO_2e/yr
Expanding Bioenergy Opportunities in Guyana	Completed	Not Applicable
Enhancing Guyana's Access to green Climate Fund (GCF) to Transition to Renewable Energy	Completed	Not Applicable
Amaila Falls Hydroelectric Project Preparation Studies	Completed	Not Applicable
Wakenaam 0.75MWp Solar Farm	Ongoing	940 tons CO_2e/yr
Small Hydropower Project for the Cooperative Republic of Guyana	Ongoing	12,344 tons CO_2e/yr
Hinterland Solar PV Farms	Planned	3,046 tons CO_2e/yr
Solar PV Public Buildings Program	Completed	15,518 tons CO_2e/yr
Promotion of Private Solar PV Rooftop Systems	Completed	1,431 tons CO_2e/yr
Transitioning to National Energy Security: Bartica as a Model Green Town	Ongoing	Not Applicable
Promotion of Energy Efficiency Measures in the Manufacturing and Service Sectors	Completed	291 tons CO_2e/yr
Project for the Introduction of Renewable Energy and Improvement of Power System in Guyana	Completed	429.65 tons CO_2e / yr
Sustainable Business Models for Rural Electrification and Energy Access in Guyana	Completed	Not Applicable

Solar Home Systems	Ongoing	5,003.71 tons CO_2e / yr
Solar PV Mini-grids	Ongoing	958.52 tons CO_2e / yr
Power Utility Upgrade Program	Completed	Not Estimated
Sustainable Operation of the Electricity Sector and Improved Quality of Service	Completed	Not Estimated
Power Sector Support Program	Completed	Not Applicable
Strengthening Capacity in Energy Planning and Supervision	Completed	Not Applicable
Mabaruma 0.4MWp Solar PV Farm	Completed	478 tons CO_2e/yr
Gas to Energy Project	Ongoing	703,150 tons CO_2e/yr
Caribbean Renewable Energy Development Programme	Completed	Not Applicable
Moraikobai Micro-grid PV System	Completed	70.20 tons CO_2e/yr

2.2. Forestry sector

In addressing climate change within the forestry sector, Guyana is employing a combination of conservation and sustainable forest management strategies. Guyana is committed to safeguarding its forests, recognising their vital role in mitigating climate change by absorbing substantial amounts of carbon dioxide (CO_2). It acknowledges that when forests are destroyed or damaged, they can become a source of GHG emissions.

In Guyana, historical deforestation has been one of the lowest rates in the world (0.02% to 0.079% per year between 2009 and 2020) (Guyana Forestry Cosmission, 2020). Guyana is therefore considered to be a high forest cover low deforestation rate (HFLD) country, with forests covering approximately 85% of the country (18.39 million hectares). The latest revision of the LCDS sets out plans up to 2030 to maintain Guyana's low deforestation and high HFLD score (Architecture for REDD+ Transactions (ART), 2021) including through the use of economic incentives. These economic incentives are grounded in UNFCCC modalities, including REDD+ and the latest evolution of market-based mechanisms underpinned by the Paris Agreement, in particular its Articles 6.2 and 6,4. Consequently, the country is actively engaged in the REDD+ framework and in the Architecture for REDD+ Transactions Environmental Excellence Standard (ART-TREES) to preserve its forests, aligning with the goals of the Paris Agreement.

Within the forestry sector, a total of 5 mitigation actions are included, comprising 2 completed and 3 ongoing initiatives. Among these, 1 is categorised as a project, while 4 are considered enabling activities.

For one mitigation action, precise GHG emission reductions could not be estimated due to insufficient information, and 2 activities do not directly lead to GHG emission reductions as they are more governance and institutional related actions. However, two specific mitigation actions within the forestry sector provide detailed insights into the associated GHG emission reductions. These initiatives underscore Guyana's commitment to mitigation GHG emissions and combatting climate change through effective and measurable actions in the forestry sector.

Table 4.3 provides a brief summary of the diverse mitigation actions undertaken in the forestry sector, while a more comprehensive outline of each mitigation action is presented in Annex III to the TNC.

Table 4.3. Overview of mitigation actions in the forestry sector.

Number of mitigation actions	5	
Total estimated GHG emission reductions	109,317,406 tons CO_2e	
Description	**Status (planned, ongoing, completed)**	**Estimated GHG emission reductions**
Institutional Strengthening for the Implementation of the LCDS 2030 under REDD+ Partnerships	Completed	Not Applicable
Guyana-EU Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement	Ongoing	Not Estimated
Guyana REDD+ Monitoring Reporting & Verification System (MRVS)	Ongoing	108,470,000 tons per annum CO_2e[8]
Forest Carbon Partnership Facility Project in Guyana	Completed	Not Applicable

2.3. Cross-cutting sector

In total, there are 6 cross-cutting mitigation actions, with 3 successfully completed and 3 currently in progress. Among these initiatives, 5 are classified as projects, and 1 is identified as

[8] The implementation of the Guyana REDD+ Monitoring Reporting & Verification System (MRVS) is anticipated to result in a substantial avoidance of 108.47 million tons CO2e over the period from 2016 to 2030 (Architecture for REDD+ Transactions, 2022). Guyana has been issued 33.47 million ART-TREES credits for the period 2016-2020, with an estimated additional 75 million credits to be issued for the period 2021-2030. Each credit being equivalent to 1 ton CO_2e, the total reduction over the 2016-2030 period is estimated at 108.47 million tons CO_2e.

enabling activity. The primary focus of these cross-cutting actions is on hinterland development and economic advancement, with 3 mitigation actions categorised by focus area.

Importantly, none of these cross-cutting mitigation actions have undergone estimation of their GHG emission reduction potential. This is either due to a current lack of information or because the nature of the action does not directly lead to GHG emission reductions.

Table 4.4 provides a brief overview of the diverse mitigation actions in the cross-cutting sector. Annex III to the TNC presents more comprehensive information for each of the actions.

Table 4.4. Overview of mitigation actions in the cross-cutting sector.

Number of mitigation actions	6	
Total estimated GHG emission reductions	Not Estimated	
Description	**Status (planned, ongoing, completed)**	**Estimated GHG emission reductions**
Amerindian Development Fund	Completed	Not Estimated
Support for Micro and Small Enterprise and Vulnerable Groups' Low-Carbon Livelihoods	Completed	Not Estimated
Amerindian Land Titling	Ongoing	Not Estimated
ICT Access and E-services for Hinterland, Remote, and Poor Communities	Ongoing	Not Estimated
Village Sustainability Plans	Ongoing	Not Estimated
Strengthened Monitoring, Enforcement and Uptake of Environmental Regulations in Guyana's Gold Mining Sector	Completed	Not Estimated

3. Projections of GHG emissions and removals

In line with international best practices, Guyana has developed and reports 'with measures' (WM) projections of all GHG emissions and removals across the five IPCC sectors, namely energy, IPPU, Agriculture, Land Use, Land-Use Change and Forestry (LULUCF), and waste.

Further details regarding the assumptions on the policies and measures (PAMs) considered in the WM scenario are provided in section 4.3.2. The WM projections provide an in-depth estimate of the impact of mitigation PAMs on future GHG emissions and removals in Guyana.

The projections will commence from the most recent year of Guyana's national GHG inventory, 2022, and extend up to 2035. This is in line with the current NDC updating process of Guyana, with the country currently revising and updating its NDC, which will cover the period from 2021 to 2030, and will prepare the subsequent NDC with a timeframe up to 2035.

3.1. Tool and assumptions used for projections of ghg emissions and removals

The models and approaches used for projecting GHG emissions and removals are presented in this section, detailing any key underlying assumptions and parameters used for projections regarding key economic and sectoral indicators.

3.1.1. Methodological framework and tool

Guyana has applied the Mitigation-Inventory Tool for Integrated Climate Action (MITICA)[9] to develop its national projections of GHG emissions and removals. MITICA provides a standardised framework to formulate specific bottom-up mitigation scenarios at the Intergovernmental Panel on Climate Change (IPCC) category level, linked to Guyana's national GHG inventory, and combined with a top-down specification of the national economy. As such, MITICA serves both as a framework and a tool to create consistent mitigation scenarios that can be tracked against historical GHG emission trends.

MITICA utilises the national GHG inventory at the highest disaggregation level and employs a consistent modelling framework for all IPCC sectors to minimise inconsistencies, while still being emission source and country specific. The modelling approach therefore considers the

[9] Martín-Ortega, J.L., Chornet, J., Sebos I., Akkermans, S., Lopez Blanco, M.J. (2024). Enhancing Transparency of Climate Efforts: MITICA's Integrated Approach to Greenhouse Gas Mitigation. Sustainability 2024, 16(10), 4219. https://doi.org/10.3390/su16104219

evolution of proxies, including macroeconomic, demographic, and sectoral drivers across various scopes, which influence the methodologies of the country-level GHG inventory.

Generally, MITICA develops mitigation scenarios based on the historical GHG dynamics of each emission source and sink, using a projected macroeconomic framework as a reference, together sectoral indicators that are also considered key determinants of GHG emissions. The macroeconomic framework is built from the evolution of the main socioeconomic and demographic variables, considering that the technology mix, consumer behaviour, and GHG accounting methodologies remain the same as in the latest historical year, changing only due to the implementation of PAMs.

3.1.2. Macroeconomic framework

The forecasting modelling approach applies a nationally-defined macroeconomic framework considering the evolution of several proxies, including the Gross Domestic Product (GDP), and population (Table 4.5).

As previously stated, these proxies influence the future GHG emissions profile of Guyana and are used in conjunction with the national GHG emission inventory to develop projections of GHG emissions and removals. In essence, activity levels of emission sources and sinks are linked to certain anthropogenic drivers that influence the evolution of the emissions/removals, such as, among others, the aggregated GDP and the number of inhabitants of the country. However, it is important to note that not all economic and sectoral proxies have an impact on GHG projections at the category level. The following list of macroeconomic and sectoral proxies is considered as an input to the category-specific models customised within MITICA; the final model design depends on the statistic characteristics of the historical dataset and the empirical explanatory capacity of the indicator for determining the given category emissions or sinks.

Table 4.5. Macroeconomic proxies considered for GHG projections.

Proxy	Theoretical relationship
Gross Domestic Product (GDP) w/o oil and gas	Increasing GDP generally involves increasing emissions. The oil and gas sector is showing an uneven dynamic compared to most economic activities of the country. For this reason, the contribution of this sector to GDP is not considered in this proxy, to isolate the effect of the expansion of oil and gas from the other economic activities in the country.
Gross Domestic Product (GDP) total	This proxy considers the aggregated GDP including all economic sectors. Despite oil and gas expansion will indirectly involve an economic growth in other sectors of the economy, the growth of the latter will be slighter. This will have an impact in most emitting categories of the country.
Population	Increased population levels generally lead to increasing emissions.

Gross Domestic Product (GDP)

GDP is a crucial and widely used indicator of economic activity across all sectors of a country, providing a comprehensive measure of overall economic performance. In the context of GHG emissions, changes in GDP often lead to changes in activity data, and therefore they strongly correlate with changes in emissions. Increased economic activity typically leads to higher energy demand, greater industrial output, and elevated consumption patterns, all of which can result in higher GHG emissions. This relationship exists because robust economic activity generally requires more energy and resources, leading to greater emissions.

Therefore, GDP dynamics are key in forecasting future GHG emissions at both sectoral and national levels. Overall economic activity significantly influences emissions, as many sectors are directly affected by the level of economic growth.

This can also be observed in Guyana, which relies heavily on petroleum imports, with a significant increase in these imports contributing substantially to the country's GDP. Diesel, fuel oil, and gasoline are the principal imports, primarily used by the transportation and electricity sectors. This dependence on petroleum imports is reflected in the GHG emissions from energy industries, which have shown a consistent upward trend from 1990 to 2022. Additionally, the recent expansion of Guyana's oil and gas sector has spurred remarkable economic growth and a notable rise in GHG emissions associated with oil and natural gas systems.

The GDP of Guyana shows two clear behaviours: an upward trend since 2021 in those economic activities related to oil and gas production, and slightly increasing trend for the remaining economic activity of the country. This trend, which is clearly observed in national GDP aggregates, is also expected to continue in the future, as suggested by several sources (International Monetary Fund (IMF), 2023); (The World Bank, n.d.).

This duality has been translated into the macroeconomic framework for the GHG projections, in the form of two GDP proxies, one with oil and gas, and one without oil and gas. Figure 4.2 illustrate the trends for these two variables, from 2006 to 2035.

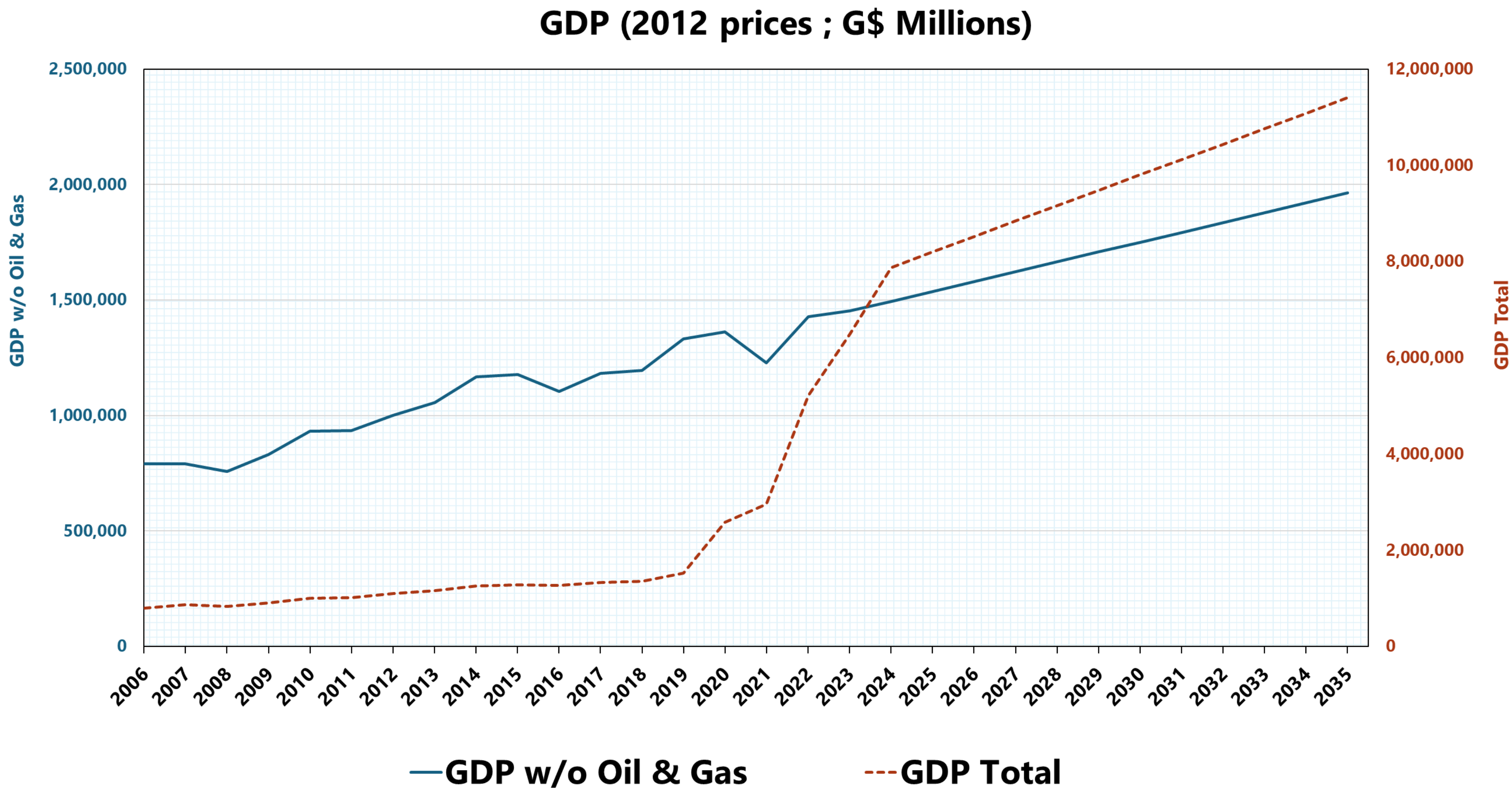


Figure 4.2. GDP of Guyana for the period 2006-2035.

Population

The development trend of the national population is a crucial determinant for the trajectory of anthropogenic GHG emissions because the size and growth rate of a population directly influences the level of human activities that generate these emissions. As the population grows, more people engage in activities that produce GHGs, such as transportation, energy consumption, industrial production, agriculture, and waste generation.

For example, more people mean more vehicles on the road, increased demand for electricity and heating, higher production of goods, and greater amounts of waste, all of which contribute to higher GHG emissions. Additionally, a larger population generally leads to an expanded economy. As economic activities increase to meet the needs of a growing population, the industrial and commercial sectors ramp up production, often relying on fossil fuels. This results in higher emissions from power plants, factories, and other industrial processes. Conversely, a declining population often coincides with a reduction in anthropogenic GHG emissions. With fewer people, there is less demand for transportation, energy, and goods, leading to a decrease in activities that produce GHGs.

In Guyana, although population growth stagnated until 2012 with even occasional periods of decline, it has gradually increased over the past decade due to significant economic development. This demographic shift has contributed to increasing emissions in several sectors. For instance, in the waste sector, where a notable rise in emissions from solid waste disposal is partially attributed to population growth and the growing population in Guyana has led to higher energy demand, which has led to higher emissions.

Population data for the period 1990-2021 was sourced from the Guyana Bureau of Statistics (Bureau of Statistics of Guyana, 2024). However, significant outliers were detected for the years 1990 and 2008, which were adjusted using slicing techniques. The forecasted years 2022 to 2030 were derived from a Population and Housing Census conducted prior to 2022. For the period 2030-2035, the growth rate trend from 2022-2030 was extended to calculate the population.

Figure 4.3 presents the actual population of Guyana for the period 1990-2021 and the forecasted population for the period 2022-2035, illustrating both historical data and future projections.

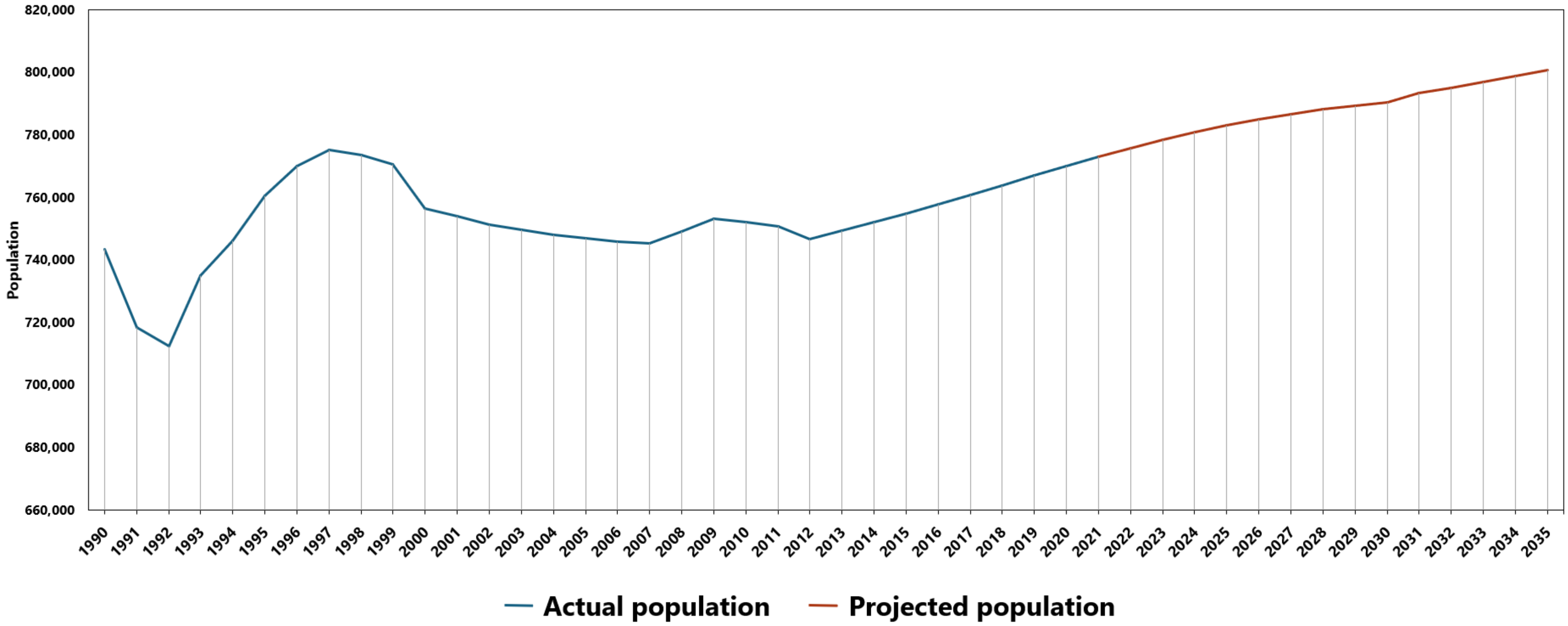


Figure 4.3. Population of Guyana for the period 1990-2035.

3.1.3. Sectoral framework

Furthermore, the modelling approach incorporates the evolution of sector-specific proxies to enhance the precision of sectoral model specifications. Although the overall forecasting methodology remains consistent across all sectors, the use of distinct sectoral proxies allows MITICA to account for additional determinants that can refine national-specific models by source and sink for projecting GHG emissions, particularly when these determinants have influenced historical emissions.

These sectoral proxies typically involve physical indicators rather than macroeconomic metrics. They assist in understanding how changes within specific sectors affect emissions, facilitating more accurate and tailored projections. By combining sectoral and macroeconomic proxies, the approach provides a comprehensive framework for projecting GHG emissions and removals. The national GHG emission inventory supplies historical emission data, while macroeconomic and sectoral proxies offer insights into broader factors affecting emissions across various sources and sinks.

Table 4.6 presents the sectoral proxies considered in the projections of GHG emissions and removals for Guyana.

Table 4.6. Sectoral proxies considered for GHG projections.

Proxy	Theoretical relationship
Energy demand	Energy demand is directly related to increased fossil fuel emissions due to consumption of fossil fuels. Energy can be produced endogenously or imported.
Indigenous energy supply	The amount of indigenous energy supplied (i.e. national energy production) is directly correlated with emissions from energy industries.
Oil production levels	Oil production levels have a direct impact on fugitive emissions.
Deforestation	Decreased forest land involves decreased CO_2 removals, therefore reduced net GHG emissions.
Forest cover	Increased forest trends lead to enhanced biomass growth and subsequent CO_2 removals, therefore reduced net GHG emissions.

Energy demand

Energy demand drives emissions primarily through the reliance on fossil fuels for various activities across different sectors, including transportation, industry and the residential, commercial and service sectors. As energy consumption increases to meet the needs of a growing population and expanding economy, the burning of fossil fuels leads to higher emissions GHGs, contributing to climate change.

Enhancing energy efficiency through measures such as improved insulation in buildings and the use of more efficient devices will be crucial for reducing overall energy consumption and demand. Additionally, expanding the deployment of small-scale renewable energy systems will contribute significantly to decreasing reliance on fossil fuels. These strategies not only support the reduction of fossil fuel consumption but also help mitigate environmental impacts by promoting cleaner energy alternatives.

The expansion of the oil and gas industry is expected to significantly influence the country's energy demand. As the industry scales up its operations, there will be an increased requirement for various forms of energy to support activities such as drilling, extraction, refining, and transportation. This growth will lead to higher consumption of fuels including natural gas, diesel, and crude oil, as well as increased energy needs for machinery and infrastructure. The rise in energy demand driven by the oil and gas sector will contribute to the overall national energy consumption, placing additional strain on existing energy infrastructure and requiring enhanced management strategies to address the growing energy needs.

Data on energy demand for the period 1990-2021 was obtained from the Permanent Secretariat of the Latin American Energy Organization (OLADE) Guyana energy supply and demand series (OLADE, 2024). Subsequent years until 2035 were forecasted using the trend from the data from OLADE from 1990 to 2021. The projected GDP, accounting for the contribution of the oil and gas sector and assuming a decreasing elasticity between GDP and energy supply from 2023 to 2035, has been used as follows:

$$\{1\} \qquad E_t = E_{2021} \cdot \left|\frac{GDP_t}{GDP_{2021}}\right|^{\varepsilon_t}$$

Where E_t is the energy demand for year t, E_{2021} is energy demand for year 2021, GDP_t the GDP of year t, GDP_{2021} is the GDP for year 2021. ε_t is the elasticity between GDP and energy demand, calculated as follows:

$$\{2\} \qquad \varepsilon_t = \varepsilon_{2021} \cdot \left|\frac{\varepsilon_{2021} - \varepsilon_{2035}}{n-1}\right| \cdot (t - 21)$$

Where ε_t is the initial elasticity (0.8), ε_t is the final elasticity (0.5), n the total number of years and t the year for which the elasticity is calculated. The reduced elasticity between GDP and energy is substantiated on several studies [(Wang, 2021); (Liddle, 2023)] that evidence that increased level of economic development tend to be associated with lower interannual changes in energy consumption.

Figure 4.4 presents the actual energy demand of Guyana for the period 1990-2021 and the forecasted energy demand data for the period 2022-2035.

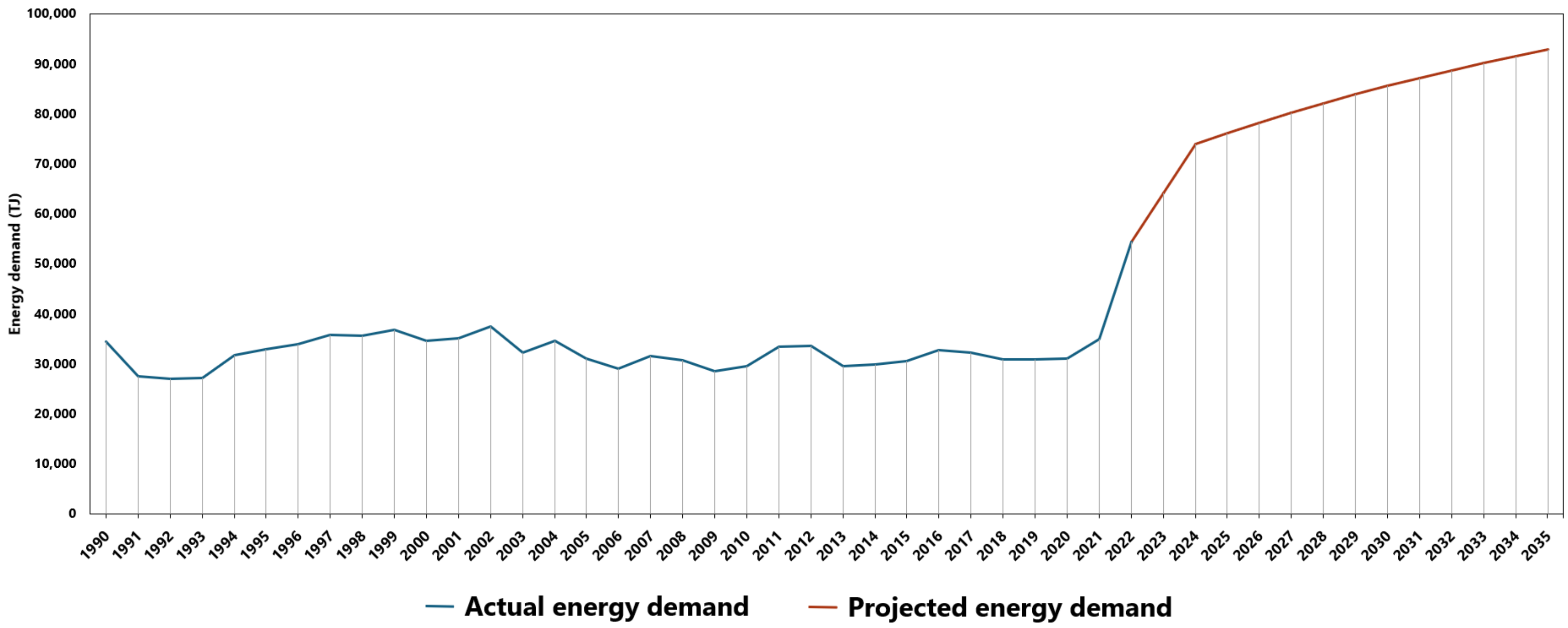


Figure 4.4. Energy demand in Guyana for the period 1990-2035.

Indigenous energy supply

Energy supply drives emissions primarily through the types of energy sources used to meet the demand for electricity, heat, and transportation. Indigenous energy supply in national energy systems refers to the energy produced within a country's borders from its own natural resources, as opposed to energy imported from other countries. In energy statistics terminology, indigenous production includes all forms of energy production, such as:

- Fossil Fuels: Coal, oil, and natural gas extracted from domestic reserves.
- Renewable Energy: Energy generated from renewable sources like solar, wind, hydro, geothermal, and biomass that are located within the country.
- Nuclear Energy: Energy produced from domestic nuclear power plants.
- Other Sources: Any other forms of energy that are produced domestically.

The choice between fossil fuels and non-fossil fuels (renewable energy sources or nuclear) significantly impacts greenhouse gas (GHG) emissions. Fossil fuels, such as coal, oil, and natural gas, release large amounts of GHGs when burned to produce energy.

Total energy demand should align with total energy supply in the economy. Energy demand is projected to grow sharply due to the expansion of the oil and gas sector, while indigenous production of energy requires more time to commission new capacity. Thus, the gap between demand and supply may need to be covered by imported fuels. This directly affects emissions from energy industries, which include emissions from fuel consumption for electricity and heat production, as well as from refining processes.

The national energy supply is determined by various factors, including production capacities, import-export dynamics, and energy infrastructure efficiency. While the oil and gas sector's expansion will increase the consumption of specific fuels, the broader energy supply landscape is influenced by multiple elements such as production levels, market stability, and infrastructure capabilities. Therefore, despite the rising demand from the oil and gas sector, the overall energy supply is expected to remain relatively stable, shaped by a comprehensive set of factors beyond any single sector's expansion.

Data on energy supply for the period 1990-2021 was obtained from the OLADE Guyana energy supply and demand series (OLADE, 2024). Subsequent years until 2035 were forecasted using the trend from the data from OLADE from 1990 to 2021. The projected GDP without oil and gas, and assuming a decreasing elasticity between GDP and energy supply from 2023-2035, has been used to calculate energy supply, using the formulas {1} and {2} provided above.

Figure 4.5 presents the endogenous energy supply of Guyana for the period 1990-2021 and the forecasted endogenous energy supply data for the period 2022-2035.

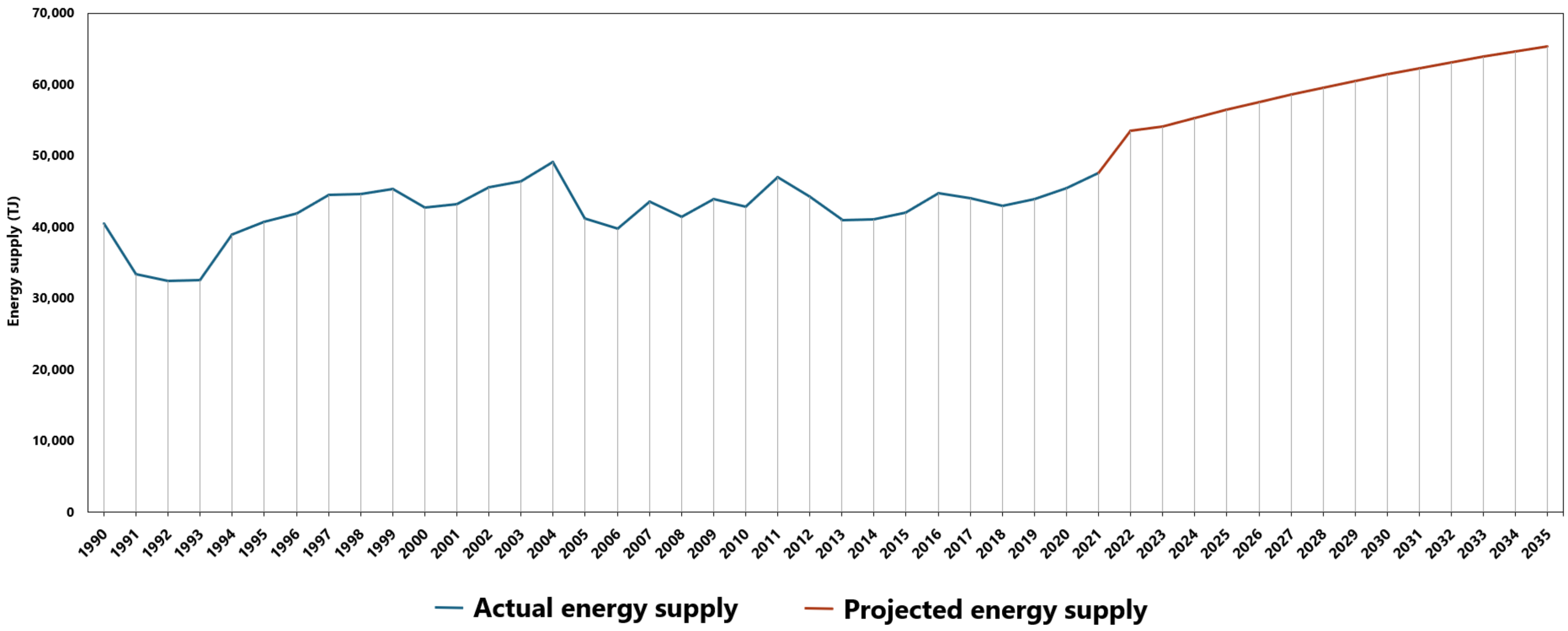


Figure 4.5. Indigenous energy supply in Guyana for the period 1990-2035.

Oil production levels

Oil production results in fugitive emissions, which comprise all GHG emissions from oil systems except contributions from fuel combustion. The sources of fugitive emissions from oil production include, but are not limited to, equipment leaks, evaporation and flashing losses, venting, flaring, and accidental releases (e.g., pipeline dig-ins, well blow-outs and spills). As such, oil production contributes to GHG emissions through various stages of the production process, each associated with different amounts of emissions.

In Guyana, oil production commenced in 2020 through the Liza Phase 1 Project, ExxonMobil's first Floating Production Storage and Offloading (FPSO) vessel. In February 2022, ExxonMobil's second FPSO began production in the Stabroek Block under the Liza Phase 2 Project and in 2023, the ExxonMobil's third FPSO began production under the Payara Project. Three additional oil production projects will commence in the Stabroek Block in the coming years. Consequently, the pace of oil production in Guyana is accelerating significantly, with a peak expected in 2030, after which production will gradually decline. Therefore, oil production will play a crucial role in Guyana's economic development and its low carbon development and emissions profile in the upcoming period.

Data on oil production for the period 1990-2023 was obtained from the Environmental Protection Agency (EPA). For the period 2024-2034, data was sourced from ExxonMobil Guyana Limited's (EMGL) oil production projection model released in November 2023. The year 2035 was derived by applying the growth rate trend from 2030-2034.

Figure 4.6 presents the actual oil production levels of Guyana for the period 1990-2024 and the forecasted oil production levels for the period 2025-2035.

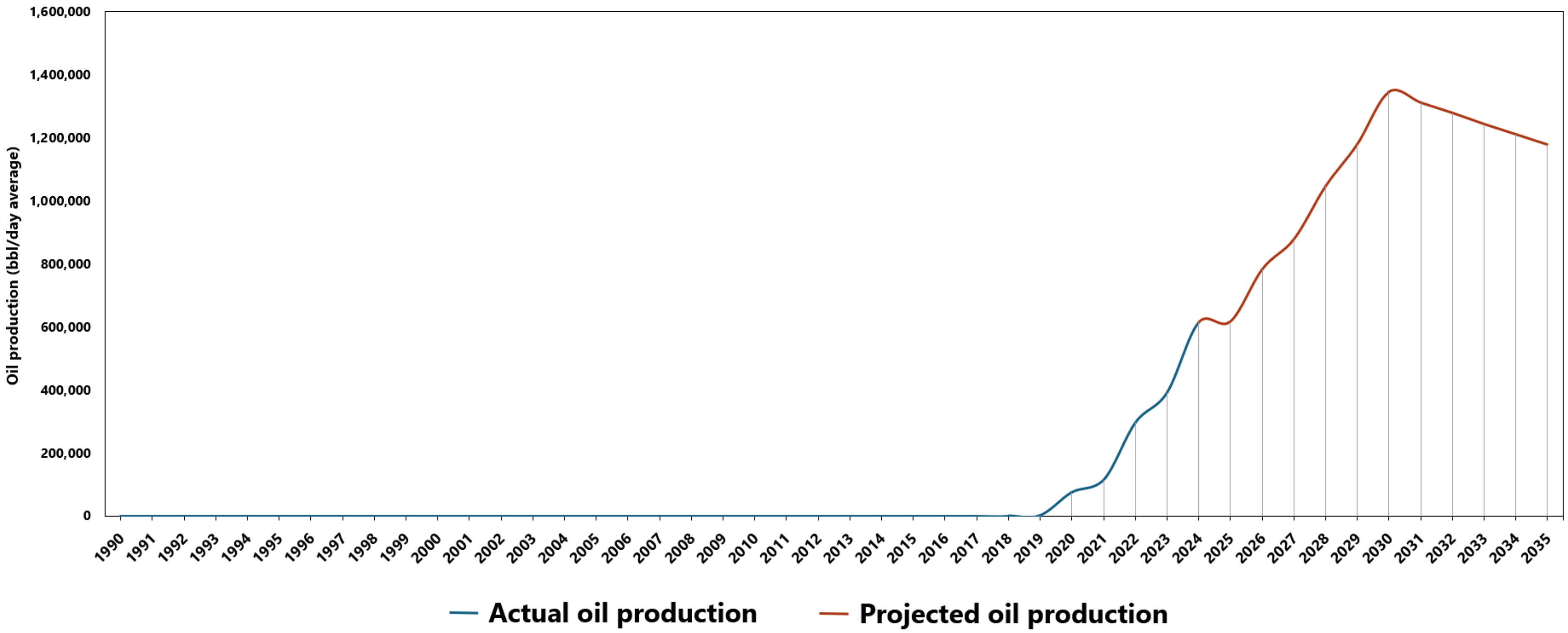


Figure 4.6. Oil production levels in Guyana for the period 1990-2035.

Deforestation

Forests are crucial carbon sinks because they absorb CO_2 from the atmosphere. When forests are cleared, the trees that sequester carbon are removed, drastically reducing the area's capacity to store carbon. Additionally, the carbon stored in the biomass of these trees is released back into the atmosphere as CO_2 when they are cut down or burned, significantly increasing GHG levels. Forest soils, which are rich in organic carbon, also lose their carbon storage ability when deforestation occurs. The disruption of soil structure leads to the decomposition of organic matter, further releasing CO_2, and erosion can deplete soil carbon. Furthermore, deforestation reduces the future potential for carbon sequestration by eliminating trees that would continue to absorb CO_2 over their lifespans. As such, deforestation diminishes the land's ability to act as a carbon sink, exacerbating climate change by raising atmospheric GHG concentrations.

Guyana has maintained a historically low deforestation rate, making it a HFLD country with approximately 85% forest cover. Deforestation has varied between years, showing peaks in 2013 and 2019, when the deforestation rates were 0.079% and 0.071%, respectively, and considerable drops in 2010 and 2022, when the deforestations rates were 0.021% and 0.036%, respectively. Mining is the primary driver of deforestation in Guyana, accounting for 85% of all deforestation between 2001 and 2012, and 74% of deforestation between 2013 and 2020. Agriculture, roads and mining infrastructure, forestry infrastructure, and forest fire are the remaining drivers of deforestation and forest degradation in Guyana.

Data on deforestation rates for the period 1990-2009 were obtained through the Guyana ART Workbook for REDD+ from the Guyana Forestry Commission, while for the period 2010-2022 data was obtained through the Guyana REDD+ MRVS Report – Assessment Year 2020 (Guyana Forestry Cosmission, 2020). The forecasted period 2023-2030 were derived from deforestation projections conducted by the Guyana Forestry Commission. For the period 2030-2035, the same deforestation rate as 2023-2030 is applied.

Figure 4.7 presents the actual deforestation rates of Guyana for the period 1990-2022 and the forecasted deforestation rates for the period 2023-2035.

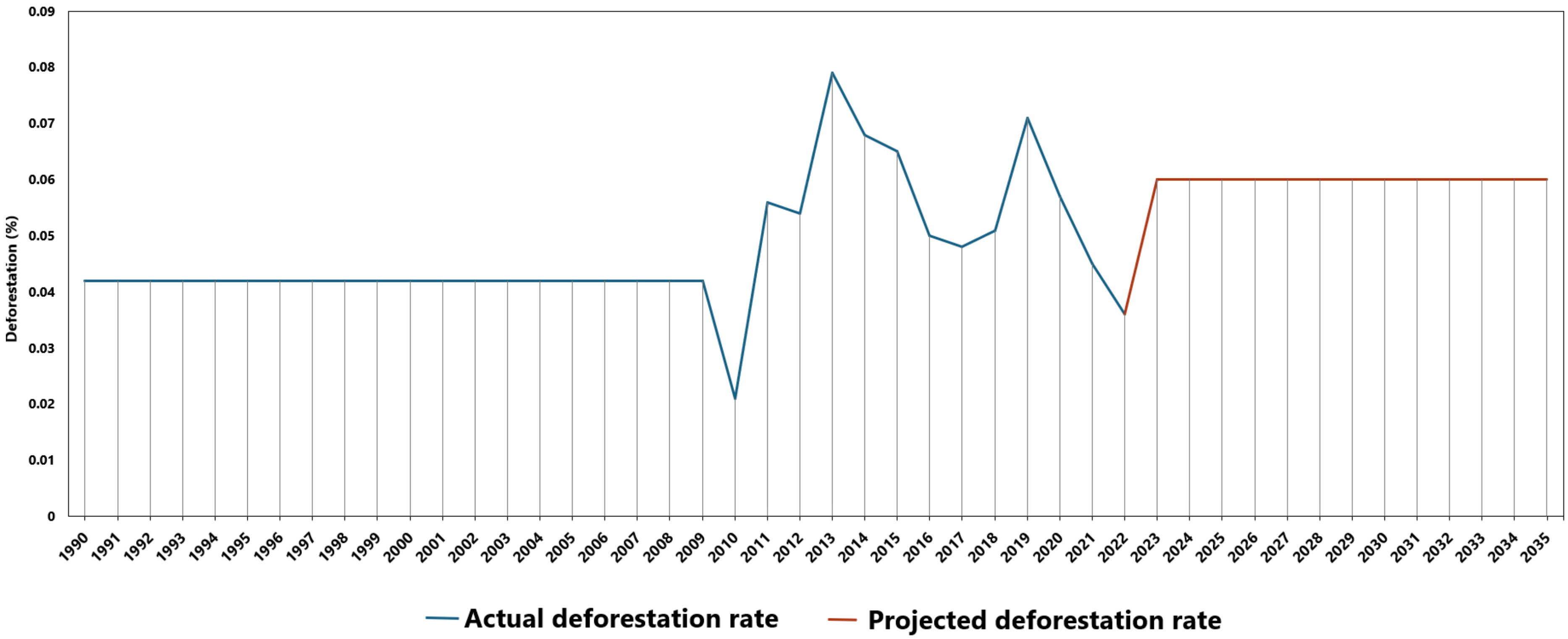


Figure 4.7. Deforestation rates in Guyana for the period 1990-2035.

Forest cover

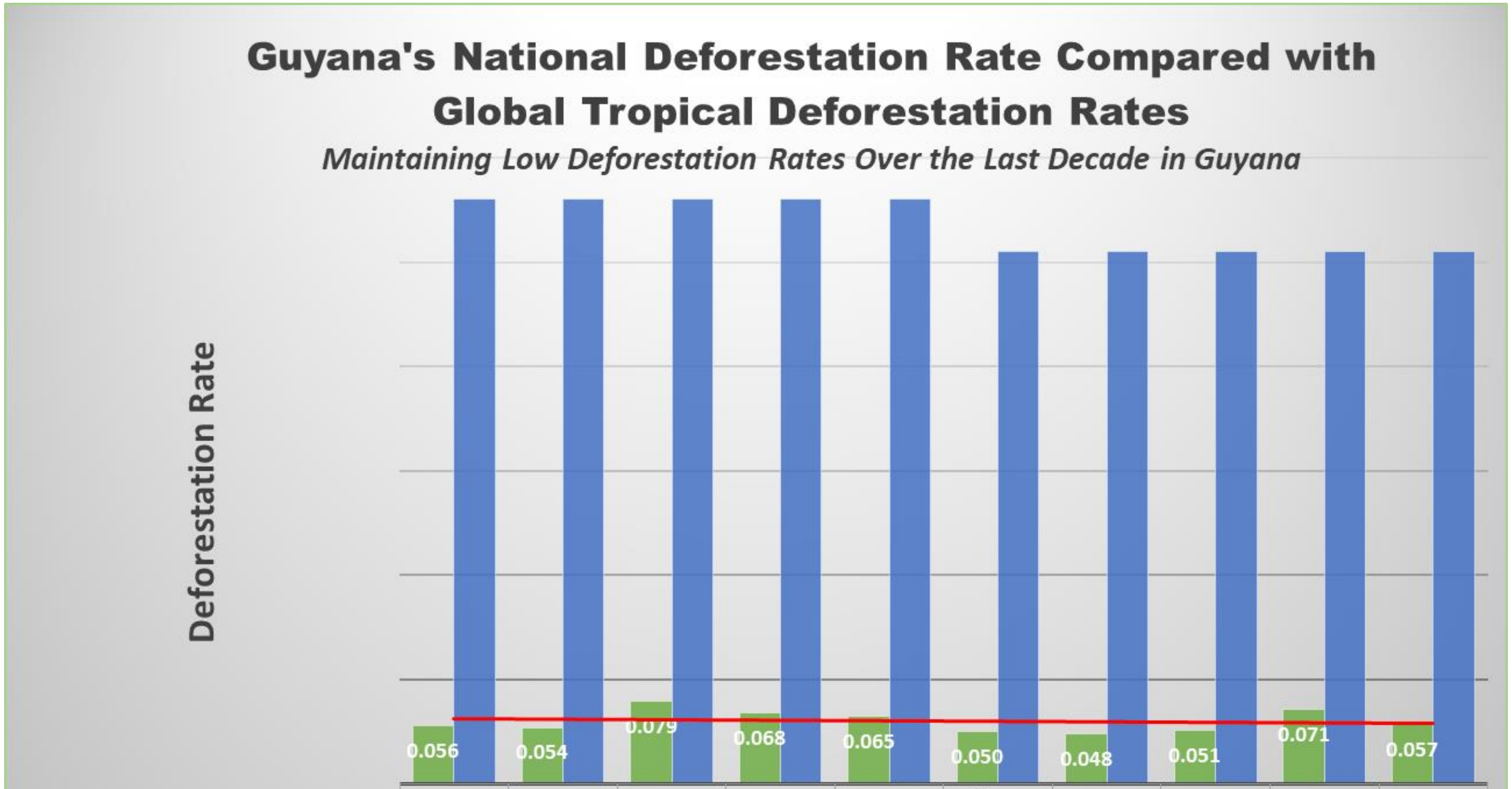
Increased forest trends lead to enhanced biomass growth, which means that trees and other vegetation are growing more abundantly and healthily. This growth results in higher rates of photosynthesis, where plants absorb CO_2 from the atmosphere and convert it into organic matter, such as leaves, stems, and roots. As a result, there is a substantial increase in the amount of CO_2 being removed from the atmosphere and stored in the forest biomass. This process of carbon sequestration helps to mitigate climate change by reducing the overall concentration of GHGs in the atmosphere. When forests grow and expand, they act as carbon sinks, capturing more CO_2 than they release. This leads to a net reduction in GHG emissions, contributing to a decrease in the global warming potential.

In summary, the trend of increasing forest areas and enhanced biomass growth directly contributes to greater CO_2 removal from the atmosphere. This process not only supports forest ecosystems and biodiversity but also plays a critical role in addressing climate change by lowering net GHG emissions.

Guyana has maintained a historically low deforestation rate, making it a HFLD country with forests covering approximately 85% of the country (18.39 million hectares) until around 2017. Slight decreases in forest cover have occurred since then, primarily due to activities such as logging, agriculture, and mining driving deforestation in Guyana.

Data on forest cover levels for the period 1990-2022 were obtained through the Guyana ART Workbook for REDD+ from the Guyana Forestry Commission. Subsequent years until 2035 were forecasted using the trend from the data from the Guyana Forestry Commission from 1990 to 2022.

Figure 4.8 presents the actual forest cover levels of Guyana over the period 2010 to 2020.



	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015/2016	Year 2017	Year 2018	Year 2019	Year 2020
Deforestation Percent	0.056	0.054	0.079	0.068	0.065	0.050	0.048	0.051	0.071	0.057
Global Tropical Deforestation Percent	0.56	0.56	0.56	0.56	0.56	0.51	0.51	0.51	0.51	0.51

Figure 4.8. Forest cover levels in Guyana for the period 2010 to 2020

3.2. Assumptions on the policies and measures in the with measures (WM) scenario

Policy or mitigation scenarios encompass a distinct set of PAMs. PAMs are all types of actions, measures, and policies that reduce emissions or enhance sinks of GHGs. These policy or mitigation scenarios allow for observing differences in emission profiles resulting from policy implementations, ultimately facilitating the assessment whether Guyana's defined mitigation targets are achieved.

In section 4.2, a detailed overview of the mitigation actions within the energy, forestry, and cross-cutting sectors in Guyana is provided. This overview indicates that the majority of these PAMs were implemented before the latest national GHG inventory year of 2022, in some cases as far back as 2010. Therefore, it is assumed that the GHG emission reductions resulting from the implementation of these PAMs are already reflected in Guyana's historical emissions profile up to 2022.

Moreover, it is important to note that the estimated GHG emission reductions for each PAM reported in section 4.2 are in several cases derived from desk-based research. While this provides valuable insights, it also introduces a degree of uncertainty regarding the accuracy of these reported figures.

Given this context, Guyana has made the informed assumption that the GHG emission reductions from these implemented PAMs are reflected in the national GHG inventory profile. Consequently, the WM scenario has been developed based on the historical GHG dynamics of each emission source and sink. This scenario incorporates the projected macroeconomic and sectoral frameworks presented in section 4.3.3, ensuring a robust and realistic projection of future emissions.

This approach in developing the WM scenario also ensures alignment with the goals and objectives outlined in Guyana's two main national climate change policies, namely the NDC and the LCDS. The mitigation actions presented in section 4.2 are primarily aligned with the goals and objectives outlined in these key national policies.

3.3. With measures (WM) scenario

The WM scenario depicts GHG trends encompassing currently implemented and adopted PAMs. More information on the assumptions on the PAMs in the WM scenario is provided in section 4.3.2. For the individual GHG impact of PAMs please refer to section 4.2.

In the WM scenario without LULUCF (Figure 4.9), the national GHG emissions are 8,488.06 Gg CO_2eq in 2022 according to the latest GHG inventory. GHG emissions are projected to subsequently peak at 20,210.66 Gg CO_2eq in 2031 and by 2035, the GHG emissions are projected to be 16,096.96 Gg CO_2eq.

In the WM scenario with LULUCF (Figure 4.10), the national GHG emissions are significantly influenced by the high removals. In 2022, the national GHG emissions with LULUCF were -133,919.14 Gg CO_2eq. By 2035, the GHG emissions, with LULUCF, are projected to be -122,843.04 Gg CO_2eq. Guyana is employing a combination of conservation and sustainable forest management strategies to safeguard its forests, recognising their vital role in mitigating climate change by absorbing substantial amounts of CO_2.

The largest contributor to the increase in projected GHG emissions until 2035 is the oil and gas sector (categories 1B1a and 1B2a) as illustrated in Figure 4.11. This correlates with the pace at which oil production in Guyana is accelerating following initial commencement in 2020. In response, Guyana has been implementing substantial PAMs related to the energy sector to transition towards a clean energy matrix from the current fossil-dependent matrix.

Projected GHG emissions from the agriculture and waste sectors are relatively limited. Agriculture GHG emissions will rise to 2,825.54 Gg CO_2eq by 2035, mainly due to the growing livestock population in Guyana. The waste sector is projected to see only a minor increase, with emissions reaching 427.73 Gg CO_2eq by 2035, primarily due to increased waste generation linked to population growth. Although Guyana has not yet prioritised mitigation PAMs in these sectors, they will eventually become part of the mitigation agenda to limit further projected GHG emissions rises.

The IPPU sector in Guyana is limited, with no ongoing industrial activities. Activities within this sector are solely associated with the use of products serving as substitutes for Ozone Depleting Substances (ODS). However, due to data unavailability, projected GHG emissions from these categories have not been estimated, as described in the chapter on the national GHG inventory of Guyana.

Table 4.7 provides an overview of the total GHG emissions in the WM scenario by sector and for the totals with and without LULUCF up to 2035.

Table 4.7. Projected total GHG emissions in the WM scenario (Gg CO_2eq).

Sector	1990	1995	2000	2005	2010	2015	2020	2022*	2025	2030	2035
Energy/Oil and Gas	1,265.88	1,631.73	1,768.28	1,484.62	1,849.70	2,145.04	4,904.53	6,116.10	10,033.90	17,086.19	12,843.68
IPPU	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Agriculture	1,123.39	1,572.71	1,569.69	1,460.76	1,797.39	2,197.35	2,252.51	1,927.02	2,346.49	2,570.05	2,825.54
LULUCF	-143,717.72	-144,049.40	-144,381.08	-144,712.75	-145,044.43	-143,970.99	-139,803.83	-142,407.20	-141,304.70	-140,242.77	-138,940.00
Waste	351.04	353.56	358.21	358.12	353.91	383.06	428.38	444.94	432.16	436.88	427.73
Total without LULUCF	2,740.31	3,558.00	3,696.18	3,303.49	4,001.00	4,725.45	7,585.42	8,488.06	12,812.55	20,093.13	16,096.96
Total with LULUCF	-140,977.41	-140,491.40	-140,684.89	-141,409.26	-141,043.43	-139,245.53	-132,218.41	-133,919.14	-128,492.15	-120,149.64	-122,843.04

***** The year 2022 is the reference year for the projections of GHG emissions and removals.

NE – Not Estimated. Historical and projected GHG emissions associated with categories within the IPPU sector occurring in Guyana have not been estimated due to data being unavailable.

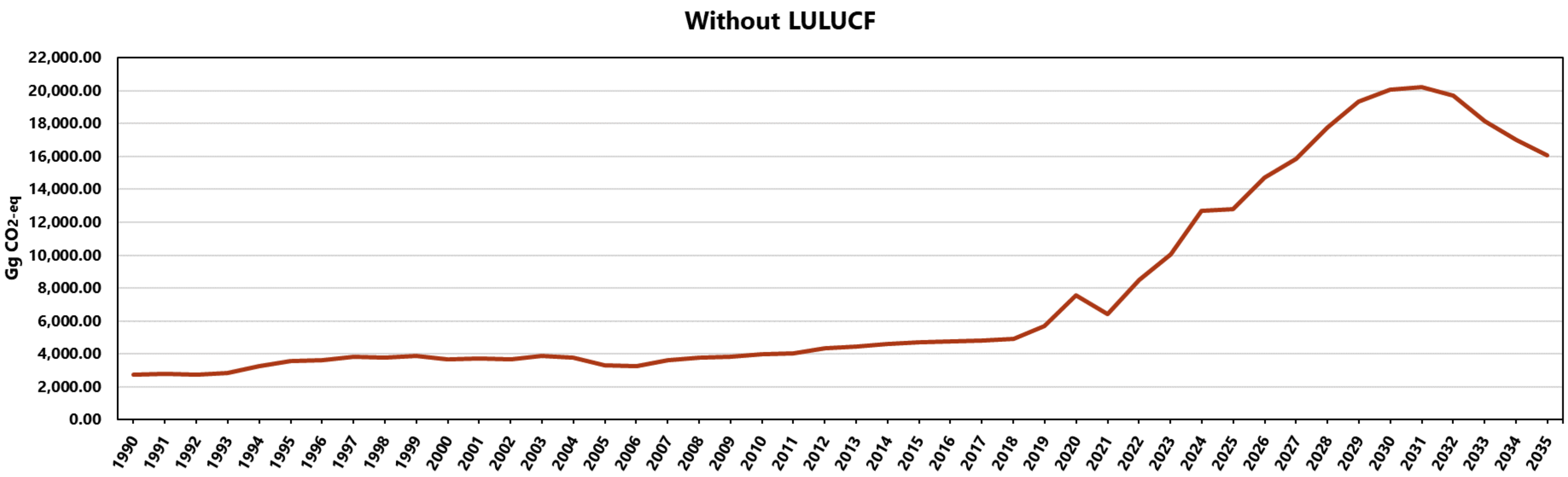


Figure 4.9. Projected total GHG emissions in the WM scenario without LULUCF.

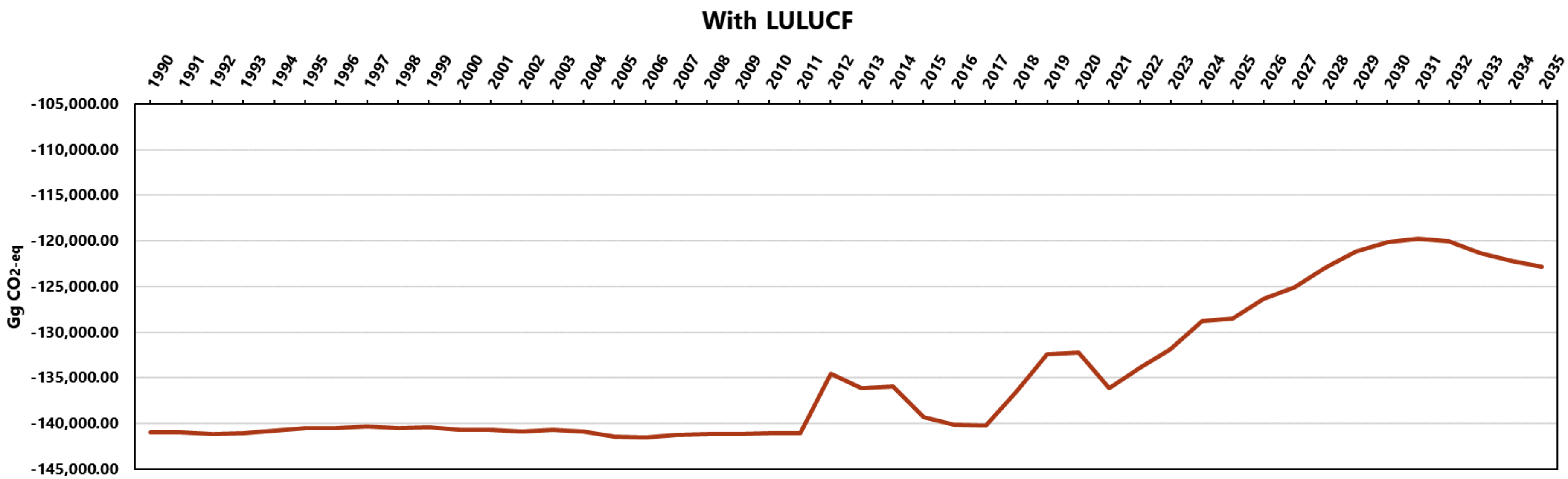


Figure 4.10. Projected total GHG emissions in the WM scenario with LULUCF.

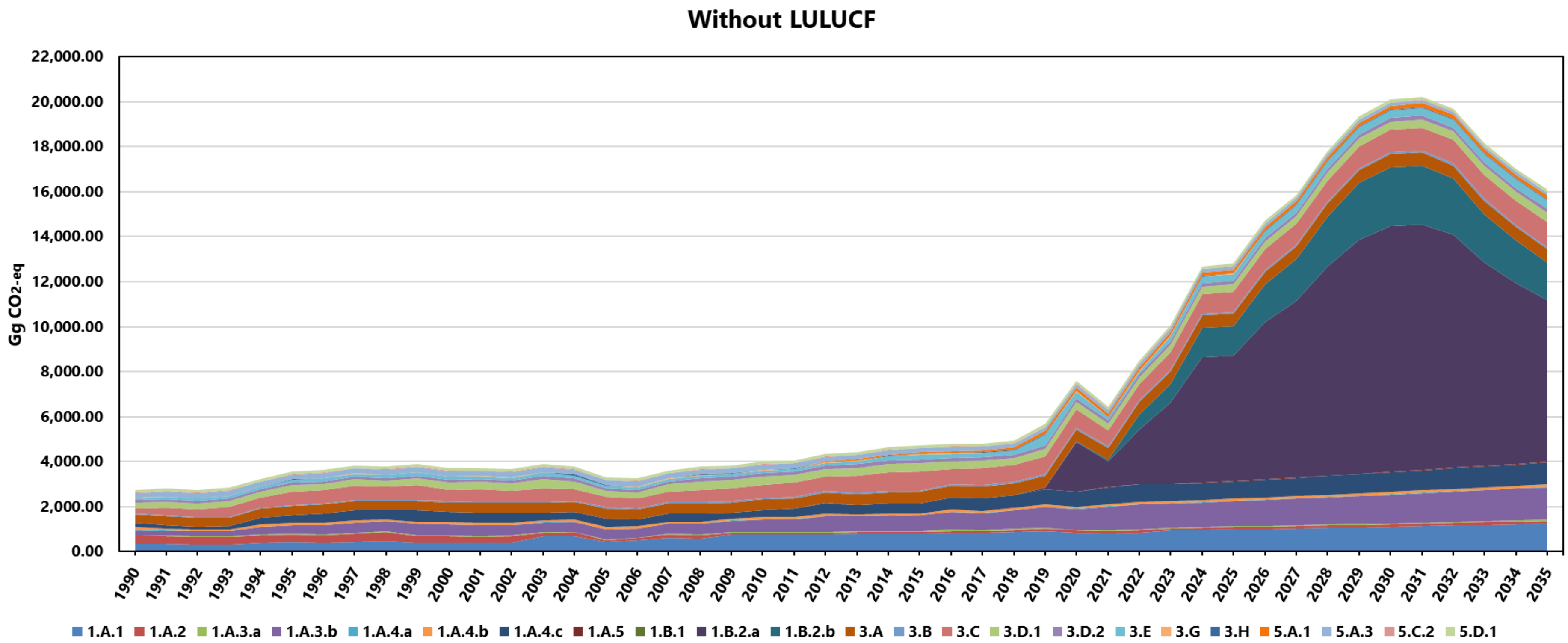


Figure 4.11. Projected total GHG emissions in the WM scenario without LULUCF split by sectoral categories.

3.3.1. Energy sector

GHG emissions in the energy sector are projected to increase (Figure 4.12) from 6,166.10 Gg CO_2eq in 2022 according to the latest GHG inventory to 17,086.19 Gg CO_2eq in 2030 and 12,843.68 Gg CO_2eq in 2035. This increase is primarily driven by the commencement and expansion of oil production in the country, leading to higher projected GHG emissions in the oil and gas sector (categories 1B1a and 1B2a). Peak oil production is expected in 2030, after which production will decline, resulting in reduced projected GHG emissions from the oil and gas sector between 2030 and 2035.

However, other categories within the energy sector are also experiencing an upward trend in projected GHG emissions. Emissions from fuels combusted by fuel extraction or energy-producing industries will continue to rise due to Guyana's reliance on petroleum imports. Additionally, emissions from transportation activities, particularly road transport, are expected to grow due to population growth and economic development, key factors driving higher fuel consumption. Emissions in the residential, commercial, and institutional sectors, as well as from fuel combustion in agriculture, forestry, fishing, and fishing industries, are also projected to rise in line with increased fuel consumption trends.

To mitigate these increased GHG emissions in the energy sector, Guyana has been actively implementing PAMs to support the transition from a fossil-dependent energy matrix to a clean energy matrix. These PAMs are focused on changing how energy is generated.

Table 4.8 provides an overview of the projected energy sector GHG emissions in the WM scenario up to 2035.

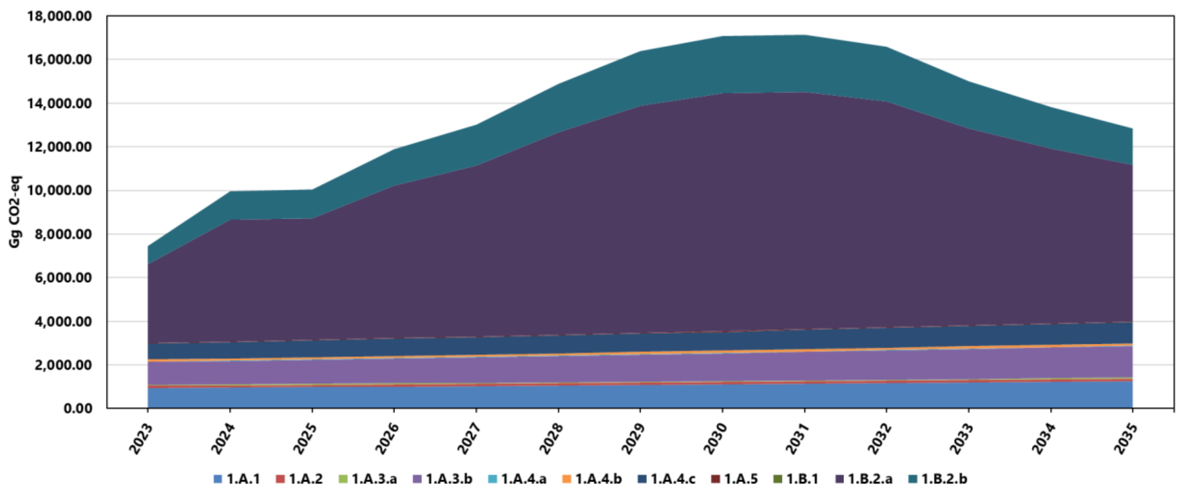


Figure 4.12. Projected energy sector GHG emissions in the WM scenario for the period 2023-2035.

Table 4.8. Projected energy sector GHG emissions in the WM scenario (Gg CO_2eq).

Sector	1990	1995	2000	2005	2010	2015	2020	2022*	2025	2030	2035
1.A.1	335.69	413.02	391.16	409.89	759.67	785.06	847.82	842.83	977.43	1,096.62	1,237.29
1.A.2	329.55	348.44	283.39	90.27	84.98	79.66	81.30	88.57	102.71	115.24	130.02
1.A.3.a	34.83	42.23	41.55	30.99	27.60	40.92	30.01	37.67	43.80	46.54	49.14
1.A.3.b	236.39	376.62	483.74	452.51	544.23	693.93	923.80	1,118.54	1,114.39	1,272.22	1,446.61
1.A.4.a	5.85	5.85	5.06	8.23	8.03	10.03	14.52	16.86	15.99	18.22	20.47
1.A.4.b	150.58	96.66	103.10	94.12	101.51	93.97	88.52	109.23	100.00	101.92	103.70
1.A.4.c	172.07	346.99	457.77	386.56	313.52	427.56	670.25	767.50	765.49	858.31	970.93
1.A.5	0.92	1.91	2.53	12.04	10.18	13.91	24.59	33.88	29.63	34.19	39.65
1.B.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2.a	0.00	0.00	0.00	0.00	0.00	0.00	2,188.38	2,414.52	5,577.89	10,905.34	7,184.80
1.B.2.b	0.00	0.00	0.00	0.00	0.00	0.00	35.33	686.50	1,306.57	2,637.59	1,661.08
Total	1,265.88	1,631.73	1,768.28	1,484.62	1,849.70	2,145.04	4,904.53	6,116.10	10,033.90	17,086.19	12,843.68

***** The year 2022 is the reference year for the projections of GHG emissions and removals.

3.3.2. Agriculture sector

The agriculture sector currently contributes a relatively small proportion of total national GHG emissions, with 1,927.02 Gg CO_2eq reported in 2022. However, these emissions are projected to rise to 2,825.54 Gg CO_2eq by 2035 (Figure 4.13). This increase is primarily attributable to the growing livestock population in Guyana and expanded rice cultivation practices, both of which are linked to population growth, economic development and previous government investment in irrigation and drainage infrastructure.

The country recognises the importance of addressing the projected increase in GHG emissions. As part of its broader climate strategy, Guyana plans to incorporate the agriculture sector into its mitigation agenda to limit further rises in emissions. This will involve developing and implementing targeted PAMs to reduce the sector's GHG emissions.

Table 4.9 provides an overview of the projected agriculture sector GHG emissions in the WM scenario up to 2035.

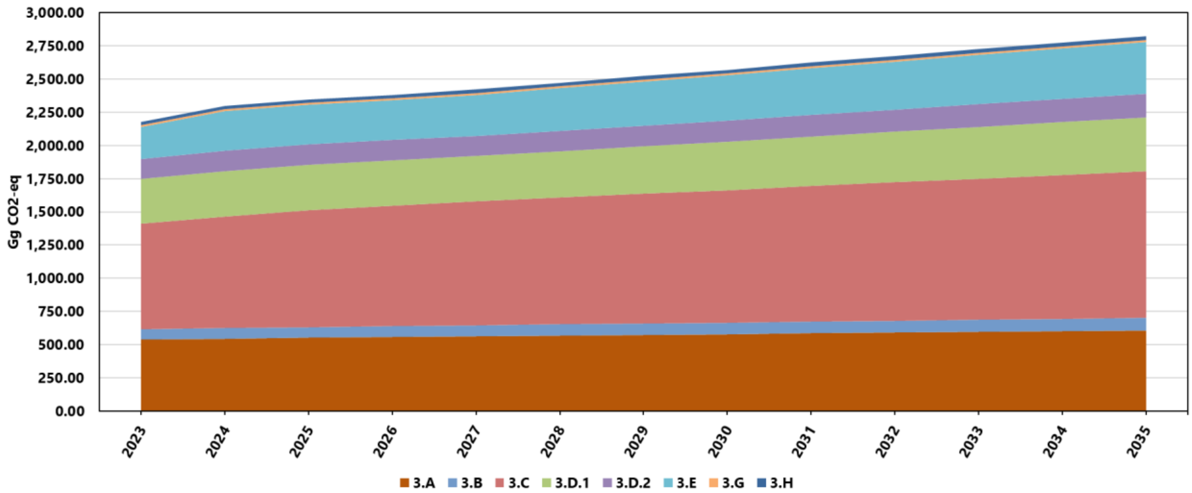


Figure 4.13. Projected agriculture sector GHG emissions in the WM scenario for the period 2023-2035.

Table 4.9. Projected agriculture sector GHG emissions in the WM scenario (Gg CO_2eq).

Sector	1990	1995	2000	2005	2010	2015	2020	2022*	2025	2030	2035
3.A	381.22	401.10	418.56	433.95	459.95	503.45	524.44	535.68	551.63	579.59	607.79
3.B	43.65	47.65	51.65	55.73	61.27	69.10	74.83	77.56	80.46	86.59	92.70
3.C	227.31	585.63	512.74	471.91	581.51	844.26	821.75	708.62	879.58	995.74	1,106.20
3.D.1	269.75	283.31	321.30	259.67	382.59	366.14	330.24	299.92	345.12	365.07	405.56
3.D.2	103.71	110.41	126.31	105.03	153.11	149.55	145.10	139.06	153.39	158.86	176.48
3.E	79.42	124.90	118.78	113.27	122.97	237.71	316.09	139.52	296.61	342.00	392.01
3.G	11.35	13.07	14.24	13.89	12.37	14.43	14.95	15.11	15.08	15.33	15.59
3.H	6.98	6.63	6.10	7.30	23.62	12.70	25.12	11.56	24.62	26.89	29.21
Total	1,123.39	1,572.71	1,569.69	1,460.76	1,797.39	2,197.35	2,252.51	1,927.02	2,346.49	2,570.05	2,825.54

***** The year 2022 is the reference year for the projections of GHG emissions and removals.

3.3.3. LULUCF sector

Guyana is a net carbon sink, with GHG removals from the LULUCF sector approximately being ten times greater than the national GHG emissions. This underscores the critical role of Guyana's forests as a significant carbon sink, highlighting their importance in mitigating climate change.

Projected GHG removals in the LULUCF sector are expected to decrease slightly, from -142,407.20 Gg CO_2eq in 2022 to-138,940.00 Gg CO_2eq by 2035 (Figure 4.14). This moderate increase in emissions underscores the need for sustained and enhanced efforts to maintain and improve the carbon sequestration capacity of the country's forests.

To address this, Guyana is employing a combination of conservation and sustainable forest management strategies to safeguard its forests through effective and measurable actions. Recognising the vital role of forests in mitigating climate change by absorbing substantial amounts of CO_2, Guyana is implementing a range of initiatives. These include institutional strengthening for the implementation of REDD+ Partners, enforcing and governing the Guyana-EU Forest Law, implementing the REDD+ Monitoring Reporting & Verification System (MRVS), and establishing a Forest Carbon Partnership Facility.

Table 4.10 provides an overview of the projected LULUCF sector GHG emissions in the WM scenario up to 2035.

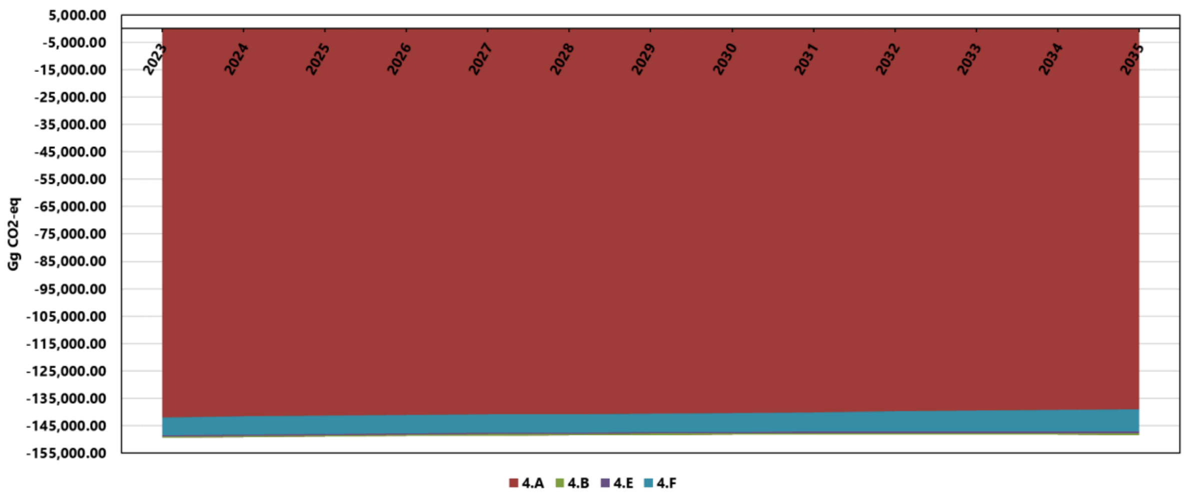


Figure 4.14. Projected LULUCF sector GHG emissions in the WM scenario for the period 2023-2035.

Table 4.10. Projected LULUCF sector GHG emissions in the WM scenario (Gg CO_2eq).

Sector	1990	1995	2000	2005	2010	2015	2020	2022*	2025	2030	2035
4.A	-152,319.30	-152,650.98	-152,982.65	-153,314.33	-153,646.01	-152,606.83	-148,089.19	-148,875.77	-149,003.64	-148,296.44	-148,348.45
4.B	564.80	564.80	564.80	564.80	564.80	940.12	1,125.86	476.21	525.29	544.02	604.36
4.E	320.02	320.02	320.02	320.02	320.02	565.61	376.24	457.89	503.19	548.20	591.19
4.F	7,716.75	7,716.75	7,716.75	7,716.75	7,716.75	7,130.11	6,783.28	5,534.47	6,670.46	6,961.46	8,212.90
Total	-143,717.72	-144,049.40	-144,381.08	-144,712.75	-145,044.43	-143,970.99	-139,803.83	-142,407.20	-141,304.70	-140,242.77	-138,940.00

***** The year 2022 is the reference year for the projections of GHG emissions and removals.

3.3.4. Waste sector

The waste sector contributes a limited proportion of total national GHG emissions, with 444.94 Gg CO_2eq reported in 2022. These emissions are projected to decrease to 427.73 Gg CO_2eq by 2035 (Figure 4.15). This steady evolution of emissions is due to a bifold effect. On one side, an increase in population will lead to more emissions from solid waste management. On the other side, there is a projected reduction attributable to category 4A3, as newly generated municipal solid waste (MSW) is increasingly diverted away from controlled and open dumps for disposal at the Haags Bosch Landfill.

As such, while Guyana has not yet prioritised mitigation PAMs in the waste sector, the country is making significant investments to enhance solid waste management and disposal technologies. This includes the inauguration of the Haags Bosch Sanitary Landfill, the rehabilitation of open dumpsites, and efforts to control illegal and informal waste management techniques. Additionally, Guyana is promoting community-scale composting and recycling initiatives, and there have been substantial achievements in improving sanitation infrastructure.

The primary focus for the waste sector has been on improving sanitation, concentrating on human and environmental health. These efforts have already contributed to a reduction in GHG emissions, and once the waste sector is fully integrated into Guyana's mitigation agenda, further reductions are envisioned.

Table 4.11 provides an overview of the projected waste sector GHG emissions in the WM scenario up to 2035.

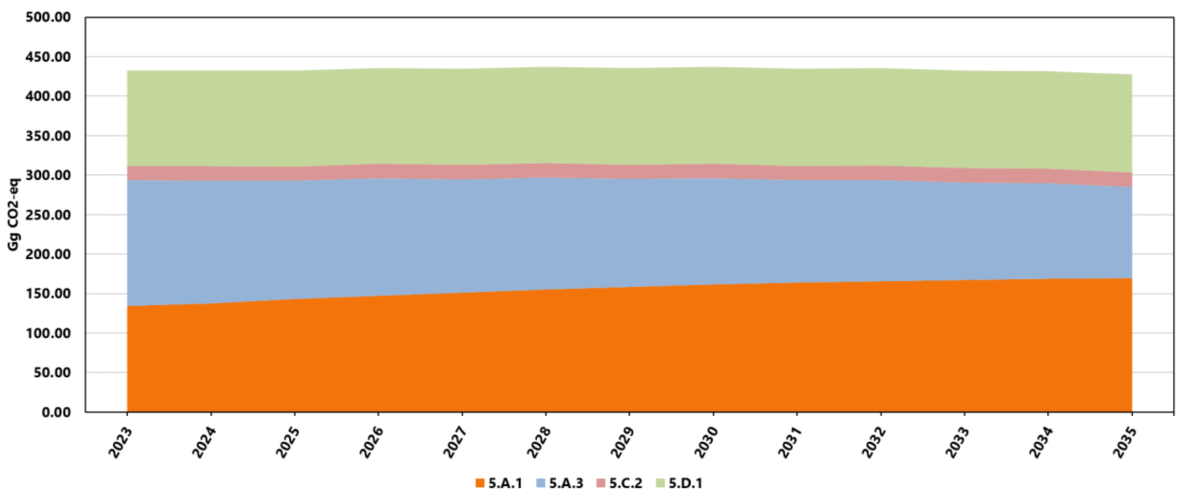


Figure 4.15. Projected waste sector GHG emissions in the WM scenario for the period 2023-2035.

Table 4.11. Projected waste sector GHG emissions in the WM scenario (Gg CO_2eq).

Sector	1990	1995	2000	2005	2010	2015	2020	2022*	2025	2030	2035
5.A.1	0.00	0.00	0.00	0.00	0.00	71.13	128.63	147.73	142.82	161.29	169.34
5.A.3	215.51	216.60	219.33	221.63	221.84	183.23	163.42	159.25	150.08	135.05	116.01
5.C.2	21.72	21.76	21.94	21.88	21.65	17.18	18.12	17.85	18.02	18.18	18.42
5.D.1	113.82	115.19	116.94	114.61	110.41	111.53	118.21	120.12	121.24	122.36	123.97
Total	351.04	353.56	358.21	358.12	353.91	383.06	428.38	444.94	432.16	436.88	427.73

***** The year 2022 is the reference year for the projections of GHG emissions and removals.

3.4. Sensitivity analysis

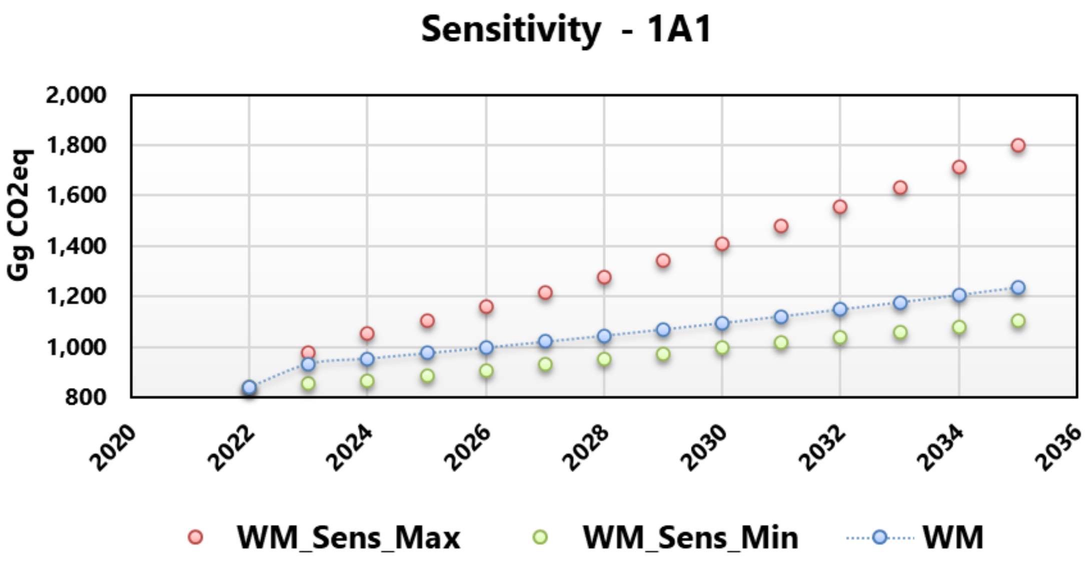
The modelling results are significantly influenced by the assumptions and the chosen modelling framework. For the projections presented in this report, the selected macroeconomic and sectoral framework provides an overarching pathway for the country's socioeconomic development. Consequently, national emission sources and sinks are driven by these factors, along with the historical progression of each time series and its main determinants. In the case of Guyana, the substantial expansion of the oil and gas sector and its likely separation from the aggregated activity levels of other economic sectors highlight the selection of GDP as a primary factor impacting the uncertainty of the estimates. Therefore, a sensitivity analysis has been conducted considering two alternative GDP pathways:

- Maximum GDP: This pathway applies the expansion of the oil and gas sector to all economic sectors.
- Minimum GDP: This pathway assumes zero real GDP growth from 2023 to 2035.

The modelling exercise has been repeated within MITICA using these two alternative GDP pathways instead of the GDP used in the WM scenario. It is important to note that the GDP applied in the WM scenario consists of a GDP series excluding the oil and gas sector, used as one of the proxies added into the models by category, and the GDP series including the oil and gas sector, which is considered only for fugitive emissions (emission sources under category 1.B).

The sensitivity analysis provides a measure of the upper and lower bounds of the estimates based on the GDP assumptions. The sensitivity analysis is developed ceteris paribus, meaning that all other modelling parameters remain unchanged. The results of the sensitivity analysis are described below by the relevant category. Categories unaffected by GDP are not included in this report.

Emission levels in the energy industry and the manufacturing industry are notably affected by the GDP trend, as observed in Figure 4.16.



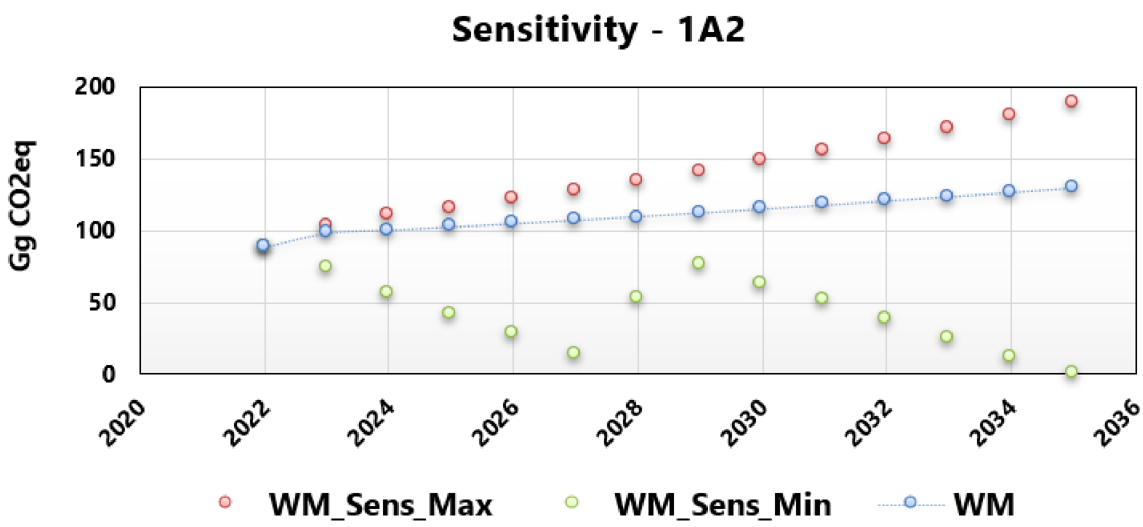
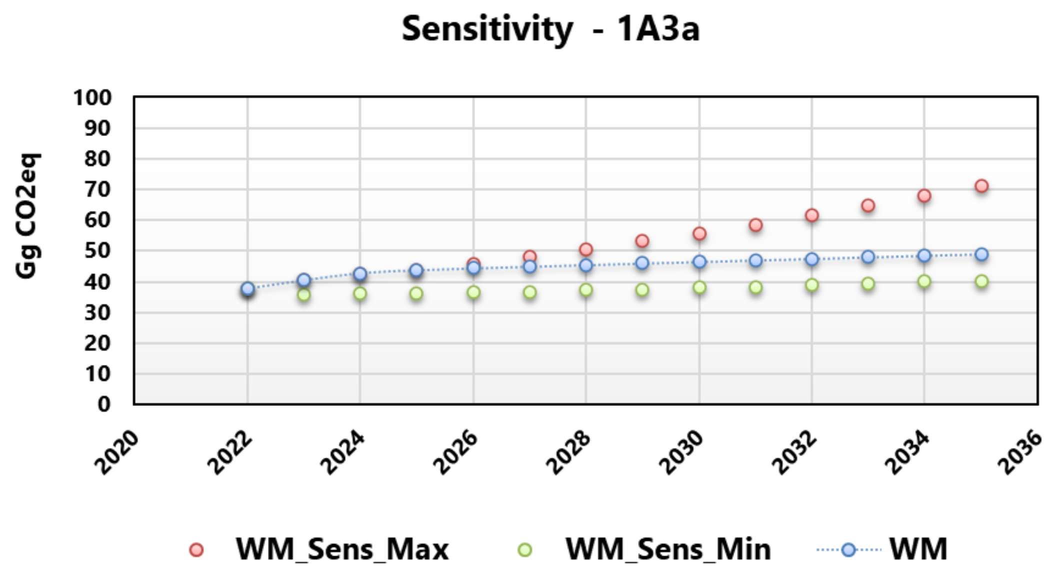


Figure 4.16. Sensitivity results for energy industries (1A1) and Manufacturing industries and construction (1A2).

The emissions from autoproducers of electricity should be reported where they occur and not in category 1A1. However, the inventory of Guyana includes these emissions in this category, which would produce relevant emissions in category 1A1. Considering an expansion in the GDP this adds significant pressure to the activity, reflected in augmented emissions in the category. The lower bound of emissions in this category remain high, as population levels and its associated energy demand is expected to remain steady even with reduced economic growth.

In the case of manufacturing industries, the reference emissions of Guyana are small, and significant changes in this category are not expected in the short term; however, when "forcing" the model to consider an expanded GDP, the emissions would growth from 130 Gg to 189 Gg of CO_2eq by 2035.

In the case of civil aviation, the GDP series considered does not result in significant changes in emissions. The nature of this activity and its evolution suggest that the model accurately captures the characteristics of the emission source, providing evidence of the robustness of the results. Conversely, road transportation is significantly affected by overall GDP when activity levels expand, but not when activity levels remain stable. This indicates an inelastic demand for aggregate land transport in Guyana, reflected in stable emission levels even during periods of economic contraction or stagnation (Figure 17).



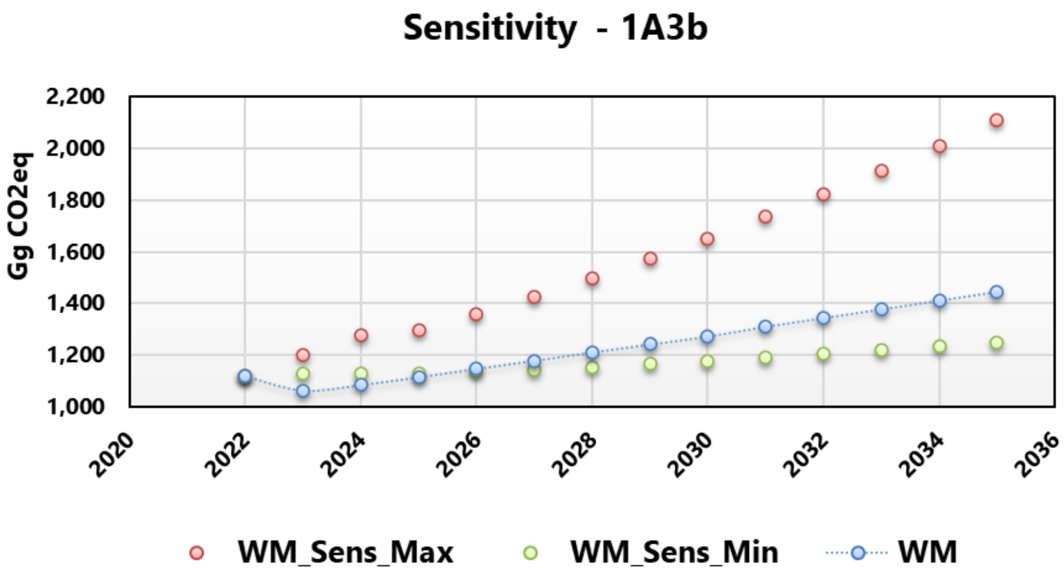
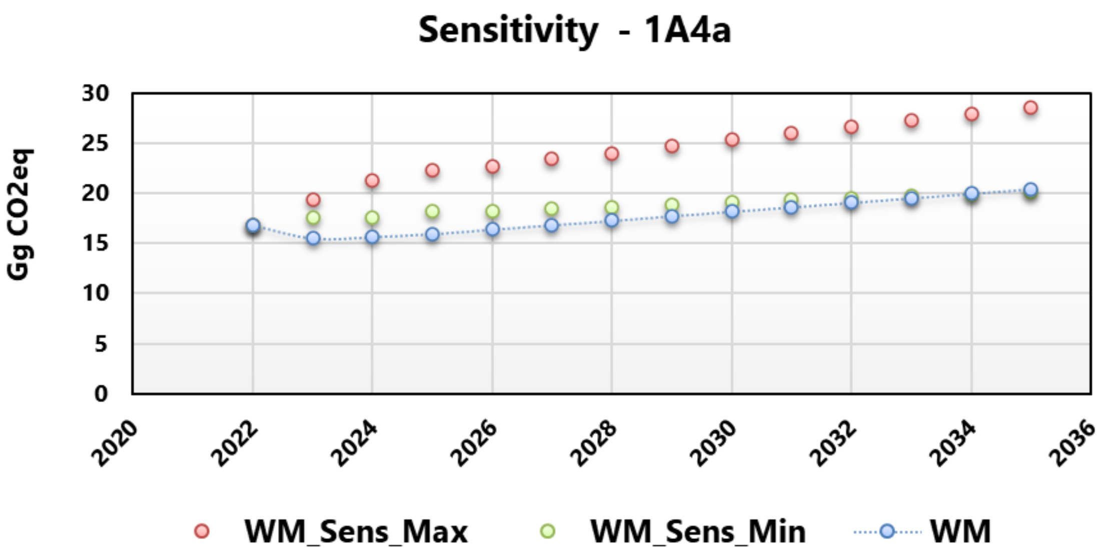
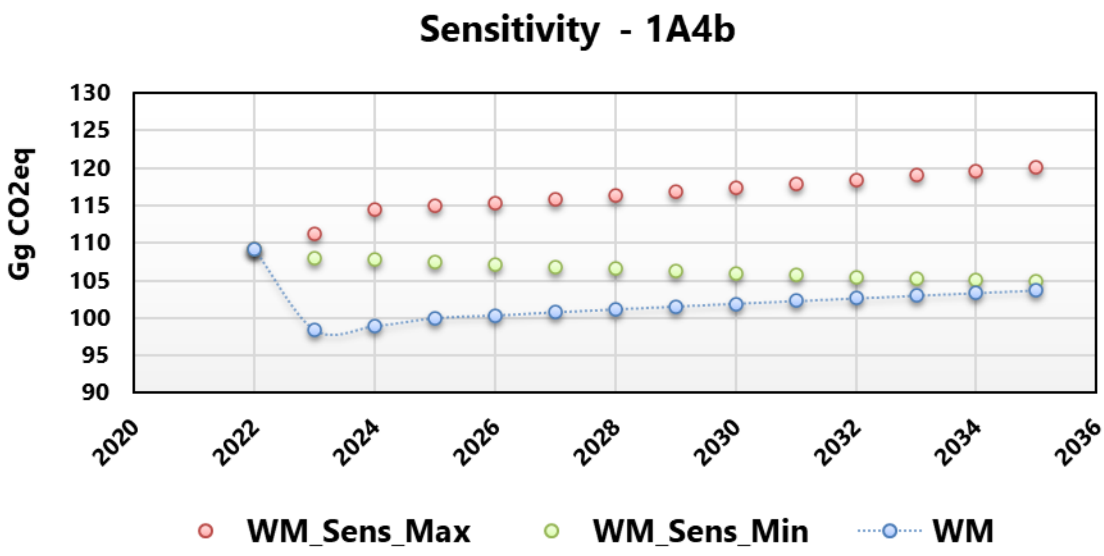
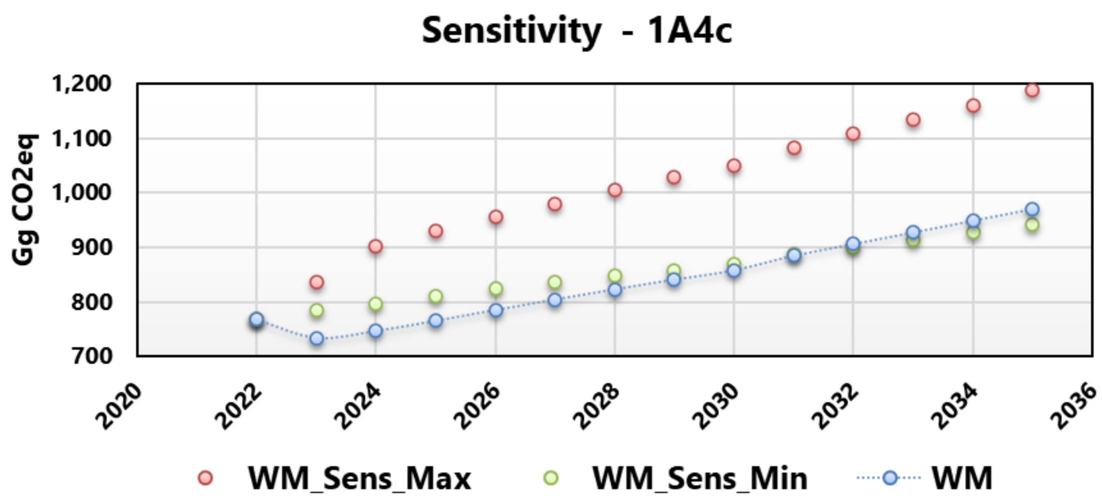


Figure 4.17. Sensitivity results for the transport sectors civil aviation (1A3a) and road transportation (1A3b).

In other sectors, encompassing residential, commercial/institutional, and agriculture/forestry/fishing, the results obtained in the WM scenario are similar to those obtained with a minimum GDP series by 2035. However, if the expansion of the oil and gas sector contributes to the added value of these sectors, emissions will significantly increase in relative terms (Figure 18). This would necessitate further efforts to mitigate GHG emissions in these sectors.







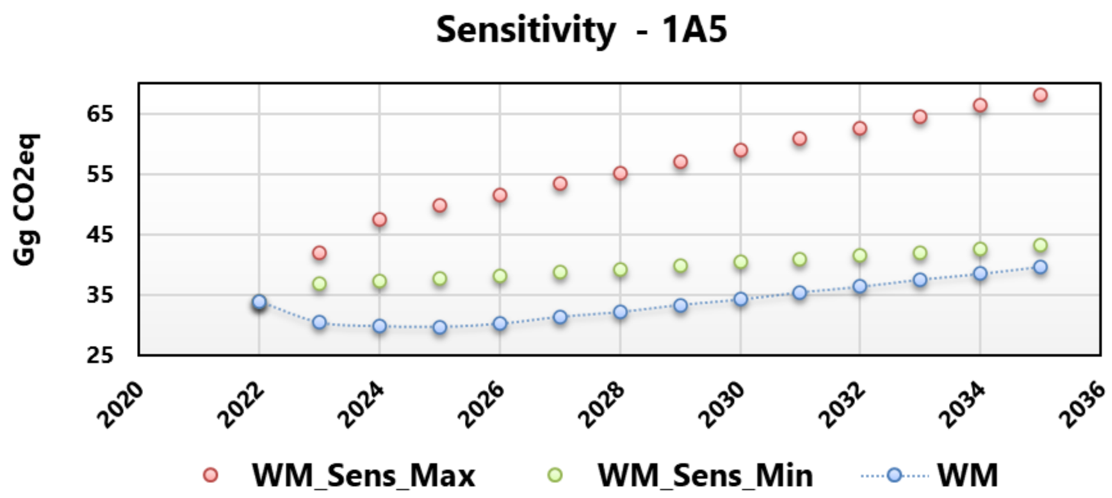
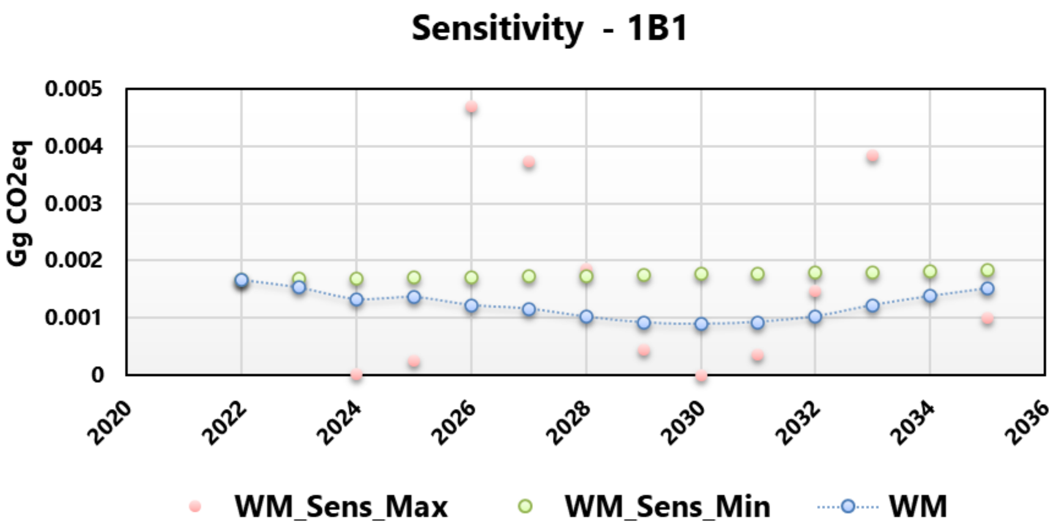
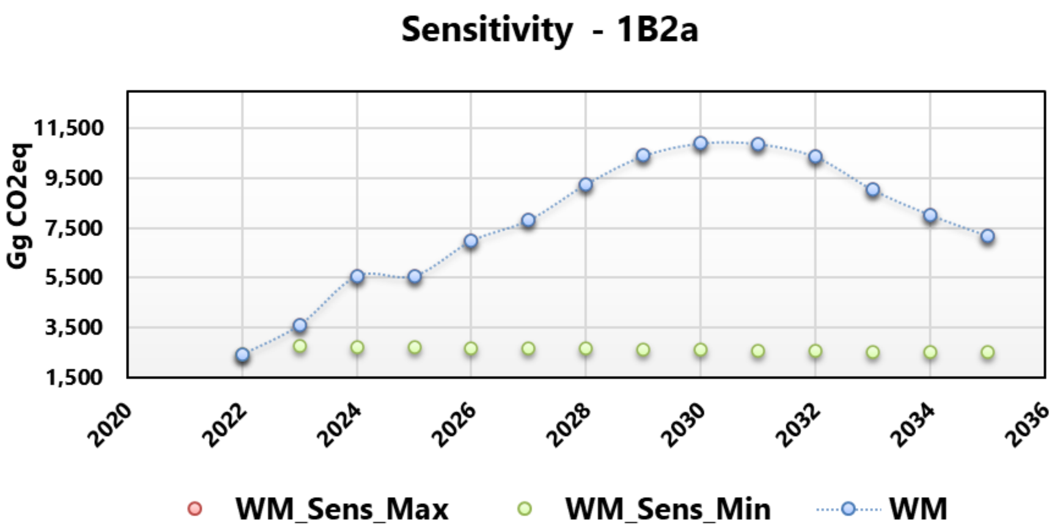


Figure 4.18. Sensitivity results for other sectors (1A4 & 1A5).

In the case of fugitive emissions, using the maximum GDP will yield the same results as the WM scenario for 2035. This is because the total GDP will follow the same trend as the oil and gas industry in the country, leading to similar emissions. Conversely, an unexpected contraction in these activities would result in significant GHG emission reductions (Figure 19).





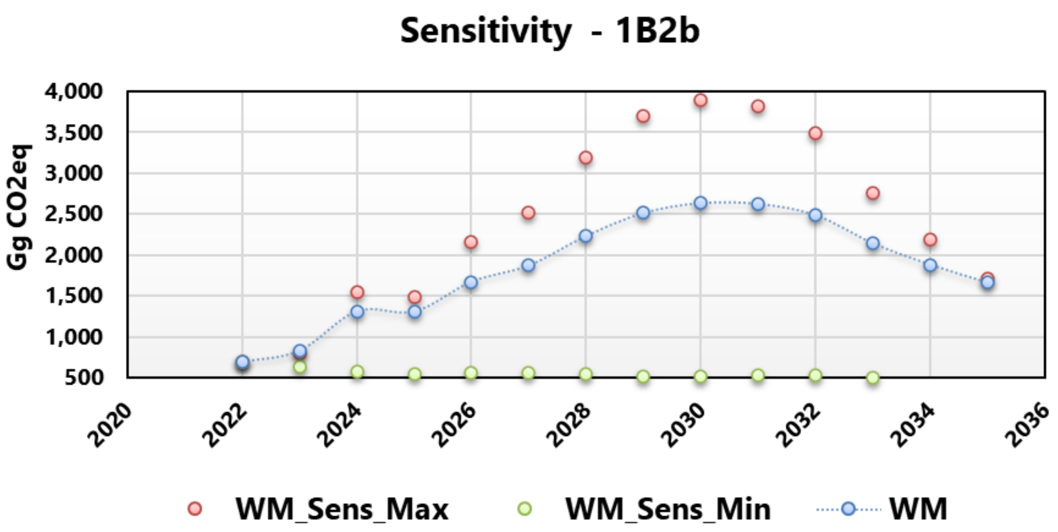
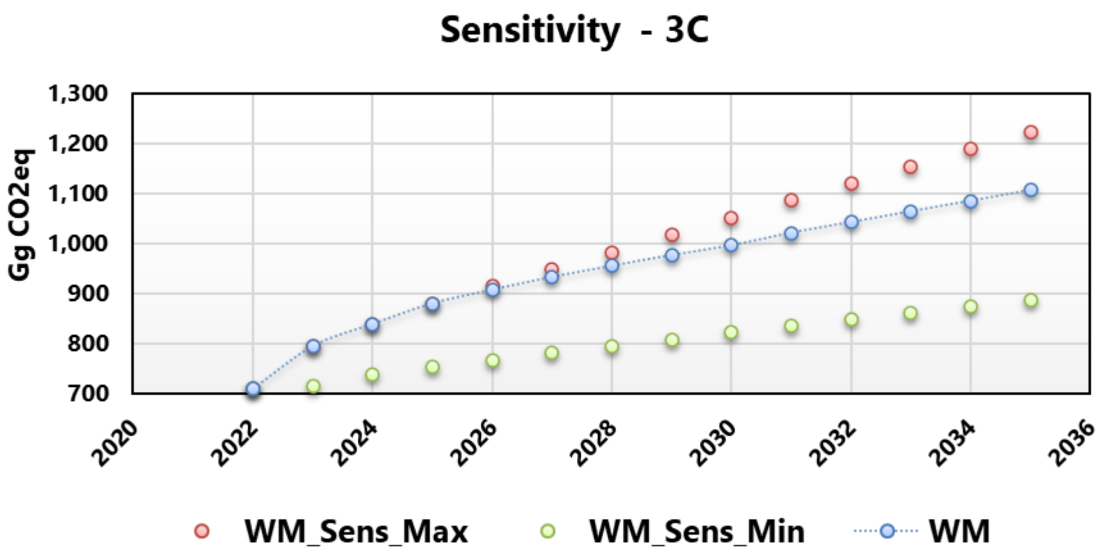
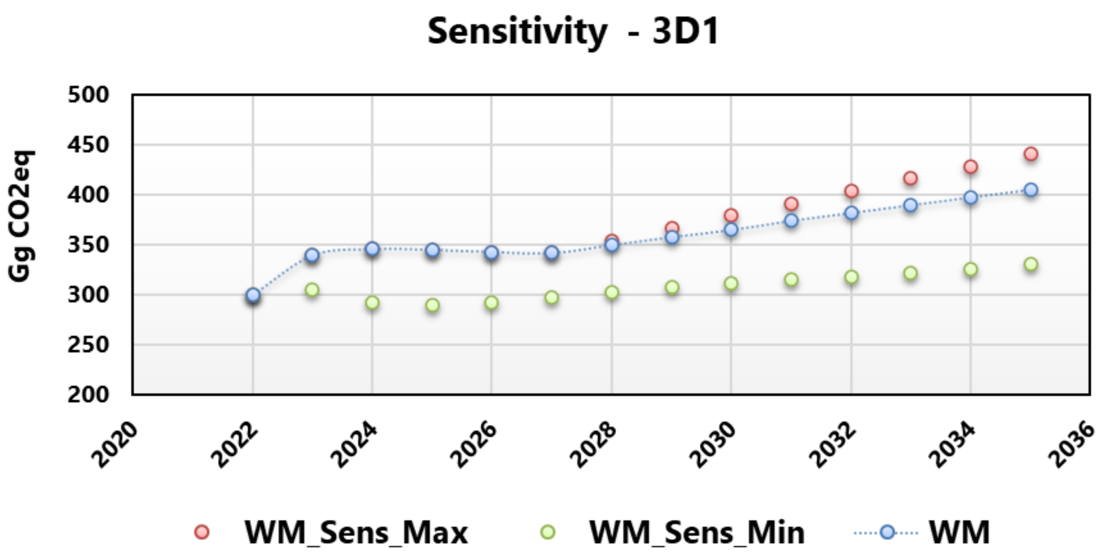


Figure 4.19. Sensitivity results for fugitive emissions (1B1, 1B2a, and 1B2b).

Regarding the emissions from the agriculture, LULUCF, and waste sectors, these are less affected by GDP levels; thus, the sensitivity analysis did not result in significant GHG emission differences, with notable exceptions. The activity levels in agriculture are expected to grow in the future due to government investments in irrigation and drainage. Increases in these areas will lead to augmented emissions in category 3C (rice cultivation) and category 3D (agricultural soils) (Figure 20).





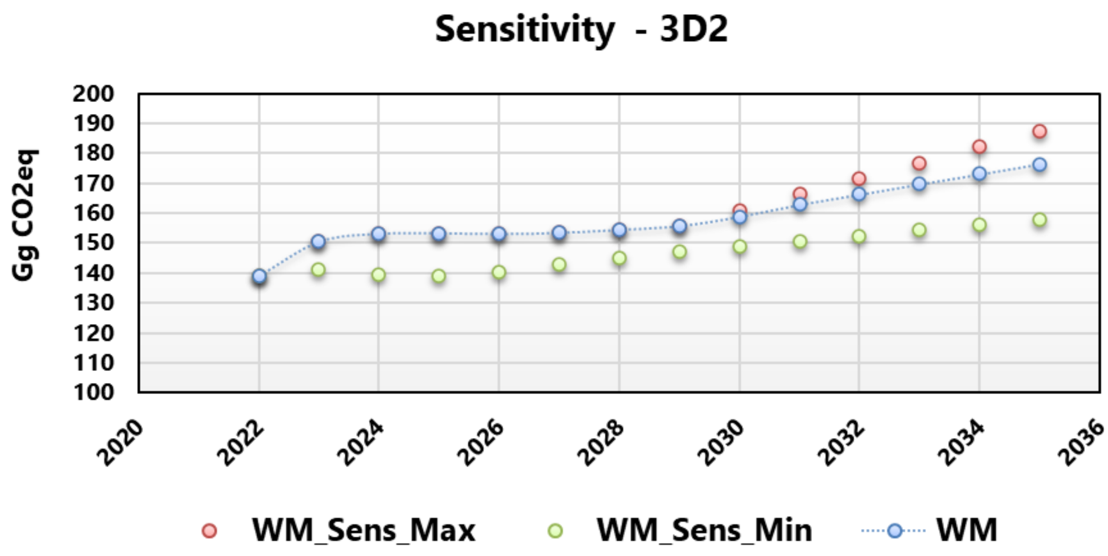
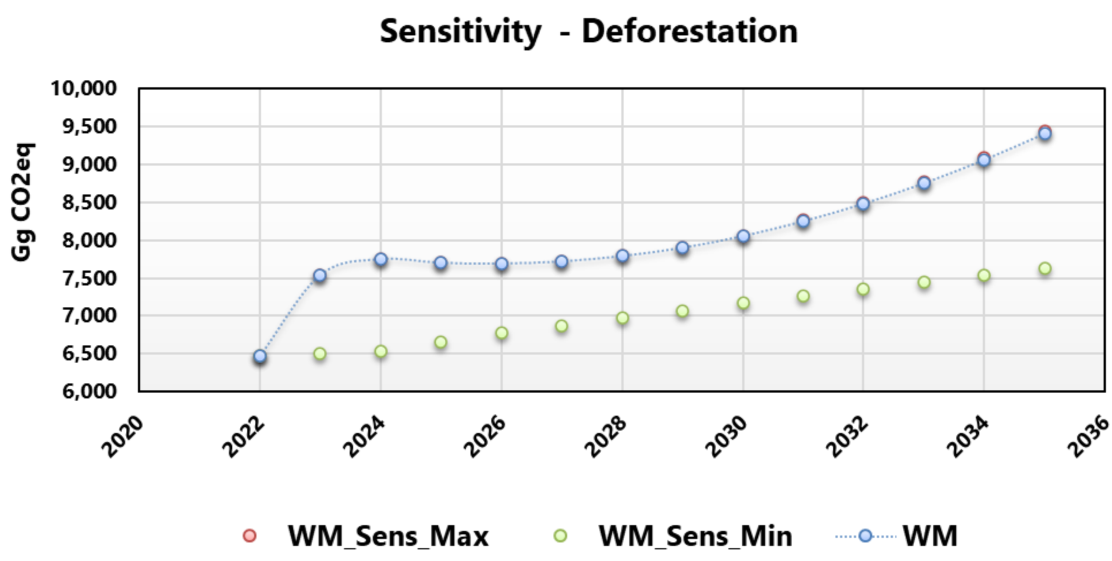


Figure 4.20. Sensitivity results for the agriculture sector, categories 3C Rice cultivation, and 3D agricultural soils.

The expansion of economic activity would also impact the LULUCF sector, resulting in increased emissions from deforestation and reduced carbon removals from forests, as illustrated in Figure 21.



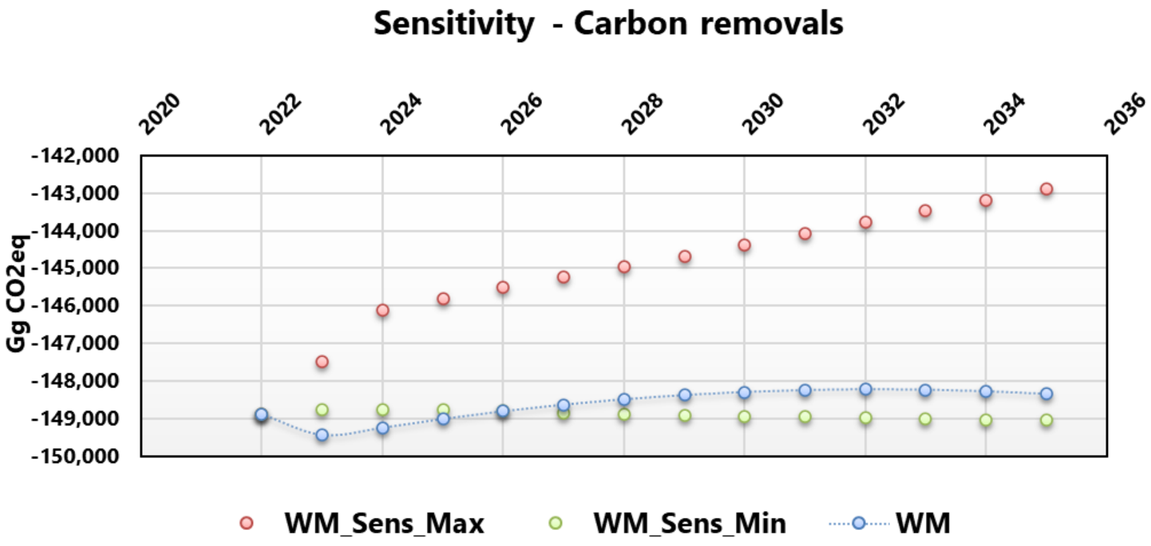


Figure 4.21. Sensitivity results for the LULUCF sector.

In conclusion, the sensitivity analysis highlights the differential impact of GDP pathways on various sectors. While civil aviation emissions remain largely unaffected by changes in GDP, road transportation exhibits significant sensitivity to economic expansion, underscoring the inelastic demand for land transport. Other sectors, such as residential, commercial/institutional, and agriculture/forestry/fishing, show similar emission levels under the WM scenario and a minimum GDP series by 2035. However, if the oil and gas sector's expansion influences these sectors, emissions will rise considerably, necessitating enhanced mitigation efforts. Fugitive emissions align with the WM scenario under a maximum GDP due to the oil and gas industry's dominant influence. In agriculture, LULUCF, and waste sectors, GDP levels have a minimal effect on emissions, except for anticipated increases in agricultural emissions from government investments in irrigation and drainage. Additionally, economic expansion is likely to elevate emissions from deforestation and reduce carbon removals, highlighting the need for sustainable practices to balance development and environmental conservation.

4. Challenges and barriers to mitigation implementation

Over the past decade, Guyana has actively implemented climate change mitigation measures at both the national and regional levels, demonstrating its commitment to contributing to the global goal of transitioning to a low-carbon economy. Despite these efforts, the country has encountered numerous challenges and barriers that impede or delay implementation of these mitigation measures. These challenges span six essential dimensions:

- Technical
- Financial
- Institutional
- Social
- Political
- Regulatory

The following sections explore each of these barriers and challenges, analysing how they hinder the implementation of mitigation measures in the priority energy and forestry sectors.

4.1. Cross-cutting challenges and barriers for mitigation implementation

Guyana faces several cross-cutting challenges and barriers that hinder the implementation of effective mitigation measures. The country has actively assessed and explored these key challenges and barriers through various national processes, including the Technology Needs Assessment (TNA) (Office of Climate Change, 2016), Barrier Analysis and Enabling Framework for Mitigation (Office of Climate Change, 2017), and Technology Action Plan (TAP) for Mitigation (Office of Climate Change, 2018).

4.1.1. Technical

One of the primary technical challenges in Guyana is the lack of advanced technological infrastructure and expertise needed for implementing mitigation measures. The country's energy sector requires technological resources for a large-scale transition to renewable energy sources. For instance, the grid infrastructure is outdated and requires significant upgrades to handle new and renewable energy sources efficiently. Additionally, there is a limited capacity for research and development within the country, which provides challenges for innovation and adapting to new technologies. The shortage of skilled professionals is also a technical barrier.

Moreover, there is a need for capacity and access to tools required for the effective implementation of mitigation strategies. Limited technical capacities hinder the country's ability to adopt and maintain advanced technologies. Furthermore, there is a need for enhanced knowledge of more sustainable technologies to facilitate the adoption of best practices and innovations that could drive the transition. Skill gaps to procure and manage large projects create additional challenges, as effective project management is crucial for the successful implementation of large-scale technologically innovative projects. In addition, there is also need for technical expertise to conduct specific technical assessments, which are essential for identifying the most suitable technologies and strategies for the country's unique context.

4.1.2. Financial

Financial constraints are a barrier to mitigation efforts in Guyana.

The high initial costs associated with advanced technologies pose a major challenge, as does the economic pressure from competing development needs, such as healthcare, education, and infrastructure development. Short pay-back periods required by available financial instruments add another layer of difficulty, as they often do not align with the longer timelines needed for mitigation projects to become profitable.

Moreover, the financial sector in Guyana is not fully developed to support climate change financing, and there are limited financial instruments and incentives available to promote mitigation investments. The lack of private funding or international funding sources further hinders progress, as there are few opportunities for securing the necessary capital. These financial constraints collectively create significant obstacles to advancing mitigation efforts in Guyana.

4.1.3. Institutional

Institutional barriers point to the need for more coordination and capacity among governmental agencies responsible for climate change mitigation. Guyana's institutional framework often faces challenges in human resources. This impacts the effective planning and execution of mitigation strategies. There is also a need for improved data collection and management systems to inform policy decisions accurately. The existing institutional arrangements could better enable efficient collaboration between public and private sectors, which is crucial for the success of large-scale mitigation projects.

4.1.4. Social

Social aspects needing further attention include public education campaigns to foster a greater understanding of the importance of mitigation measures. This should be aimed at building awareness of the importance for climate change mitigation which will impact the adoption of sustainable practices and will help to build cognizance of the potential economic benefits alongside climate change ones.

Socio-economic factors may impact community participation in mitigation efforts. communities, particularly in rural areas, may prioritise immediate economic needs over long-term environmental sustainability. Cultural attitudes and traditional practices can sometimes conflict with modern mitigation approaches, necessitating tailored strategies that respect local contexts while promoting sustainability.

There is also need for an enabling mechanism to foster education and engagement on climate issues, especially in remote areas, which would require sufficient resource allocation. To adequately address these social challenges, it would be necessary to foster a national effort to address both immediate socioeconomic needs and long-standing cultural practices.

4.1.5. Political

Politically, matters relating to governance and policy continuity are crucial to climate programmes. This should take cognizance of policy continuity following changes in government and developing mechanisms to continue implementation whilst policies align following changes in political landscapes. Political will and commitment to climate change mitigation can be influenced by needing to align policies with national interests, such as economic development and resource exploitation. Effective management of these areas are essential to achieving set environmental objectives and attaining economic gains.

4.1.6. Regulatory

Regulatory considerations in Guyana pertain to addressing legislative updating related to climate change mitigation efforts. Land-use policies and advancing efforts to further strengthen the management of natural resources is also another area for continued work. This would require adequate resourcing to enable resource management planning and efforts to mitigate climate change impacts.

4.2. Sectoral challenges and barriers for mitigation implementation

The challenges and barriers across these six dimensions influence the priority mitigation sectors of Guyana, namely the energy and forestry sectors. The following sections explore how these challenges and barriers specifically impact the implementation of mitigation measures in these sectors.

4.2.1. Energy sector

The energy sector in Guyana faces some challenges in mitigation implementation. In the transition to renewable energy sources, the sector at present is reliant on fossil fuels, primarily due to existing infrastructure and technological factors. The grid infrastructure requires upgrades to integrate renewable energy sources efficiently. There is also need for more technical expertise and capacity to manage and maintain renewable energy projects. Financial resourcing is also required to foster the development of renewable energy infrastructure.

4.2.2. Forestry sector

In the forestry sector, Guyana faces unique challenges related to continued capacity building in new and emerging areas of technical implementation. Institutional capacity on forestry regulations needs to be continually strengthened to ensure effective implementation of mitigation efforts. At the local level, socio-economic pressures, including economic demands and land management factors, make continued engagement with stakeholders on governance matters necessary. Addressing these barriers requires continuous capacity building which is often times resource intensive.

5. Support mechanisms for effective mitigation implementation

Different support mechanisms are essential for the successful implementation of mitigation efforts in Guyana. These may include policy backing, capacity enhancement, technical aid, financial mechanisms, and international collaboration to aid Guyana's activities in climate change mitigation.

5.1. Policy and regulatory

Effective policy frameworks are crucial to support mitigation efforts in Guyana. This involves aligning sector level policies with national targets, timelines, and responsibilities for mitigation actions, such as those laid out in the LCDS 2030. Integrating climate considerations into sectoral policies, such as energy and forestry, is vital. Moreover, creating incentives and regulations can promote sustainable practices and discourage high-carbon activities.

5.2. Financial and institutional

Financial and institutional support mechanisms are essential to overcome financial barriers and enhance governance structures. A significant amount of international effort is required to advance this objective. This includes establishing financing instruments tailored to support low-carbon projects. Enhancing public-private partnerships encourages collaboration between government entities, private sectors, and international donors to mobilise investments for mitigation projects. Strengthening institutional capacities within governmental and non-governmental institutions is crucial to effectively manage and oversee climate finance, ensuring transparency and accountability.

5.3. Capacity building and technical assistance

Capacity building and technical assistance play a vital role in equipping stakeholders with the skills and knowledge needed for effective mitigation actions. This involves providing training programmes and workshops to enhance technical skills in areas such as renewable energy technologies and sustainable land management. Offering technical support services, including expert advice and knowledge sharing, supports the implementation and monitoring of mitigation projects. Facilitating knowledge exchange and collaboration with international experts and institutions fosters innovation and best practices in climate change mitigation.

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5 Other Information

1. Introduction

Following the guidance of the United Nations Framework Convention on Climate Change´s (UNFCCC) **Decision 17/CP.8 Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention** this chapter aims to share relevant information on the considerations given to climate change in social, economic, and environmental policies and actions in Guyana. To accomplish this, the chapter is divided into six sections that highlight the integration of climate change into policies and actions in the Co-Operative Republic of Guyana, demonstrating a strong commitment to Article 4, paragraph 1(f) of the Convention, which calls for countries to "take climate change considerations into account, to the extent feasible, in their relevant social, economic, and environmental policies and actions, and employ appropriate methods [...] formulated and determined nationally, with a view to minimising adverse effects on the economy, on public health and on the quality of the environment, of projects or measures undertaken by them to mitigate or adapt to climate change" (UNFCCC, 1992).

The chapter is divided as follows:

1. **Transfer of Technologies in Priority Sectors**.
2. **Research and Systematic Observation**.
3. **Capacity-Building**.
4. **Information and Networking**.
5. **Education, Training, and Public Awareness**.
6. **Main Challenges and Recommendations**.

Transfer of Technologies in Priority Sectors offers details on initiatives that involve the transfer and access to environmentally sound technologies and know-how, also including efforts to grow and strengthen local capacities and technologies, and a review of the barriers affecting the uptake of these technologies. **Research and Systematic Observation** provides information on climate change research and systematic observation such as activities of research networks and observing systems, and programmes with measures to mitigate and adapt to climate change. **Capacity-Building** covers an overview of existing capacities, but also identifies capacity-building activities and priorities for improving skills and knowledge, and mainstream climate change into planning processes. **Information and Networking** discusses Guyana's engagement with networks for the sharing of information. **Education, Training and Public Awareness** contains information on activities relating to climate change education, training, and public awareness. **Main Challenges and Recommendations** reviews the main challenges identified in each section and shares recommendations to overcome them.

2. Transfer of technologies in priority sectors

The UNFCCC's Article 4.5 identifies technology transfer as one of the important means by which climate change mitigation and adaptation could be addressed, and thereby requires the developed countries to promote, facilitate and finance the transfer of, or access to, appropriate technologies and know-how in developing countries. In this section, the transfer of technologies for priority sectors will be discussed drawing inspiration from Guyana's Technology Needs Assessment (TNA), which was a UNFCCC-supported process and was adopted using a multi-criteria analysis and a logical problem analysis.

2.1. Energy

In Guyana, the TNA process has clearly identified the need for a transition in favour of renewable energy sources, urging greater efforts for the growing in importance of solar, wind, hydropower, and biomass. This energy transition requires technology development and to this effect, initiatives have been devised, such as the Low Carbon Development Strategy (LCDS), which integrates actions for clean energy. Technologies being considered for energy are evaluated on three criteria:

1. **Technical Potential**: the technology's potential to be successfully implemented to meet required needs, considering national circumstances (technical skills, knowledge, and available resources).
2. **Climate Resilience**: whether the technology of interest advances climate resilience, and to what degree.
3. **National Development Priority**: the extent to which the technology in question is aligned with national development priorities and strategies.

In the energy sector, three technologies were highlighted:

1. The development of solar farms.
2. Hydropower plants.
3. Standalone windfarms.

These technologies were highlighted by the TNA because of their potential to service urban centres and supply Guyana's national grid. To advance towards the integration of these technologies in the energy sector, proposed actions for Technology Action Plans (TAPs) have been devised, these include:

- Integrating energy policy into broader national development frameworks.
- Plan and carry out education and awareness campaigns and develop learning programmes.
- Facilitate incentives to encourage investments.
- Develop capacity-building activities to train national staff.
- Encourage research to establish baselines and find improvements.
- Continuously update energy infrastructure.

In 2012, the Government of Guyana signed a Memorandum of Understanding (MoU) with Brazil for the establishment of a working group that would conduct feasibility studies for the development of hydropower projects in some specific locations in Guyana. This was to provide a renewable energy source intended for export to Brazil and also for that nation's industrial development. The location considered included the Upper and Middle Mazaruni area, revitalisation of the Amaila Falls Hydro-project, and rehabilitation of the Moco-Moco and the Tumatumari hydropower stations. Since then, the Amaila Falls project has been paused and is currently in a re-tendering process, the Hosororo project has been completed, and Moco-Moco hydropower station is expected to be completed by 2025. The government's overall goal is to develop an energy mix as set out in the LCDS 2030 (Government of Guyana, 2022).

2.2. Agriculture

Crops and grazing areas are expected to be negatively affected by climate change, with a significant negative potential impact being the reduction of agricultural production, driven in large measure from more frequently occurring drought like conditions. At present climate change has highlighted the value of integrating effective irrigation systems and other technologies as the need to adequately manage climate change becomes ever more important considering unpredictable and extreme climate conditions.

Guyana's LCDS has among its objectives to promote investments in agriculture subsectors with high potential for production and low emissions like fruits and vegetables. To attain the objectives of the LCDS, it is necessary for Guyana to continue counting on support for the transfer of technology and technical skills. Doing this requires the implementation of policies that facilitate the access to sustainable agriculture practices and to new technologies that contribute to a more resilient agriculture sector.

Since 2013, Guyana has been promoting the adoption of new agricultural systems and practices with the potential to facilitate adaptation to climate change. This development corresponds to increasing awareness of the risks associated to climate change, and the impacts that extreme weather events can bring to the agriculture sector, and the domino effect this could have on livelihoods, food security, and human health. Some of these systems that have been explored in Guyana are: (Office of Climate Change, 2016)

- **Protected seedling production**: the use of structures to protect plants from potential damages such as those arising from storms.
- **Shaded cultivation (inclusive of hydroponics)**: this smart agriculture technique has multiple benefits; the implementation of this technique in Guyana has shown its potential to protect crops from high precipitation by offering protection from flooding, preserving soil by preventing soil compaction, avoiding losses caused by lack of oxygen available for roots, and reducing the likelihood of diseases affecting crops, therefore contributing to productivity in the agriculture sector.
- **Drip irrigation systems**: this technology has been growing in relevance because of the increase in temperature caused by climate change, which in turn increases evapotranspiration and demand for water in the agriculture sector. Given how various agriculture regions in the country depend on natural rainfall for their crops, irrigation technology has increased in importance for its role in providing water supply to crops. The implementation of efficient irrigation systems is a key strategy for the agriculture sector in Guyana, as it allows for better management of water supply and improves the adaptation of agriculture to drought.
- **Fertigation**: this technology involves applying fertiliser directly with the water of a micro-irrigation system to the roots of the plants with the use of injectors.

Guyana also has ample experience in freshwater harvesting for its use in irrigation. For example, the East Demerara Water Conservancy (EDWC) is one of the most important water conservancy systems in the country. The use of impoldering technology for the damming of catchment areas and capture of overflows of excess water in Guyana allows for water storage from extreme precipitation, which reduces the damages from flooding. This water storage facilitates adaptation in the agriculture sector by providing water for crops, livestock, and inland fisheries, which offers protection against food insecurity and forced population displacement.

Supporting farmers in the use of new technologies remains a top priority, as their use can improve resilience towards climate change through improved efficiency and better crop management. For example, the transfer of technologies like newer and more efficient irrigation systems can significantly improve the effective use of scarce hydrological resources. Transferring new technology to farmers and assisting in their implementation will better prepare them for climate risks, simultaneously promoting adaptive and sustainable agriculture that is more capable to manage climate variations and extreme impacts more effectively (Ministry of Agriculture, 2021).

A guiding force in the elaboration of priority technologies for agriculture was the National Strategy for Agriculture 2013-2020 which identified priority areas for technology development. Other important initiatives for the identification of technology needs and that signal a commitment to strengthen capacities in the agriculture sector in Guyana include:

- The Food and Nutrition Security Strategy (2011-2020), which focused on improving the agriculture productivity of rural farmers and promote healthier diets.
- The Grow More campaign, promoting agricultural diversification, investing in development programmes for agriculture development, enhancement of drainage and irrigation, and training programmes for management aimed at farmers.

The priority technologies selected in Guyana for the agriculture sector as part of the TNA are shown in Table 5.1 with the rank and weighted score assigned (Office of Climate Change, 2016).

Table 5.1. Rank of technologies selected in Guyana for the agriculture sector.

Rank	Technology	Score
1	Freshwater Harvesting	85
2	Agro meteorology for forecasting and Early Warning Systems	75.3
3	Varietal Development of Saline Tolerant Crops	30.8
4	Composting	20.0

Source: TNA Adaptation Final Report, 2016.

The criteria employed for the assessment of the most appropriate technologies for future development in Guyana focused on three main categories: cost, adaptation benefits, and development benefits (Table 5.2).

Table 5.2. Criteria per technology category in Guyana.

Category	Criteria
Cost	Implementation Cost
	Operation & Maintenance Cost
Adaptation Benefits	Role in promoting food and nutrition security
	Associated loss of crops & livestock reductions
	Benefits to the response to weather variability
	Improvements to farm management (benefitting soil fertility, and reducing pesticide use)
	Contribution to crop and livestock yields
	Strengthening of agrobiodiversity
Development Benefits	Potential to enhance livelihood security
	Attracting investments
	Increasing incomes

Source: TNA Adaptation Final Report, 2016.

A number of technologies were considered for prioritisation as part of the TNA, but ultimately not selected as viable options for the following reasons:

- The technology was not considered an urgent priority in Guyana.
- The technology had already achieved a sufficient level of development.
- Sufficient programmes and measures had been enacted or were well under way.
- There was an overlap with other technologies.
- Limitations in regard to the technical potential of the technology.

Table 5.3 provides the full prioritisation of technologies list (the four shortlisted technologies for agriculture are highlighted).

Table 5.3. Technology list with comments.

Technology Category	Specific Technology	Comments
Crop Management	Integrated Pest Management	Not an urgent priority
	Crop Diversification	Overlap with Varietal Development
	Flood Resistant Crops	Overlap with Varietal Development
	Varietal Development (flood, drought, salinity)	Revised into **Varietal Development of Saline Tolerant Crops**
	Seed and Grain Storage	National plans already ongoing

Technology Category	Specific Technology	Comments
Fisheries Management	Aquaculture	Already well developed and included in sectoral strategy
Livestock Management	Selective Livestock breeding	Breeding programmes already underway
	Pasture Restoration	Considered as having a limited technical potential and therefore not a priority
Farming Systems	Agro forestry	Not a priority
	Integrated Mixed Farming	Not a priority
	Shade house / Greenhouse	Already introduced and gaining popularity
	Aquaponics	Low technical potential
	Hydroponics	Low technical potential
Sustainable Water Use	Micro-irrigations (drip / sprinkler)	Technology already available
	Freshwater Harvesting for Inland Regions: Impoldering of Water Collection Areas, Drip & Sprinkler Irrigation	Requiring infrastructure development with a focus on impoldering.
	Rainwater Harvesting	Technology already available
Sustainable Waste Management	**Composting of Agriculture Solid Waste (Livestock and Crop)**	Good potential
	Integrated Nutrient Management (Organic and Inorganic)	Not urgently needed
Planning for Climate Variability	**Agro-meteorological System for Forecasting and Early Warning**	Good potential
	Extension System to Promote Green Technologies in Agriculture	Not considered an urgent need
	Agriculture Insurance	Environment not conducive

Source: TNA Adaptation Final Report, 2016.

Agrometeorology

The TNA identified areas of interest for the transfer of technology. For instance, limited capacities were identified in the use of agro-climatic data to help plan and manage crops. A better use of this technology can help measure the degree of soil moisture to improve water management or provide forecasts for timely decision-making, improving networking and communication channels to help with risk assessments and planning. Continued efforts in this area will enable farmers to have access to detailed information and projections and is therefore an area in which Guyana will require sustained support.

Freshwater Harvesting

Water harvesting technologies considered as relevant for Guyana include:

- Hillside runoff / conduit systems.
- Large semi-circular or trapezoidal bunds (earth or stone).
- Road runoff systems.
- Groundwater dams (sub-surface, sand, and percolation dams).
- Above or below-ground tanks (cisterns).
- Horizontal and injection wells.

Varietal Development of Saline Tolerant Crops

The development of technologies that assist in the development of saline tolerant crops and their implementation in Guyana are considered as valuable tools for sustainable development in Guyana. Climate change can increase salinity, resulting in negative effects for yields in agriculture, and for this reason the development of stronger varieties can improve resistance to stresses like saltwater intrusion caused by sea-level rise. Strategies to improve tolerance to salinity identified in Guyana's TNA consist of:

- Selection for yield, mutation, and breeding.
- Screening within phenotype.
- Introducing germplasm from wild species.
- Rejuvenation of germplasm lines.
- Maintaining genetic purity of commercial varieties
- Production of sufficient quantity of seeds of high genetic purity.
- Hybridisation as a means of creating variability for increased yield potential, salt tolerance, and submergence tolerance.

Composting

Climate change gives rise to changes in temperature and other conditions like high levels of precipitation, an increase in sea-level, storm surges, and drought that might affect the quality of the soil employed in agriculture by increasing erosion and diminishing crop yield outcomes. Given the importance of having quality soils for successful climate change adaptation, composting is a valuable practice for Guyana. Composting is a technology with the potential to significantly contribute to improving soil quality in Guyana by reducing the need for inorganic fertilizers, preventing water pollution, and has mitigation co-benefits as it helps reduce nitrous oxide and methane emissions. Furthermore, composting allows for a better management of livestock waste, contributing to a sustainable management of resources and a reduction in pressure to natural ecosystems (Office of Climate Change, 2016).

2.3. Water

Existing technologies

Guyana has had experience with various technologies applicable to the water sector in the country, most notably rainwater harvesting, conservancies development, and drainage and irrigation.

Rainwater harvesting has been successfully popularised through the use of storage tanks and has become an important source of drinking water, especially in rural areas. However, this technology faces challenges such as limitations with tank sizes, the high costs of large-volume storage options, and water shortages resulting from drought-like conditions.

Conservancies, which are low-depth reservoirs connected to water flows, offer water supply and a degree of flood control. This technology, however, is threatened by sea-level rise, changes in rainfall, and infrastructure damages from extreme climate events. Repairing these systems can be costly, as evidenced by the estimated USD 200-300 million needed to repair the EDWC.

Drainage and irrigation have been present in Guyana for a long time, but many of the systems are over 100 years old and have not been maintained adequately. One of the main threats to these systems is sea level rise, which allows more saltwater to enter with the high tides, further stressing the already aging infrastructure.

Technologies needed

The TNA process set out to identify the best technologies to contribute to sustainable development against climate change while keeping Guyana's national circumstances such as present vulnerabilities in mind. For this reason, it has been noted that knowledge gaps remain regarding Guyana's coastal and interior aquifer systems. As population (and therefore water demand) increases, a better understanding of the aquifer systems and the pressures they are facing such as water mining, salt intrusion, and mining damage, is needed in order to devise preparations for the future. Drought conditions also threaten both ground and surface water availability. Considering this situation, the following technologies have been considered for transfer into and development in Guyana:

1. Groundwater mapping and modelling.
2. Surface water mapping and modelling.
3. Geographic Information System (GIS) mapping and modelling for water catchment protection.

The selection of these technologies considered their application potential considering existing skills and necessary resources, the potential the technologies have to facilitate adaptation to climate change, and the alignment of the technologies with national strategies. In Guyana, a strong development of these technologies can facilitate an integrated water management system to address current and future risks more effectively.

Groundwater mapping and modelling is an important technology to help address information gaps by facilitating data collection. The need to better understand the condition of water sources in Guyana has been noted since the late 1990s, however more needs to be done to facilitate the monitoring of hydrological resources to better understand the threats they face and how well they can fulfil the water demand for hydropower and human and agricultural use. This technology requires important resource allocation and the development of technical skills to be used effectively as knowledge is needed for the use of instruments and the application of models. However, given Guyana's exposure to drought conditions that can lead to water deficits, this technology needs to be continuously developed and new instruments and methods be transferred into Guyana due to its potential to facilitate water management.

Similarly, surface water mapping and modelling encompasses remote sensing, image processing and the use of GIS and can make water management easier and help prepare for future conditions through the use of simulations and models.

GIS for water catchment protection is the application of GIS technologies and remote sensing that can provide information on:

- Surface water flows.
- Groundwater flows.
- Runoff rates.
- Rate of flows into river systems.

With GIS for water catchment protection, a better understanding can be obtained on catchment and micro-catchment areas, and buffer zones. This in turn helps prepare safety plans and simplify management by providing timely and accurate data.

2.4. Coastal zones

In March 2021 a **Memorandum of Understanding (MoU) to Support Research and Geospatial Risks** was announced and signed by the University of Guyana, National Aeronautics and Space Administration (NASA), and SERVIR-Amazonia. This MoU was in effect until December 20th, 2023, and was focused on mangrove mapping and monitoring and included training local personnel and disseminating the newest geospatial technologies and satellite imagery techniques. (USAID, 2021).

Mangroves are of special interest in coastal zones as they play an important role in ecosystems, for example contributing to fisheries and biodiversity. Mangroves are capable of this by acting as breeding habitats, refuge zones, and feeding grounds, as they excel at supplying, controlling, and sustaining ecosystems. Additionally, mangroves operate as carbon sinks through their carbon storage capabilities as soil carbon and within mangrove roots, and act as a coastal protection mechanism. However in recent decades, mangroves worldwide have been negatively affected as a result of anthropogenic challenges. Climate change induced seal-level rise and precipitation changes, together with land conversion of coastal zones to agriculture, aquaculture, and human settlements and infrastructure developments driving coastal erosion are major factors in the disruption of mangroves through, for example, changes to soil balance (Chan-Bagot et al., 2024).

Stemming from the recognition of the importance of mangroves, recent mangrove monitoring initiatives have taken place, aiming at integrating synthetic aperture radar (SAR) technology, optical, and machine learning along Guyana's coast (Chan-Bagot et al., 2024). These technologies can help in approximating the area of mangrove extent more precisely as previously inaccessible areas that cannot be accounted for without high added costs become available to be surveyed. In Guyana, this has meant that the National Agricultural Research and Extension Institute (NAREI), which has the responsibility of monitoring mangroves, has been able to employ remote sensing technology since 2018. Under the SERVIR programme of the United States Agency for International Development (USAID) and NASA, NAREI is embracing remote sensing technology like optical synthetic aperture radar and data fusion approaches or random forest models implemented in a cloud computing platform to better carry out its mandate. These technological developments are helping in addressing deficiencies in Guyana's monitoring activities identified in 2010 when mangrove restoration activities began to grow in popularity, and they allow for the compilation of critical information on protected areas such as baselines that help identify areas in need of protective measures from erosion (USAID, 2021).

As part of the Guyana Mangrove Restoration Project, an Information System[10] was developed, consisting of a web application dedicated to monitoring the extent and the change of mangroves in the country. The tool allows the open public to access information in a visual way to find out about gain, loss, the extent of and restored mangrove areas of the country from 2010 until 2020 (Figure 5.1 and Figure 5.2). It is an ongoing project, and it continues being developed. Further layers are planned to be included in it, such as impacts, connectivity, and biodiversity, among others.

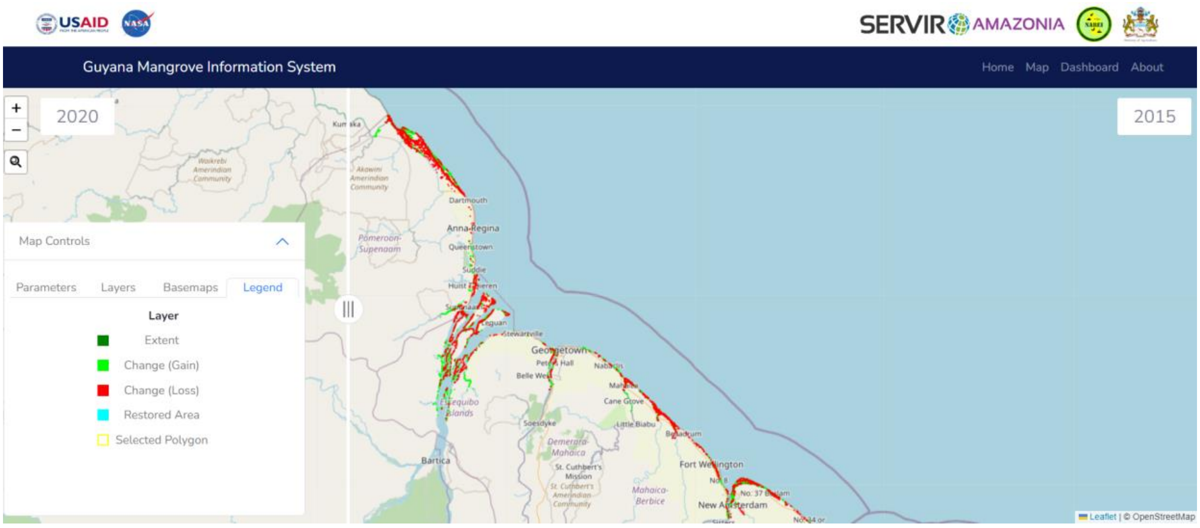

Figure 5.1. Guyana mangrove information system 2015 view on mangrove loss and gain. Source: USAID, 2021. Year 3 Annual Report.

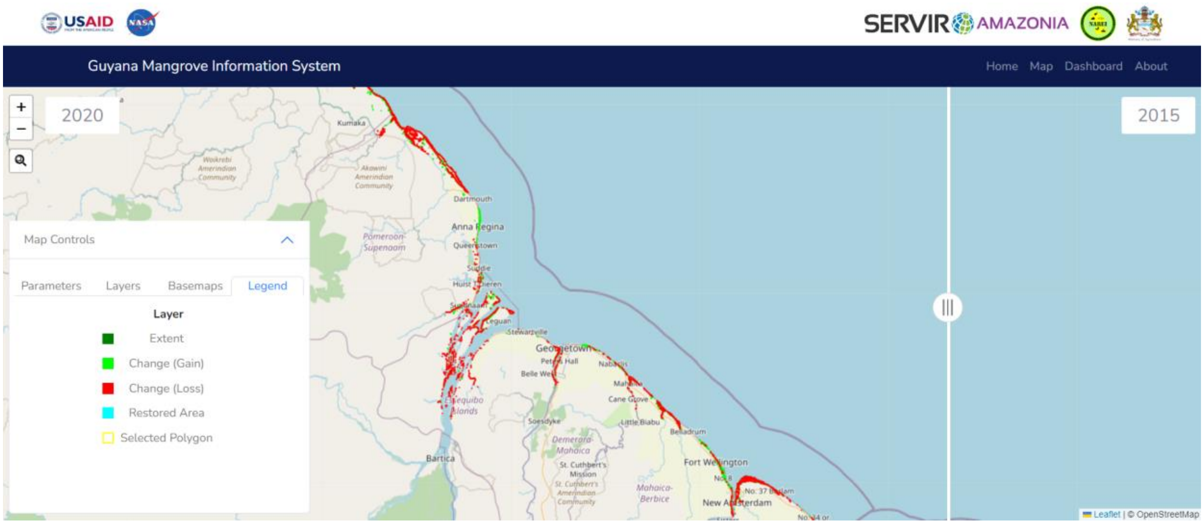

Figure 5.2. Guyana mangrove information system 2020 view on mangrove loss and gain. Source: USAID, 2021. Year 3 Annual Report.

[10] https://guy-mangroves.servirglobal.net/map/

The transfer of these technologies and their successful implementation are key to Guyana's development. The use of the latest technology for the monitoring of mangroves in coastal zones is in line with Guyana's LCDS because of their carbon sink and storage abilities given how estimates suggest that globally mangroves can rectify around 17 metric tonnes of carbon per hectare, per year. In addition, their economic value resulting from ecosystem services and coastal protection make access to technology for coastal and mangrove monitoring a priority.

2.5. Transport

Guyana has identified electric vehicles and more efficient batteries as important technologies for national development due to lower emissions and the increased competitiveness in terms of costs for these vehicles. Support will be needed to electrify transport fleets and set up charging stations that are linked to renewable energy sources.

Electric vehicles, however, depend on transport infrastructure. Guyana has over the years received support from the Inter-American Development Bank to sustainably enhance urban transport and its infrastructure to address an increasing number of vehicles on the road and low efficiency. Relevant projects are presented in Table 5.4.

Table 5.4. Overarching transport strategies.

Overarching Strategies:

1. **Expand capacity**.
2. **Sustainably enhance transportation**.
3. **Improve efficiency of the transport sector.**

Project	Year
Transport Infrastructure Rehabilitation Programme	2006
Road Improvement and Rehabilitation Programme	2009
Support to the Road Improvement and Rehabilitation Programme	2009
East Bank Demerara Four Lane Extension	2010
Support for Road Network Upgrade and Expansion Project	2011
Expansion of Pre-investment Programme for Georgetown-Lethem Highway	2011
Road Network Upgrade and Expansion Programme	2012
Guyana - Brazil Land Transport Link and Deep-Water Port	2013
Support for a National Aviation Master Plan for Guyana	2016

3. Research and systematic observation

The following section covers relevant research relevant to Guyana's sustainable development that have tangible consequences in the country. National efforts to devise, maintain, and strengthen systematic observation. This section will also cover identified weaknesses and gaps in regard to systematic observation efforts, drawing links to the required transfer of technologies and areas in need of national and international support.

3.1. Research

Important research has sprung or is closely related to the MoU signed between the University of Guyana, SERVIR-Amazonia, and NASA in March 2021 to support research to help Guyana manage climate risks. The signing of this MoU represented the conclusion of research and workshop activities by specialist from NASA, and the University of Guyana's scientist belonging to the Faculty of Earth and Environmental Sciences (FEES) and the Centre for Study for Biological Diversity (CSBD), which also included the participation of more than fifteen agencies belonging to the Government of Guyana. The MoU was conceptualised as a means to provide research to aid the University of Guyana in developing academic programmes to increase local capacities and retain knowledge. The university programmes whose development was benefited by the research initiative were:

- Human Resiliency Systems Programme.
- Geosciences Programme.
- Data Sciences Programme.

In line with these developments, and considering the significance of mangroves, a need for additional research to provide the latest information on mangrove cover to discuss changes and provide a strong scientific base for sound judgements to be made, research initiatives have relied on modern mechanisms like Random Forest Machine Learning Algorithm, and satellite technology like Landsat-8 OLI, Sentinel-2, and Sentinel-1 for the surveying of mangrove forests in Guyana. These research tools stand out as they merge optical data with radar data, and their use helped verify mangrove losses, demonstrating that certain areas suffering mangrove losses had not been accounted for (Chan-Bagot et al., 2024). Therefore, this research initiative proved instrumental in the ongoing drive to adequately manage and preserve mangrove forests. Research carried out in this domain is directly related to systematic monitoring projects. For instance, research into improved remote sensing technology allows Guyana's NAREI to conduct systematic monitoring on an annual basis more successfully as better information is available for the process of determining priorities in terms of special protection measures needed, understanding changes in forest cover, managing coastal erosion, and elaborating base measurements to evaluate carbon storage of mangrove forests and potential support measures. The research conducted in this area has undoubtedly helped NAREI in producing datasets that are reliable and facilitate monitoring initiatives, allowing NAREI to provide both monitoring and protection through the selection of appropriate techniques that provide insights on losses and the effectiveness of restoration initiatives.

Guyana has experience in the realm of collaboration for research. In 2013, research was done in high vegetable production regions as part of the project Improving the Nutrition and Health of CARICOM (Caribbean Community) Populations promoted by the Canadian International Food Security Research Fund (CIFSRF), which showed the potential that drip irrigation could have. Research efforts such as these have allowed for the development of a better understanding of the benefits and challenges associated with new technology in Guyana's national context. Furthermore, the experience gained from research projects helps promote the adoption of innovative practices that contribute to adaptation and mitigation of climate change.

Research on saline tolerant crop varieties in Guyana has had a history of focusing on rice and sugar crops. The Guyana Rice Development Board (GRDB) encourages technology transfers for the rice sub-sector and conducts research covering saline, drought, and flood resistant varieties of rice that can continue to provide high yields through their tolerance to salinity, acidity, and other stresses. The Guyana Sugar Corporation (GuySuCo) plays a similar role in the sugar sub-sector. More recent efforts are extending this scope to encompass the development of vegetable crops to promote improvements in diversification/variety, crop quality, and crop yields.

3.2. Systematic observation

This is an area in need of further improvement and support in Guyana. For example, the agriculture sector faces difficulties in access to agro-climatic data, and the lack of this technology prevents better development. In Guyana, the Hydromet Service is the body entrusted with the provision of agrometeorological data and services such as providing weather and climate information to farmers. Information for systematic observation is needed to prepare for and to timely identify climate impacts affecting crops, livestock, fisheries, and human well-being. For instance, a rise in sea surface temperature can alter the migration and reproductive patterns of fish stock, and therefore systematic observation should be in place to be able to monitor temperature changes.

Systematic observation is needed particularly for the water sector as increasing demand and challenging climatic conditions take hold. In this regard the transfer of technologies for water sector such as GIS, remote sensing, and modelling identified in the technology transfer section could assist systematic observation in Guyana, an activity that has been lacking in recent times. Capacities at the National Drainage and Irrigation Authority (NDIA) and Guyana Water

Incorporated (GWI) need to be enhanced, clear responsibilities need to be assigned, and the right technology should be made available to the relevant staff. For systematic observation in the water sector, cooperation is needed between various actors: NDIA, GWI, GuySuCo, Water Users Associations (WUAs), NAREI, and Mahaica, Mahaicony, Abary/Agriculture Development Authority.

The importance of systematic observation has been noted; already in 2017, the use of data provided by the Guyana Forestry Commission (GFC) in order to pilot a Monitoring, Reporting, and Verification (MRV) system. This activity, with the use of past data, allowed the observation of changes over time, highlighting the importance of systematic observation/monitoring. This pilot was the beginning of Guyana's MRV system currently in place, and as a result scientific and technical papers were developed (Table 5.5.), facilitating knowledge retention and institutional memory for systematic observation efforts.

Table 5.5. Scientific and technical papers developed.

Name	Type
Quantifying the trade-off between cost and precision in estimating area of forest loss and degradation using probability sampling in Guyana	Scientific paper
Tree Biomass Equations from Terrestrial LiDAR: A Case Study in Guyana	Scientific paper
Accounting for Greenhouse Gas Emission from Forest Edge Degradation: Gold Mining in Guyana as a Case Study	Scientific paper
Comprehensive Accounting for REDD+ Programmes: A Pragmatic Approach as Exemplified in Guyana	Scientific paper
An Assessment of Global Forest Change Datasets for National Forest Monitoring and Reporting	Scientific paper
Using Guyana's Monitoring Reporting and Verification System to Guide National Forest Management and Decision Making	Technical paper
Interoperability of various data streams within Guyana's MRV System	Technical paper
Object-Based Image Analysis Approach to Determine the Fallow Periods for Shifting Cultivation in Indigenous Communities in Guyana	Technical paper

A review of the MRV system in 2019 determined that staff members had improved their confidence with monitoring systems, that staff members and other stakeholders properly understood the importance of monitoring, and that there are still further opportunities to keep improving the national MRV system. The review highlighted that the MRV system:

1. Remains relevant.
2. Improves effectiveness and efficiency.
3. Encourages sustainability.
4. Facilitates decision-making.

4. Capacity-building

It should be noted that in preparation for the Initial National Communications (INC) and the follow-up Second National Communications (SNC), capacities were built in the country for greenhouse gas (GHG) inventories, wider public education and awareness on climate change, assessments of Guyana's key sectors for vulnerability and mitigation, and assessment of the capacity and technology needs for the key sectors. Additionally, over the years, various other activities have yielded the strengthening of capacities and technologies in early warnings and weather forecasting, improvement in sea defence infrastructures, installation of pumps for drainage and irrigation systems, disaster and disaster risk management, improvement in research into new species and varieties of rice, sugar, other crops, and livestock aimed at increasing agricultural yields (Office of Climate Change, 2016). These capacities need to be continuously strengthened through a coordinated process (Figure 5.3).

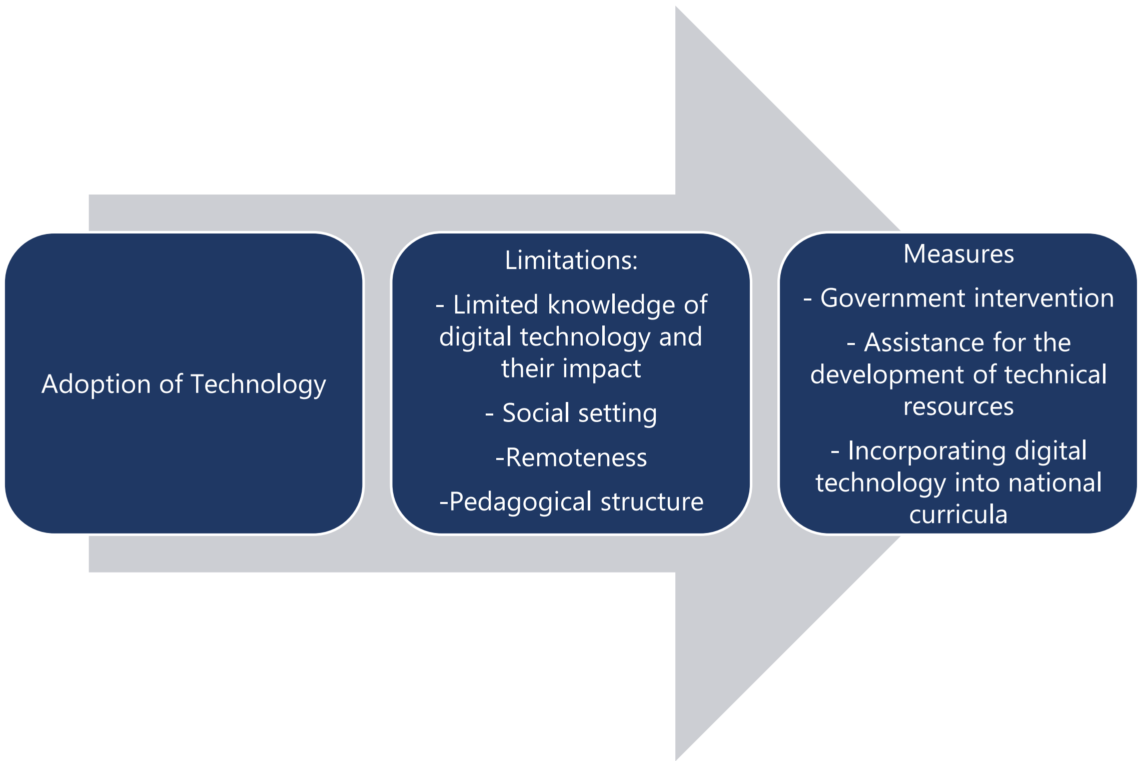

Figure 5.3. Adaptation of technology, limitations and measures.
Source: Elliott, 2020

NAREI, with the assistance of the project Improving the Nutrition and Health of CARICOM Populations under the CIFSRF, carried out a capacity-building initiative to provide farmers with scientific information on irrigation water application rates. This allowed farmers to gain knowledge in regard to the timing of application for secure and sustainable food production.

Different capacity building campaigns were also led by the Mangrove Restoration and Management Department at NAREI, aimed at providing capacity building and at enhancing public understanding of mangroves for the general public, contributing to a sense of shared national responsibility in terms of restoration and protection of the Guyanese coastal ecosystem (Bovell, 2019). For example, in 2023 the Community-Based Mangrove Restoration and Management Training was provided, including several training workshops facilitated by staff members of the Mangrove Restoration and Management Department, from NAREI. These trainings were part of a broader consultancy assignment to increase public awareness activities and to engage with local communities overall to raise awareness and knowledge on the importance of the mangrove forest and coastline conservation and restoration. Specific objectives of the consultancy were:

- Providing participants with a comprehensive understanding of mangrove ecosystems and their importance.
- Introducing community-based approaches to mangrove conservation, management, and restoration.
- Equipping participants with practical skills for sustainable mangrove restoration and management.
- Fostering collaboration and active participation among participants for effective community-based mangrove management.

The two training workshop sessions were held between September and October 2023 and they comprised of two days training consisting of a theoretical session on ecology and mangroves benefits, laws, and policies protecting mangroves and mangrove management enterprises conveyed via group work sessions, brainstorming, presentations and different interactive activities; and a practical session via field trips dedicated to the observation of mangrove ecosystems and mangrove restoration infrastructure along the Essequibo coast conveyed by visiting different sites and undertaking different practical activities on the places such as mangrove seedling planting or construction of geotextile tube groynes.

Some of the recommendations extracted from these sessions highlighted serious concerns regarding the use of mangroves for fishing gears and props for farmers that can be damaging to existing forest. Many of the participants were unaware of alternative wood species and their sources to avoid the use of mangroves. It would be highly advantageous for future workshops to be held in collaboration with the GFC, Private Forest Sector Operator, and the Fisheries Officers.

Furthermore, initiatives for technical capacitation in the use of climate models or capacity building in the assessment and monitoring of climate impacts with the tools have also been developed. For instance, the Caribbean Climate Online Risk and Adaptation Tool (CCORAL) is a tool developed by the Caribbean Community Climate Change Centre (CCCCC) with the objective to provide an online system to increase knowledge and understanding of climate change and its impacts and to facilitate the decision-making process. The tool is open and ready for its use, being usable by those that have limited or no understanding of climate change and its impacts. The targeted audiences are CARICOM government ministries, departments and agencies, but other users include non-governmental organisations (NGOs), universities and research institutions, private sector organisations and development partners.

In line with this type of capacity-building activities, as part of World Wildlife Day 2024, the NGO Policy Forum Guyana engaged in several environmental activities: a wildlife fair was held, they introduced a board game which featured local species for its use as gamification in education and developed a reference book in several indigenous languages to cover the topic of water pollution among freshwater species. Furthermore, a mobile application and digital platform was launched with the name of "LittaReporta" to promote solid waste disposal initiatives and mechanisms among the population. It is an app dedicated to rubbish reporting which aims at solving solid waste disposal issues through a collaborative approach to provide landfill monitoring and to promote cleanup efforts among the relevant authorities and volunteer work. Furthermore, Policy Forum Guyana has partnered with the University of British Columbia to create infographics to inform and inspire conservation actions among population.

Figure 5.4. Litta Reporta's app dashboard.

In addition, several capacity building initiatives and programmes were completed from the National Agricultural Research and Extension Institute, within the Mangrove Restoration and Management Department from 2017 to 2022. A Marine Turtle Conservation and Awareness training session was conducted in 2018 with the Eastern Leguan Secondary School students who attended, followed by a field visit to Okum Beach to participate in activities to determine the type of sea turtles that nest on the island. The Turtle Specialist, the Wildlife Officer, and the Mangrove Ranger facilitated this training to educate students about mangroves as well as the importance of other marine aquatic life so that adjacent communities can appreciate and acknowledge their presence.

Also, in collaboration with the Ministry of Education, Culture, Youth and Sports, the Mangrove Restoration and Management Department conducted a mangrove awareness workshop and session addressed to youth groups in 2017 followed by a second session in 2018. The sessions included presentations to provide information about mangrove forests and the status and community involvement in mangrove restoration on Leguan. Additionally, a field visit was also conducted in Betrowen to observe nature and reflect on its connection to the rest of the world, and several interactive games were incorporated into the session.

An East Coast Victoria Mangrove Action Committee (VMAC) Workshop was held in 2018 where VMAC members were educated on the status of mangrove restoration and management, anthropogenic impacts on mangroves as well as on the review of roles and responsibilities within VMAC members. The outcome of this workshop produced solutions to reduce negative impacts on mangroves as well as the development of a work plan for mangrove awareness and management. Additionally, a VMAC end-of-year workshop was held, focusing on a review of the 2018 community-based activities implementation, and on an analysis of mangrove restoration activities' impacts, prioritising 2019 work programme for a better management of mangroves.

Another series of capacity building sessions were conducted in 2019, addressed at VMAC members on the topic of climate change and the sustainable development goals (SDGs), as part of the community-based mangrove management activities. Village #6, Wellington Park, East Coast VMACs, and rangers benefited from this training that enabled them to better manage and protect mangrove forests while raising awareness on their importance within the context of climate change and SDGs.

In 2019 more capacity building programmes for Mangrove Rangers on revised electronic monthly report and data collection were conducted. In these sessions, rangers were trained in using the Kobo Toolkit software, an electronic format implement to support their monthly reporting activities. Rangers were also trained in the elevation reading and documentation from the installed monitoring gauges at the Lusignan restoration site. Additionally, they were also trained in the use of installed measuring gauges, by participating on training and field exercises prepared by Surveying & Project Management Inc. The 35 gauges that had been installed at Columbia to Aberdeen, and at Anna Regina to Henrietta in Regions 2 and 4 served as an efficient measurement tool of accretion and erosion at these locations. Lastly, it is important to note that the COVID 19 Pandemic impacted the implementation of in-person training during the years of 2020-2021.

5. Information and networking

This section includes a summary of the main institutions in Guyana involved in environmental information spreading and networking creation across different sectors and levels. Many of the research projects and capacity building activities are supported by some of these institutions and programmes. Some of them constitute an agreement between several organisations.

Caribbean Community Climate Change Centre (CCCCC): The CCCCC is a knowledge hub acting as a climate change focal point in the Caribbean region, being recognised by the UNFCCC and United Nations Environment Programme (UNEP) as such, and by the United Nations Institute for Training and Research (UNITAR) as a "Centre for Excellence" thanks to the CCCCC's efforts to provide training and capacity-building. Mainly, the CCCCC shares knowledge and data on climate change with Caribbean countries through contact with the Secretariat to the Caribbean Community (CARICOM) to help them develop more effective policies. The CCCCC was founded in 2002 and its contributing members are:

- Antigua and Barbuda.
- Bahamas.
- Barbados.
- Belize.
- Dominica.
- Grenada.
- Guyana.
- Haiti.
- Jamaica.
- Montserrat.
- Saint Lucia.
- St Kitts and Nevis.
- St Vincent and the Grenadines.
- Suriname.
- Trinidad and Tobago.
- Anguilla.
- Bermuda.
- British Virgin Islands.
- Cayman Islands.
- Turk and Caicos Islands.

European Forest Institute Technical Assistance Project (EFITAP): Project spearheaded by the European Forest Institute (EFI) and funded by the United Kingdom's Foreign, Commonwealth and Development Office (FCDO) to develop national forest governance arrangements. In Guyana, EFITAP is also geared towards assisting with Forest Law Enforcement, Governance and Trade (FLEGT) agreements between Guyana and the European Union. Founded in 1993, EFI possesses a network of experts through their staff, associates, scientific advisory board, board, and council. Currently, EFITAP is active in:

1. Gabon.
2. Ghana.
3. Guyana.
4. The Republic of Congo.
5. Papua New Guinea.
6. Solomon Islands.

In 2022, The Ministry of Natural Resources and the GFC, together with other partners such as UK Aid and EFI Technical Assistance Project (EFITAP), hosted the fifth national learning event titled "Forest Regulator Workshop: Changing Roles in a Changing Climate". The three-day event was livestreamed and consisted of different presentations that were held during the first two days, and a field trip session held during the third and final day of the event. The aim of these sessions was to provide a learning forum for forest regulators and those within the forestry sector to evaluate their roles and responsibilities, while discussing current challenges within the framework of forest regulation, forest economics and climate impact. Both national and international stakeholders were brought together to encourage building collaborative networks and facilitate dialogue between the government and the different sector stakeholders.

Programme for Endorsement of Forest Certification Systems (PEFC): PEFC is a non-for-profit organisation providing forest certifications to those managed following sustainability principles and requirements. The acquisition of PEFC certifications improves Guyana's international credibility, guaranteeing trust in the country's forests and allowing it to engage in broader networks.

In May 2023, the Guyana National Forest Certification Scheme was submitted for assessment to the PEFC in a public consultation for endorsement. The development of the national system began in 2019 and was restarted in 2021 to undergo two public consultations and an independent desktop assessment and field testing to confirm it was fully developed in line with PEFC requirements. It counts with the support of the Government of Guyana and of key stakeholders from the affected sectors. As part of the public awareness initiatives, an informative open webinar on the new national system was held at the end of May 2023. On

January 2024, the Assessment of the Guyana National Forest Certification Scheme Against PEFC Council Requirements Final Report (Hegarty, K. M., 2024) was published.

Guyana European Union Voluntary Partnership Agreement (VPA): Guyana engaged (ended 2023) in a partnership with the European Union on the enforcement of forest law, improvement of governance, and ease of trade in timber products. This international collaboration includes efforts to promote capacity-building and information sharing for the fulfilment of the Agreement. VPA's are a pre-requisite for FELGT Licenses.

FLEGT Licenses: FLEGT Licenses are designed to confirm that timber and timber products follow appropriate rules, including the European Union's Timber Regulation (EUTR). Aiming for FLEGT Licenses means that Guyana continuously learns about and implements best practices in forest management.

International frameworks: SDGs, nationally determined contributions (NDCs), Aichi Targets on Protected Areas, Leaders Pledge for Nature, and UN Net Zero by 2050. Engagement in these international frameworks opens the door to knowledge sharing and an expanded support network through showing commitment in the fight against climate change. This enables multilateralism in climate action to share solutions to address climate change.

Iwokrama International Centre (IIC) for Rainforest Conservation and Development: The ICC, located in Guyana, was founded in 1996 and is currently staffed by almost seventy professionals conducting research in forest sustainability. IIC's partners include Exxon Mobil Foundation, Amazon Conservation Treaty Organisation (ACTO), Biodiversity and Protected Areas Management (BIOPAMA), RENFORESAP cooperation (between Guyana, Suriname and French Guyana), Repsol, Newcastle University, and African-Caribbean-Pacific Forest Research Network (ACP FORENET) funded by the European Commission and ACP Secretariat.

Government of Norway (NORAD): Norwegian Agency for Development Cooperation, Guyana's partner for the bilateral partnership on Reducing Emissions from Deforestation and Degradation (REDD+).

World Bank: Global partnership including 189 countries with a focus on financial products and technical assistance for the major areas in international development.

Conservation International Guyana (CI-Guyana): Non-for-profit partnership active in over 70 countries and providing assistance on: wildlife extinction, deforestation, overfishing, climate change, unsustainable economies, and freshwater health.

United Nations Educational, Scientific and Cultural Organisation (UNESCO), Caribbean UNESCO (Associated Schools Project Network): UNESCO / UNESCO Associated Schools

Network is an international network that provides support the SDGs (4) to promote learning that encourages sustainable development.

Reducing Emissions from Deforestation and Degradation (REDD+): International framework to help reduce emissions from deforestation and to assist in other initiatives beneficial to forests. Various organisations and diverse stakeholders take part in REDD+ to assist developing countries, including access to technical research papers, reports, workshops, and expert meetings.

International Union for Conservation of Nature (IUCN) Netherlands: The broader IUCN network encompasses more than 15,000 nature experts distributed among 1,400 authorities, social organisations, and knowledge institutions. IUCN NL follows IUCN's guidelines and collaborates with parties and other IUCN offices. By collaborating with IUCN NL, Guyana gains access to a much broader knowledge network.

World Wildlife Fund (WWF) for Shared Resources: Non-for-profit nature conservation organisation actively present in close to 100 countries. WWF works with expert staff in the areas of climate, communities, food, forests, freshwater, oceans, policy, sustainability, and wildlife. The goals of the organisation are to:

- Create a climate-resilient and zero-carbon world.
- Rebuild food systems to nourish people and nature.
- Conserve the world's most important forests.
- Protect freshwater resources and landscapes.
- Achieve healthy oceans and nature-positive seascapes.
- Conserve wildlife and wild places.

Joint Solutions Programme: As part of collaboration with WWF for nature conservation, this programme improves collaboration between Suriname and Guyana for capacity-building thanks to the creation and strengthening of partnerships. The project (2015 – 2020) was a collaboration between WWF, IUCN NL, and the Dutch Government.

Green Heritage Fund Suriname: Non-for-profit foundation based in Suriname for animal conservation and educational activities on coastal zones. Collaborated with Guyana´s Protected Areas Commission on the four-year project "Promoting Integrated and Participatory Ocean Governance in Guyana and Suriname: The Eastern Gate to the Caribbean" starting in 2017.

CARICOM: Caribbean Community of 20 countries to facilitate regional integration (economic, foreign policy, human and social development, and security).

Caribbean Development Bank (CDB): Development bank supporting inequality reduction and the alleviation of extreme poverty in the Caribbean region.

Caribbean Public Health Agency (CARPHA): Regional public health agency established by CARICOM members covering, amongst various health topics, regional responses to natural disasters like flooding.

Caribbean Disaster Emergency Management Agency (CDEMA): regional inter-governmental organisation with 18 Member States for disaster management with the goal of coordinating emergency responses and facilitating assistance.

Caribbean Institute for Meteorology and Hydrology: Regional organisation with 18 Member States conducting research, facilitating training, providing expert advice, and raising awareness regarding meteorological and hydrological services in the Caribbean.

Education and Training Activities (covered in **5. Education, Training, and Public Awareness**)

Caribbean Youth Environment Network (CYEN): Regional youth organisation seeking to provide development and raise the participation of the Caribbean youth in areas related to the environment, climate change, sustainable development, and conservation to highlight how these topics affect youth well-being.

6. Education, training, and public awareness

6.1. Introduction

Throughout this section, an overview of Guyana's initiatives developed and implemented regarding environmental education and training, as well as public awareness projects is presented. Firstly, key international and national strategies, policies, and plans are analysed as they constitute the corresponding framework to understand Guyana's evolution in terms of climate change education. Secondly, several educational initiatives and projects at national, international, and regional level, are presented and described in detail, divided into initiatives at national, international, and regional level. The selected projects that are presented constitute the most relevant initiatives, trainings, and awareness campaigns in which the country has been actively participating during the last years. Further, an in-depth analysis of Guyana's progress since the SNC is shared. An assessment of the level of achievement for each recommended action, with information per target group and type of activity is provided. Finally, an assessment of Guyana's current needs and level of awareness in terms of environmental education and climate change knowledge is included. The analysis focuses on different studies and contemplates survey results within the different regions, identifying key areas of progress achieved.

Annex to Decision 17/CP.8 on communication from Parties not included in Annex I to the United Convention (non-Annex I Parties), states that non-Annex I Parties are encouraged to provide information on any steps they have taken to integrate climate change considerations into relevant social, economic, and environmental policies, with the intention to facilitating the formulation and implementation of sustainable development programmes. Parties are expected to facilitate a number of actions designed and implemented related to Education, Training, and Public Awareness (Article 6) in order to fulfil commitments expressed in Article 4. Countries are also encouraged to provide information on any actions taken in accordance with Article 4, paragraph 1 (i) of the Convention, which encourages the promotion and cooperation in education, training, and public awareness related to climate change and which encourages the widest participation in this process, including that of NGOs.

According to a United Nations International Children's Emergency Fund (UNICEF) study inadequate education and learning affect directly to children’s vulnerability to climate shocks and environmental stresses. Educational attainment levels are a proxy for a wider range of vulnerabilities, including access to resources to manage environmental risks, among others. In families with lower levels of education, children are the most likely to be removed from school in order to become part of the work force when environmental disasters occur.

Guyana’s formal education system is formed by pre-school level or nursery, primary level, secondary level, post-secondary level, which includes technical and vocational education, as well as teacher training programmes, and tertiary level. The Ministry of Education highlighted in its Strategic Plan 2008-2013 “*Meeting the quality imperative some key issues and challenges within the Guyanese education sector, from its challenges to deliver quality education to the shortage of training teachers and the difficulty of achieving universal secondary education across all regions of the country*”.

Also, Guyana occupies the eighty-fourth position in the Children’s Climate Risk Index (CCRI) Rank with a CCRI score of 4.8 in terms of Children’s Climate Risk index, a score of 3.3. regarding Child Vulnerability, and a score of 6 in Climate and Environmental Factors. Across the different pillars (Figure 5.5), the CCRI analyses fifty-seven variables to measure risk across 163 countries worldwide, measuring exposure to climate and environmental shocks and stresses, and child vulnerability, including education as one of those analysed categories. Furthermore, in this area it is relevant to mention the National Centre for Educational Resource Development (NCERD) as it cooperates with the Ministry of Education on promoting science technology, engineering, arts and mathematics in schools, and has even launched technology literacy and robotics programmes at the national level.

Figure 5.5. CCRI pillars according to UNICEF.

According to the Ministry of Education of Guyana, several environmental risks have a direct impact on the education system in Guyana affecting students, teachers, and education facilities and structures. The level of impact varies slightly per region, however the main identified impacts in the country include flooding, drought, water pollution, bushfires, and air pollution.

Thus, educating and empowering children can have transformative effects in terms of environmental and climate preparedness, by expanding their adaptive capacity and by reducing their vulnerability. Children with adequate access to climate change education have the necessary skills to adapt and respond, are more environmentally empowered, have an increased resilience to climate shock, a diversity of options for future livelihoods, and have higher capacity for innovation and solutions. In sum, continuous and correct access to education, including disaster and climate change preparedness and school safety, and increased training and capacity on responsiveness and adaptation is essential.

6.2. Key strategies, policies, and plans

There are several broad international and national framework policies and strategies that must be considered when analysing Guyana's pathway towards implementing climate change education, training, and public awareness across the country. They serve as frameworks that contribute to Guyana's educational and public awareness development and progress. Table 5.6. shows those relevant agreements and provides a brief explanation on their relevance regarding education.

Table 5.6. National and international environmental agreements relevant to Guyana's education, training, and public awareness development.

Name of Framework/ Agreement	Type of Framework/ Agreement	Brief description
Rio Conventions; Agenda 21	International	Successful implementation of the Rio Conventions requires a multidisciplinary approach which includes initiatives regarding public awareness, education plans, development of legislation and policy implementation, among other actions that affect both stakeholders, business, and governments. Chapter 36 of the agenda is dedicated to promoting education, public awareness, and training. It enhances the need to include public awareness as part of the educational needs and curriculum of general societies.
UNFCCC Article 4.1 and Article 6	International	Article 6 is dedicated to education, training, and public awareness. The link between providing education and stakeholder engagement is direct, and it encourages policymakers, businesses, and organisations to support climate change policies that will lead to lowering emissions. The Parties, shall, then, promote and facilitate specific and relevant training on climate change and its effects, making it available and publicly accessible and encouraging open participation.
The Constitution of the Co-operative Republic of Guyana (1980), and Amendment No. 2 (2003)	National	It is the first public policy document that acknowledges and highlights the importance of public environmental education for Guyanese society. The Constitution of the Co-operative Republic of Guyana Amendment No. 2, recognises again the link between education and public awareness, and it states that every citizen has a duty to participate in actions and initiatives aimed at improving the environment and empowering society in terms of environmental education.
LCDS (2009, 2013, 2022)	National	It outlines the country's vision for sustainable development and while not solely focused on education. It includes certain elements related to awareness raising, capacity building, and public training on climate change issues that are nationally relevant. It plays an important role in enhancing the country's capacities regarding climate change education.
National Climate Change Adaptation Strategy	National	It aims to strengthen the country's resilience to the impacts of climate change and, while it focuses on adaptation measures, it also recognises some elements related to education and raising of public awareness.

Name of Framework/ Agreement	Type of Framework/ Agreement	Brief description
Guyana's National Environmental Policy (NEP)	National	It provides an overarching framework for environmental management across the country and it sets broad legal frameworks to consider related to educational climate change objectives and broader environmental education and awareness.
National Environmental Education and Public Awareness Strategy (NEEPAS), (1999)	National	Strategic document developed by Guyana's government to address environmental challenges and to promote general sustainable development, environmental education, and public awareness within the country. It targets stakeholders and emphasises the need to encourage their involvement.
National Environmental Action Plan 2001-2005 (NEAP) (Guyana Environmental Protection Agency, 2001)	National	It provides a comprehensive framework for action on integrating environmental education into formal and informal education systems, as well as raising public awareness about environmental issues. The main objectives of this strategy are to enhance environmental literacy across all Guyanese sectors and regions, fostering a sense of environmental responsibility, and empowering society to understand and act upon environmental conservation by participating in relevant sustainable development initiatives.
National Risk Management Policy for the Education Sector in Guyana (Ministry of Education, 2021b)	National	Comprehensive framework for managing risks and ensuring safety across educational institutions, including different policy assessments and protocols which impact indirectly on climate change education and preparedness, as well as on raising public awareness on climate change impacts and its effects across the Guyanese society. Thanks to this type of strategies, climate change education, environmental awareness, and disaster risk prevention training is currently integrated in the school's curriculum as a strategy to support in the prevention of climate change impacts and disaster management.
Educational Sector Plan	National	The Ministry of Education's Education Sector Plan 2021-2025 (Ministry of Education, 2021a) outlines the importance of teachers as the main input of educational production function to the education system. Improving teacher's training and capacity building is critical to improving overall educational performance in Guyana, across the different educational levels and curricula.

6.3. Initiatives at national level

A selection of highlighted educational, training, and public awareness initiatives and projects developed and implemented by Guyana at a national level in the last years is presented below.

At a national level, there are a number of organisations that contribute to providing environmental education on the different sectors and industries, as well as training and public awareness regarding sustainability-related issues. For instance, within the LCDS framework, Guyana plans to establish an International Center for Biodiversity Research which will work alongside local and international partners to connect research at various levels and facilitate networking and knowledge sharing. The main objective for this institution will be to focus on participating in different national and international research opportunities, as well as promoting support of transversal programmes involving several political, economic, and social agents as the Government, civil society, private sector, indigenous people, and local communities. The research institution will engage with multiple academic institutions, at national level, and local level. For instance, the University of Guyana, the Cyril Potter College of Education, Iwokrama, the National Centre for Educational Resource Development, and the Bina Hill Institute will partake in it. The programme aims to reach both formal and informal educational institutions.

The **University of Guyana Green Institute (UGGI)** is part of the Faculty of Social Sciences of the University of Guyana, and it was created to enhance research collaborations across Faculties, Schools, and Centres to provide innovative methodologies, sharing recent insights, and spreading public awareness on learning development for a Green Economy by engaging in education, training, research, and advocacy. The Green Institute gets involved in different environmental and climate change events, such as workshops, conversations, forum series or any other initiatives related to environmental community outreach. For instance, UGGI Conversations is an interactive webinar based on student-suggested topics and created with students as panellists to enhance public discussion forums on environmental topics. Also, the initiative “Policy Dialogues on the Triple Planetary crises” comes from a signed contract between the UGGI and the United Nations Resident Coordinator to provide consultancy and build constructive advocacy as well as to promote conversations on climate change, biodiversity loss, and pollution. The objectives are to generate new knowledge on climate topics that are crucial for Guyana’s future: carbon pricing, energy production incentives, environmental protection, and conservation incentives, air pollution and carbon emissions penalties.

The UGGI also offers a set of resources as part of its website, which includes economic, social, and environmental data and documentation for open access, and some technological tools, such as the Development Impact Assessment Toolkit, a search method for assessing the impacts of low emission development strategies (LEDS) on country development goals. The UGGI conducts annual or biannual virtual workshops which cover different topics across the areas of economy, society, environment, and technology. Some of the objectives are to promote UGGI work and to recruit associates, as well as testing ideas for academic programmes. Also, establishing working relationships and working groups for national investors promoting green economy.

The **ICC for Rainforest Conservation and Development** is an international NGO established in 1996 to provide conservation, environmental balance and sustainable management of the forest, working in close cooperation with the Government of Guyana, the Commonwealth and any other international partners interested in creating conservation practice. The different lines of work of Iwokrama are centred around sustainable tourism, sustainable forestry, but also around promoting research and creating community development joining with local people to ensure economic and social benefits from forest use and conservation through a participatory approach.

CI-Guyana is a transversal organisation established in 1989, specialising in climate change, environmental sustainability, natural disasters, and species conservation. CI-Guyana partners with countries, communities, and organisations to empower societies in biodiversity and sustainability, by providing effective local and national solutions. From 2013 to 2020, CI-Guyana has produced yearly or biyearly impact reports that display the organisation's work across several projects in Guyana and assess its impact. One of the latest initiatives presented in their Impact Report 2019-2020 (Conservation International Guyana, 2019) that are most related to environmental education is the collaboration between CI-Guyana and University of Guyana to expand field-based experiential learning opportunities by promoting student and faculty participation in different forest expeditions to forest stations, coastal mangroves, such as the Iwokrama Forest, Pibiri, and Manaka forest stations and the Roraima Agricultural Research Station in Brazil. These initiatives contributed to increasing firsthand experience in biodiversity monitoring, reduced impact logging, coastal dynamics, biodiversity conservation, and sustainable agriculture, among other topics. Additionally, CI-Guyana supports UG faculty and students to enhance their academic qualifications through training in collaboration with the Arizona State University.

The Sandwatch initiative started being implemented in Guyana in 2001 and is still active currently. It was initially developed through UNESCO's Coasts and Small Islands Platform in 1998, and it began as a regional activity involving the Caribbean UNESCO Associated Schools Project Network. It is currently a global programme that is implemented worldwide with the aim to link classroom activities to real-life issues relating to climate change, environment, sustainable development, science, and more. It links academic subjects across different science curriculum to social studies and art, to encourage participants to take action to become more involved with the environment and promoting local and regional understanding of policies and actions. It is linked to the Sandwatch Foundation, which is a volunteer network formed by students, teachers and principals, youth groups, and non-governmental organisations who work together to monitor and enhance their coastal and beach environments. An online platform called "Beach Records" was created as a tool for schools, youth groups, NGOs, and community groups to learn, record, share, and apply their scientific observations to positive community action to enhance their beach and coastal environments to be able to adapt to climate change.

The last **Sandwatch Workshop** was held on November 2023, where the Guyana Ministry of Education in collaboration with the NCERD organised a workshop addressed towards teachers of Primary and Secondary Schools across the country. It aimed to empower educators and educational officers with the necessary tools, skills, and understanding regarding sustainable coastal management. The participants came from thirty different schools from different regions in Guyana. The main focus of the workshop was placed on understanding the importance of coastal ecosystems and the need for active conservation measures, explaining a specific methodology based on Monitoring, Analysing, Sharing, and Taking Action (MAST), which provided the participants with an in-depth understanding of coastal environments monitoring actions, and of the importance of maintaining accurate records. The workshop also included practical exercises and case studies, as well as direct activities which provided participants with the opportunity to apply theoretical knowledge in real-world scenarios. Previous activities provided within the scope of the Sandwatch programme include the Policy Forum Guyana's Lifestyle Campaign launched in 2023. This event sought to encourage sustainable and environmentally conscious lifestyles aligned with a Zero Single-Use Plastic Policy and an exhibition of science fair projects, murals, musical and life-size games related to the topic. This campaign aimed to challenge destructive ways of living and foster pathways to a more unified, healthier, inclusive, and environmentally friendly future.

Additionally, the **9th Annual Environmental Education Workshop for Teachers** was held in 2019 by Guyana's Environmental Protection Agency (EPA), where sixty-four trainee teachers and lecturers from the Cyril Potter College of Education benefited from impactful teacher training workshops to stimulate the integration of environmental education into the school curriculum. The approach of the workshop was eminently practical in order to enable participants to enhance their critical thinking, analytical, problem-solving, decision-making, and team-building skills. A variety of methods to integrate environmental education into the main subject areas of the school's curriculum were proposed, including issues such as climate change, biodiversity, solid waste, and energy. During the last journey of the workshop, teachers were encouraged to develop a lesson plan that includes environmental topics infused into the different areas.

In line with this, in 2014 the **"Climate Change Education Inside and Outside the Classroom" training course** was held in the Dominican Republic for 4 days to provide capacity building and training to primary and secondary teachers, school principals, teacher educators, educators from ministerial positions, and community educators from NGOs from Small Island

Developing States (SIDS) in the Caribbean and from Central American countries. The course covered three separate modules including training on climate change science and Education for Sustainable Development (ESD) through a holistic approach including diverse activities such as discussions, lesson planning, round tables, and presentations, as well as covering instruction on the Sandwatch initiative and finalising with a final field trip and workshop. At the end of the course, all participants completed an evaluation about the conducted programme. Additionally, there were two Guyanese teacher participants that conducted a 2-day workshop with instructors for teacher training, focusing on sea level rise and its effects on Guyana. They presented the Guyana Mangrove Restoration Project as a case study to illustrate how the project helped establish better management capacity for sustainable support in Guyana.

Another initiative worth mentioning is the **train-the-trainers** workshop held in 2019 in cooperation with the Ministry of Education and the **NCERD**, the Trinidad and Tobago's Sandwatch Networks, and UNESCO, aimed to train participants on Education for Sustainable Development, Lesson Planning and Science of Climate Change, an Introduction to Ocean School Literacy and Man and the Biosphere Programme. It consisted of providing practical sessions to more than thirty participants from Guyana to work together to scientifically monitor and critically evaluate problems and conflicts related to beach environments and coastal ecosystems. Other initiatives including public awareness and capacity building are the collaboration with the Regional Democratic Council to provide capacity building at key regional governmental agencies and in direct cooperation with the Rupununi and Region 8. The mission was to develop sustainable long-term village plans, working with regional stakeholders to develop integrated sustainable development strategies for land use planning and management, enterprise and livelihoods, governance, capacity development, and sustainable financing.

Within the scope of the project "**Strengthening Technical Capacities to Mainstream and Monitor Rio Convention Implementation through Policy Coordination**", there were two main workshops conducted to provide specific training within the scope of the project's activities and themes during the 2017-2018 period. The first workshop implemented was a learning-by-doing training on writing environmental articles and it targeted media professionals. A variety of interactive methods were used, such as incorporating group discussions, writing articles, presentations, debating issues, and a final workshop evaluation was undertaken to obtain feedback regarding potential areas to strengthen and improve. On completion of the workshop, it was expected that participants would be able to demonstrate basic proficiency in environmental reporting using articles, and to write environmental articles that foster critical thinking and address emerging environmental issues. Some of the environmental topics that were analysed during the sessions were: The importance of the Rio Conventions, Guyana's commitments under the Conventions, Greenhouse Gas Emissions, Climate change mitigation and adaptation, the effect of the global environment on daily lives, disaster mitigation, and disaster risk management, among others. The second workshop implemented was aimed at the private sector and consisted of a series of policy dialogues and presentations around different climate change and environmental sustainability topics. Different members of several organisations such as the United Nations Convention to Combat Desertification (UNCCD), the EPA, the UNFCCC, Guyana Lands and Surveys Commission, and the Department of Environment, among others, participated in the discussions.

Regarding initiatives addressing Guyana's youth groups, a relevant stepping point was Guyana's participation in the **2022 North American Association for Environmental Education (NAAEE) annual conference** with the conference titled: **"The Importance of Environmental Education for Indigenous Youth in the Rupununi"** conducted by Alyssa Melville and Neal Millar from the South Rupununi Conservation Society. The conference covered how indigenous people across the world play an essential role in preserving the environment and the main challenges they face in achieving this goal, being directly threatened by the impacts of globalisation. It highlighted the importance in delivering environmental education to indigenous youth to ensure continuation of their capacity to protect their surroundings.

The same information was also covered in the article published previously that same year (Van Vliet, N., et al. 2022). The paper provided an assessment of the level of participation in subsistence activities and the level of acquisition of subsistence skills among Indigenous children in Guyana, under the premise that the imparting of Ecological Traditional Knowledge (ETK) is essential in sustaining cultural practices and lifestyles. The conducted analysis also pays attention to different factors such as location, social characteristics, age groups, gender, and parental occupation as potential drivers that explain unequal ETK acquisition and transmission levels. The study shows that South Rupununi students maintain high levels of involvement in subsistence activities and its skills, such as the use of bow and arrow in hunting and fishing practices. However, participation in subsistence activities varies according to gender. There is also a correlation with parental working professions in the level of involvement in those activities. Finally, the study advocates for the need to integrate more indigenous subsistence ways of life into the regular school curriculum to adequate for real Indigenous needs and as a way to promote sustainable environmental practices for land preservation and lifestyle practices.

Additionally, a mangrove camp was hosted at Wellington Park in 2017 addressed at youth groups, where they were educated on the value of mangroves in abating the impacts of climate change, and on the different species of mangroves found in Guyana, the various changes occurring at the site and how living things interacted with each other in their physical environment. A field visit was also conducted where mangrove ecology was discussed.

Also, a series of Community Sensitisation Sessions were conducted in 2022 along Regions 2 to 6 targeting resource users, NDC councillors, and community leaders with a focus on the education and awareness needed to foster Community-Based Mangrove Forest Management. Different Mangrove Stakeholders Consultations were also conducted throughout 2022 in Regions 2, 4, and 6 to educate and receive feedback from stakeholders of the public sector, NDC councillors, and community leaders about the updated Mangrove Management Action Plan (2022-2032).

Also, **the Guyana Youth and Environment Network** is a nationally accredited non-profit organisation led by young people and for civil society focused on empowering young people and their communities and promoting environmental stewardship and youth inclusion across Guyana. As part of its most recent outreach actions a training workshop for youth and indigenous activists in Guyana is prepared for April 2024 to promote actions towards building a youth movement for climate justice. The agenda of the training workshop encompasses different discussions on climate change experiences, insights into existing climate justice initiatives within the Caribbean region, and an exploration of several opportunities for enhancing a grassroots movement building at national level.

Finally, in the **National Risk Management Policy for the Education Sector in Guyana** (Ministry of Education, 2021b) some progress was noted regarding gender inclusiveness at different educational levels is acknowledged. Issues related to inclusiveness linked to climate change adaptation for primary and secondary levels have been reviewed and included in the curriculum. Also, one of the strategic objectives of the Access programme of the Policy is to ensure equitable access to education and a safe and protective learning environment to all children and youth affected by crises. It emphasises the need to grant the access of girls and children in vulnerable situations to continuous education during and after a disaster. According to the **Situation Analysis Report on Women and Children in Guyana** (UNICEF, 2016) there are more than five identified different groups of children and women that see their access to education from early childhood through primary and secondary education unfairly limited: those who live in the hinterland; Amerindians; children with disabilities and/or special needs; children from single-parent households; and those who come from poor households.

6.4. Initiatives at international level

In this section, further relevant educational initiatives, campaigns, projects, and workshops developed by Guyana in collaboration with various international institutions are presented.

Additionally, **CI-Guyana** has supported the collaboration between the **NORAD** and the GFC since 2010 in the development of Guyana's MRV System. As part of a consortium of Guyana's REDD+ a development of the REDD+ Strategy was produced in 2019 including capacity building and stakeholder engagement activities from 52 indigenous local communities, as well as the participation from public and private sector organisations, open to civil society.

WWF in Guyana works supporting various projects related to natural heritage conservation, human well-being, environmental, and sustainable development regarding oceans, freshwater, wildlife, people, forests, and the economy. For instance, **the Shared Resources, Joint Solutions** programme is coordinated by WWF-Guianas, developed in partnership with **IUCN Netherlands**, local indigenous communities, and an NGO, and funded by the Dutch Ministry of Foreign Affairs. The aim of the project is to conserve natural resources, raise awareness, and build capacity among civil society regarding conservation and sustainable government policies. It has been successfully implemented from 2015 to 2020 in both Guyana and Suriname, producing a number of educational leaflets and informational articles on climate change by the various partner organisations that are open and available online.

One of the Shared Resources, Joint Solutions programme main focus areas is environmental and gender responsiveness and inclusiveness, and it advocates for civil society to increase their participation and engagement in policies, behaviours, and practices in order to increase vulnerable groups presence in natural resource and environment governance and decision-making processes. From its inception in 2015 to its last stages in 2020, the gender component of SRJS has been fully integrated and applied both in Guyana and Suriname through the development of gender responsive tools and approaches applied and tailored to specific needs of the national partners.

Another relevant project conducted by WWF, in collaboration with Green Heritage Fund Suriname (GHFS), Guyana's Protected Areas Commission (PAC), and the Nature Conservation Division (NCD) of the Suriname Forest Service, is the four-year project on Marine Spatial Planning: **"Promoting Integrated and Participatory Ocean Governance in Guyana and Suriname: the Eastern Gate to the Caribbean"**. The project aims to protect marine and coastal resources in Guyana and Suriname and to promote collaborative processes between stakeholders and parts involve, by improving knowledge of coastal resources and marine environment and providing capacity building to build informed decision making and to enhance sustainable marine spatial management. Some of the conducted activities and outputs of the project that are mostly related to enhancing environmental awareness and capacities are, among others: Identification of capacity needs to assess gaps and enable planners and decision makers to fill those capacity gaps; Creation of environmental sensitivity index maps which provide a summary of the coastal and marine resources that are at risk from human activities; Development of national guidelines on risk and impact mitigation on coastal habitats and marine wildlife; Producing a GIS marine atlas which integrates local knowledge, satellite data and other relevant information to inform decision-makers and management actions; The development of an engagement platform to facilitate regular and effective interaction among all stakeholders, through group meetings and a website, among others an equivalence-gap analysis for indigenous people and gender, to explicitly address their needs and to increase their engagement in the decision-making of the project.

6.5. Initiatives at regional level

Some initiatives implemented in Guyana regarding environmental education, climate change training, and public awareness raising are part of regional programmes or initiatives, and/or implemented in collaboration with several Caribbean organisations. Highlighted projects and campaigns are further explained throughout this section.

At the regional level, the **CCCCC** promotes the climate change agenda across the Caribbean developing and implementing many initiatives in collaboration with different regional counterparts such as the Caribbean Community (CARICOM) Secretariat, the Caribbean Regional Climate Centre, the CDB, the CARPHA, the Caribbean Catastrophe Risk Insurance Facility, the CDEMA, and the Caribbean Institute for Meteorology and Hydrology.

There are further initiatives developed by numerous organisations at the regional level, some of them are interdisciplinary and aim to provide capacity building and information to the civil society on environmental issues related with areas such as Health, for example. Within those health sensitisation programmes and campaigns, there are also educational and training initiatives. For instance, an ongoing programme funded by the European Union is currently in place in Guyana from 2020 to 2025 on *Strengthening Climate Resilient Health Systems in the Caribbean* to improve capacity of Caribbean countries in reducing negative impacts of climate change on health. This programme includes multisectoral training and education modules as part of their educational approach.

Additionally, the CCCCC launched a campaign addressing young groups and communities from the 16 CARIFORUM Member States called "I deserve a #BetterClimate4MyHealth" in 2023 for participants to partake in different activities and competitions to increase awareness and knowledge surrounding Climate and Health. Some of the proposed activities included a selfie contest for Climate and Health, Story, Art, Poetry and Photo competitions, a Walk for Climate and Health, a Clean-up initiative, a Youth Forum, and a Letter to the Leaders initiative.

Examples of these initiatives include training courses for organisations at distinct levels of management in climate change related issues. For example, the "Enhancing Climate Resilience in CARIFORUM Countries" project aims to strengthen the Climate Risk Management Framework in the 16 CARIFORUM member countries, assisting them to enhance their climate monitoring networks and improving their capacity-building skills, while supporting the expansion of educational and outreach programmes to enhance public awareness and education on climate change.

Another example of Education and Training initiatives is the "Climate Change and Health Leaders Fellowship Programme" is a part-time blended-learning programme which targets career professionals from 16 Caribbean countries with the objective to create a cohort of inter-sectorial, multidisciplinary leaders with strong and effective climate change skills and leadership in the Caribbean. Additionally, as part of the Guyana's Policy Forum initiatives public awareness events were organised among the community as part of the Earth Day 2023, and World's River Day 2023, among others.

Furthermore, the **Bina Hill Institute Youth Learning Centre (YLC)** was established in 2010 and it is an important institution for the local indigenous communities within Region 9 in Guyana, specialised in Childhood and Youth Education. It collaborates with several partners across the North Rupununi District Development Board such as Iwokrama, to develop training, research, and other resources in the North Rupununi. It is an educational organisation set up to develop indigenous learning about their land, to promote indigenous leadership to help develop their own communities, and to focus on conservation, natural resource management and indigenous languages education.

Also, as part of the existing regional initiatives oriented towards youth communities and other vulnerable groups, **the CYEN** stands out as a non-profit network organisation led by youth groups dedicated to improving young people's life quality in the Caribbean by promoting personal development and activism involvement in all matters pertaining to the environment and related to sustainable development. CYEN prioritises actions regarding promoting the SDGs, enhancing youth employment, education and training aimed at young people, participation, and advocacy initiatives. The organisation is involved in several actions regarding climate change disaster resilience, water resources management, health and wellness, and environmental biodiversity.

6.6. Progress made since Second National Communication (SNC)

Throughout this section, the different recommended actions for Guyana as proposed in its SNC are analysed in detail to rate the level of achievement – high, moderate, or low – acquired by the country, disaggregated by theme, target group, and activities.

The recommendations outlined in the SNC submitted in 2012 emphasised the need for coordination of climate change awareness actions across different agencies operating independently but led by the Office of Climate Change (OCC). The OCC, now Department of Environment and Climate Change (DECC), is the National Focal Point (NFP) for UNFCCC and it engages in activities and initiatives aimed at strengthening capacity and advancing the country's climate agenda, as well as coordinating climate change activities undertaken by other agencies such as adaptation and mitigation policies and key education and awareness plans. Seventeen recommendations were established in the SNC, and they can be categorised under seven themes that overlap among some of the ideas put forward. The seven themes are included in Table 5.7.

Table 5.7. The seven themes to categorise SNC recommendations.

#	Theme
1	Strengthening collaboration among agencies
2	Creation of climate policy
3	Promotion of scientific research on future climate change scenarios
4	Creation and implementation of a long-term national public awareness and education strategy for climate change
5	Establishment of a multifunctional website
6	Capacity-building
7	Education and training for monitoring and forecasting

Source: Second National Communication, Government of Guyana, 2012

Table 5.8 presents the recommendations outlined in Guyana's SNC regarding environmental education and training, public awareness, and climate change capacity building, allocated to an assigned theme of the seven categories specified above.

Table 5.8. SNC recommendations and assigned theme.

Item	SNC Recommendations	Assigned Theme
i	There is need for greater collaboration among agencies that address climate change issues. Work programme and capacity enhancement initiatives should be extended always to key stakeholders, in view of the fact that capacity building is a cross-cutting theme. The National Climate Committee will be able to address this issue.	1, 6
ii	There is the need for research on how the climate is expected to change in the future. The resources for these studies will have to be provided from external assistance since global and regional models will have to be accessed and professional and academic resources will be needed.	3
iii	Relevant training in various agencies for these to be better equipped to monitor impacts such as erosion, inundation, along with changes in pest abundance, health signals, changes in fisheries, rice, and sugar yields.	7
iv	Development of a policy paper that will outline an agenda for climate research in Guyana; this initiative should be carefully coordinated to ensure that the information generated from the research activities are available to government agencies to inform climate change policy development and review.	2, 3

Item	SNC Recommendations	Assigned Theme
v	The University of Guyana needs to respond urgently to the human resource gap in regard to climate change by developing and offering short professional courses aimed at enhancing the capacity of key agencies which operate at the national and community levels.	1, 3, 6, 7
vi	Further strengthening of the Hydrometeorological Services for improved climatological monitoring and forecasting, and capacity building in the area of Climate change modelling. This will help national agencies with their climate and climate change predictions and provide invaluable data for decision-making.	1, 6
vii	A long-term National Public Awareness and Education Strategy for Climate Change beyond the 1999 National Environmental Education and Public Awareness Strategy (NEEPAS) has to be designed, implemented, and co-ordinated by the Office of Climate Change, Office of the President.	4
viii	Incorporation of studies on climate change and the general environment into the curricula of schools.	7
ix	National Co-ordination of Public Awareness and Education efforts need to be streamlined, and the Office of Climate Change in the Office of the President needs to ensure inter-agency collaboration on awareness efforts to maximise effectiveness and use of resources.	1, 2, 4
x	A national Climate Change website needs to be developed and promoted as a portal for information on climate change, and its use as a "central clearing house" for information needs to be highlighted.	5
xi	Public Awareness and Education efforts need to be 'scaled up' to address climate change issues in-depth, and to highlight scientific concepts.	3, 7
xii	Issues related to climate change and its consequences need to be more clearly articulated to reduce misconceptions about the issues directly related to climate change.	3, 7
xiii	Public Awareness efforts need to highlight personal responsibility as a critical component for mitigating climate change. Citizens need to better recognise the connection between their actions and the consequences on the environment.	6, 7
xiv	Public Awareness and Education efforts need to target hinterland regions, and materials designed that are cognizant of language and socio-economic barriers.	6, 7
xv	The Office of Climate Change, Office of the President, needs to conduct more outreach activities, especially in the remote areas of Guyana, to	1, 6, 7

Item	SNC Recommendations	Assigned Theme
	raise awareness, and to establish the office as a national coordinating point for climate change in Guyana.	
xvi	Messages need to be tailored in order to reach specific audiences.	6, 7
xvii	The Regional Democratic Councils can be used to help disseminate messages and facilitate training of village officers to help reduce 'ignorance' about climate change mitigation and adaptation actions.	1, 6, 7

Source: Second National Communication, Government of Guyana, 2012

The recommended actions were not replicated in all ten of Guyana's Administrative Regions identically, however different initiatives were undertaken at a national level by the Department of Environment and Climate Change and some key sector agencies and organisations, either independently or collaboratively, targeting multiple groups and communities. The accomplishment of education and public awareness recommendations' implementation has been moderate, as many recommended initiatives and activities were not implemented nationwide. However, there has been a heightened interest in climate change learning and an increased knowledge and public awareness on the topic. Some groups and communities have taken action to deal with the impacts of climate change and several organisations constantly participate in initiatives in this regard.

Table 5.9 presents the different status levels of implementation, from "High" when they were completed in most Administrative Regions, to "Moderate", when they were implemented in a few Administrative Regions, and "Low" in case they were not completed in any Administrative Region. Subsequently, Table 5.10 presents the level of achievement of the recommendations and actions included in the SNC.

Table 5.9. Status levels of implementation.

Status	Description
High	Implemented in most Administrative Regions
Moderate	Implemented in a few Administrative Regions
Low	Not implemented in any Administrative Region

Table 5.10. Level of achievement of SNC recommendations/actions.

Target	Activities	Status of Implementation
Households	Television documentaries on coastal vulnerability to climate change and the role of Guyana's forests in climate mitigation	High
	Observance of international events (Earth Day and World Environment Day, World Water Day, etc.)	High
Children and Youth	Hosting of youth camps, hikes, and tours during summer breaks	High
	Essay, poster, and painting competitions	High
	Quizzes and debates	High
Consumers	Flyers and stickers	High
Religious Groups and Mother's Unions	Seminars	High
Indigenous Peoples	Workshops	High
	Community meetings	High
Tradesmen and Technicians	Brochures	High
Resource Users (Farmers, Miners, Fishermen, Loggers)	Newsletters	High
	Demonstration projects	High
	Sensitisation seminars or outreaches	High
Professionals	Short professional training courses (two to three days)	High
	Workshops	High
	Seminars	High
Scientific and Academic Communities	Workshops	High
Private Sector	Short training programmes (two to three days)	High
Media Personnel	Two-day Training Workshops	High
	Media symposia	High
	Organisation of biennial media awards for best article on climate change	High
Households	Billboards in each of the ten administrative regions	Moderate
	Signage	Moderate

Target	Activities	Status of Implementation
	Live radio and television programmes that allow for interaction	Moderate
	Radio announcements and jingles	Moderate
	Public exhibitions	Moderate
	Plays, poetry, songs, dances, and short stories	Moderate
	Public forums, panel discussions	Moderate
Children and Youth	Auditing of present school curricula at nursery, primary, secondary, and technical level	Moderate
	Infusion/integration of climate change issues in existing curricula, using pilot subject initially (e.g. Integrated Science, Geography, Social Studies, Agricultural Science, and English)	Moderate
	Formation of Environmental Clubs in schools and communities	Moderate
	Science Fairs focusing on Climate Change	Moderate
	Preparation of booklets, pamphlets and workbooks	Moderate
	Integration of climate change in the Adult Education Curricula	Moderate
Teachers and Teacher Trainers	Curriculum audits	Moderate
	Development of training curricula/teachers' manuals for colleges	Moderate
	Regional training seminars and workshops	Moderate
Policy- and Decision-Makers	Short training programmes (two to three days)	Moderate
	Partnership demonstration programmes with government agencies and the private sector, as well as communities. This is particularly relevant to adaptation.	Moderate
	Television programmes	Moderate
	Panel discussions	Moderate
	Guest lectures	Moderate
	Summary Reports	Moderate
Consumers	Signage	Moderate
	Jingles for radio and television	Moderate

Target	Activities	Status of Implementation
	Green products	Moderate
Indigenous Peoples	Awareness Seminars	Moderate
Tradesmen and Technicians	Training workshop	Moderate
	Awareness Seminars	Moderate
Private Sector	Television programmes	Moderate
	Workshops	Moderate
	Awareness Seminars	Moderate
Media Personnel	Press Conferences	Moderate
Resource Users (Farmers, Miners, Fishermen, Loggers)	Radio programmes	Moderate
	Paraphernalia	Moderate
Professionals	On-the-job training	Moderate
Scientific and Academic Communities	Symposia	Moderate
	Infusion of climate change into existing University of Guyana curricula	Moderate
	Development of a special modularised course on Climate Change, to be offered by the University of Guyana	Moderate
Households	Bi-monthly feature articles in each major national newspaper	Low
Children and Youth	Magazines and comic books	Low
	Production of bi-annual newsletters by Environmental Clubs	Low
Religious Groups and Mother's Unions	Workshops	Low
	Panel discussions	Low
	Sticker labels	Low
Private Sector	Short training programmes (two to three days)	Low
Resource Users (Farmers, Miners, Fishermen, Loggers)	Stickers/labels	Low

In summary, several of the SNC outlined objectives were achieved and implemented across the majority of Administrative Regions among all targets, reaching households, children and youth groups, religious groups and mother's unions, indigenous people, consumers, tradesmen and technicians, resource users, professionals, scientific, and academic communities.

The objectives regarding education and training dedicated to **households** mainly focused on disseminating climate change information to enhance awareness and to encourage responsible actions, providing opportunities for self-reflection on individual lifestyles and understanding on how these contribute to climate change impacts. Also, to potentially change attitudes and values, as well as on providing a forum for national discourse on climate change issues to correct possible misconceptions. The most effective activities implemented consisted of television documentaries on coastal vulnerability and the role of Guyana's forests in climate mitigation and the observance of international events, such as the Earth Day, World Environment Day, World Water Day, etc.

The objectives across the different target groups varied and were adapted accordingly. Among the **groups of children and youth groups**, the activities focused more towards increasing knowledge and broadening the understanding on climate change issues, providing opportunities for local actions that address climate change and its impacts, and on developing youth skills to understand relationships between lifestyle choices and climate change impacts, promoting critical thinking and problem-solving skills. Many activities were implemented effectively across the groups of children and young people, such as quizzes, debates, essays, poster and painting competitions related to climate change, youth camps, hikes, and tours during summer breaks.

Regarding the **consumers groups**, the aim was focused on enhancing consumer's education about climate change impact that results from their choices, creating awareness about the direct link between consumerism and climate change, as well as empowering consumers to make informed decisions regarding purchases through flyers, leaflets, and informative stickers.

Regarding **religious groups and mother's unions**, the main objectives were to promote awareness and understanding of the role religious leaders play in spreading awareness and values related to environmental consciousness in their sermons and through their seminars. The main goal through the activities implemented across groups of indigenous peoples was to enhance awareness about climate change, its causes and consequences as well as its impacts, and to empower them to take actions to mitigate and adapt to it. These objectives were mainly achieved through community meetings.

For **tradesmen and technicians**, the objectives focused mainly on disseminating climate change information in order to enhance public awareness, and to encourage responsible actions. For resource users such as miners, farmers, fishermen, and loggers, the actions were aimed at enhancing awareness of the sensitivity to climate change issues which are related to livelihood activities within natural resource sectors, and at encouraging these groups to adopt practices that are more sustainable and support climate change mitigation and adaptation.

The most effective actions were the brochures, the newsletters, the demonstration projects and through the sensitisation seminars and outreach activities.

For the different **groups of professionals** the main objectives were to facilitate the decision-making processes on climate change issues, to formulate and review existing policies that will give structural support to the implementation of public education on climate change issues, as well as to equip planners, economists, engineers, local government personnel and any other professionals with appropriate knowledge and skills that will enable them to incorporate climate change issues in their planning and decision making processes. The most effective actions implemented were seminars, workshops and short professional training courses of two or three days.

For **scientific and academic communities**, the focus was to enhance the technical knowledge on climate change issues, adaptation, and mitigation options for Guyana, and to promote networking between the different groups and sectors with the broader community as well. Also, to provide opportunities for ongoing robust research on climate change, for instance on the topics of vulnerability studies or carbon sequestration, among others. The most effective actions to achieve these objectives were the workshops undertaken.

6.7. Awareness of current needs and level of awareness

This section provides an analysis of the current needs and current level of awareness regarding climate change and environmental education, training, and public awareness across different regions in Guyana. Using as a basis the different initiatives implemented at national, international, and regional levels previously described, and considering the progress analysis made since SNC recommendations, an assessment of the current state of the art in terms of environmental education is included below.

The level of public environmental knowledge and awareness has significantly increased in the country across the different administrative regions. A number of studies have shown an upward trend in the understanding of climate change and its effects and causes among the population, taking into account different areas of knowledge, such as perception of what climate change consists of, its causes, the impact it has on lifestyles, understanding of actions needed and taken in order to reduce the level of risks or the different methods used to communicate and transfer climate change information among the communities.

A recent article (Ferguson and Bramwell-Lalor, 2023) presents **Environmental and Sustainability Education (ESE) initiatives within the Caribbean** region implemented during the last few years. Some key findings and reflections of the study are relevant in order to assess the situation of current needs and level of awareness regarding climate change and environmental issues in Guyana. It is important to understand that these issues are considered within the scope of *Education for Sustainable Development* and are no longer referred to as *Environmental Education*. The definition of ESD as outlined by UNESCO (UNESCO, 2020) is considered a continuous transformational process that encompasses learning contents, outcomes, and pedagogy. Its goal is to empower learners with knowledge, skills, values, and attitudes to make responsible actions towards environmental integrity. Thus, acting towards promoting climate change education and ESD includes developing national action plans including specific actions and monitoring systems to track learning development; producing new curriculum across different educational levels and reviewing the existing curriculum; enhancing teacher's capacity and climate change knowledge through teacher training courses and professional development.

The underlying implications that this study assumes (Ferguson and Bramwell-Lalor, 2023) are linked to the importance of teaching ESD to students from an early age, in a way that builds real environmental action. The role that teachers play in the transfer of relevant knowledge as agents who interact directly with students daily is crucial. The areas that need more work are those related to policies. Further efforts should go into easing the gap between informal and non-formal education, and towards spreading a correct understanding of the main climate change concepts.

Education is an essential cornerstone for sustainable development as it empowers and equips people with the necessary awareness, knowledge, skills, and attitudes to undertake adaptive and mitigating actions towards climate change. Environmental education has been broadly introduced in different levels across Guyana's formal curriculum for education. Additionally, The Ministry of Education has benefited from projects financed by UNICEF, CI, and UNESCO, promoting lessons on biodiversity conservation, and providing training workshops for teachers as part of those projects (UNICEF, 2018), which have contributed to achieving major progress in terms of level of public awareness and environmental knowledge in Guyana.

Some of the **current needs regarding Guyana's environmental education** are:

- The need for a **continuous approach** to include environmental and sustainable development education across all educational levels, covering formal and informal initiatives for **Primary**, **Secondary**, **and Professional education** levels;
- Some more progress is still to be made to include more climate change education elements across the **different curriculums and different modules**;
- Further understanding regarding the extent to which successfully including **environmental education in the syllabi of many different subjects and educational levels** is contingent upon training teachers on the matter;
- Thus, **further teacher's training courses** and climate change education capacitation is needed.

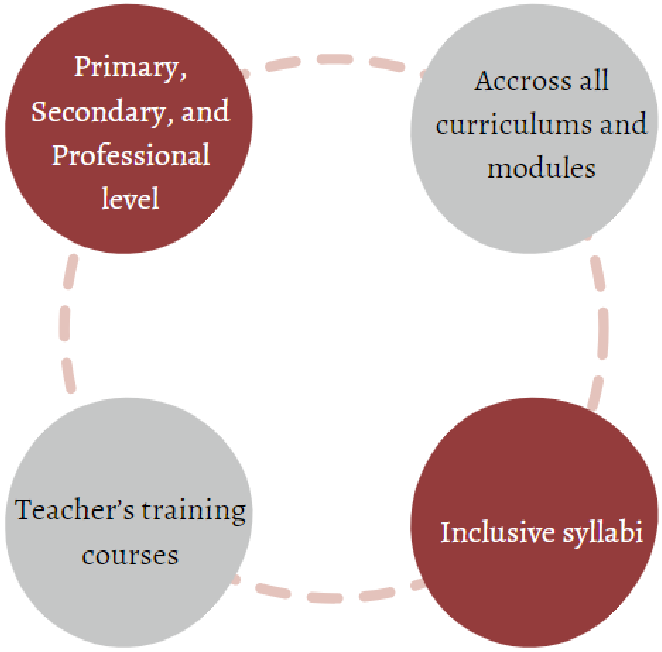

Figure 5.6. Guyana's current environmental education needs.

There is an initiative spurred by UNESCO as the Conference Framework for Teachers (CFT) to improve skills among teachers, notably in Information, Communication, and Technology (ICT) areas in which to develop their digital skills. The initiative involves assistance with policy, curriculum updates, training, and capacity-building to align learning and technological development with national strategies and goals.

Among other initiatives, for instance, the "**Strengthening Technical Capacities to Mainstream and Monitor Rio Convention Implementation through Policy Coordination**" project (previously described in section 6.3. Initiatives at National Level), implemented by the Ministry of Natural Resources in collaboration with United Nations Development Programme (UNDP) Guyana between the 2016-2020 period had the goal to enhance Guyana's capacities regarding decision-making processes to sustain global environmental obligations. As a result of this four-year project, a Global Environmental Issues in education module was prepared to be included as part of the secondary and post-secondary (technical) school students. The objective was for students to gain a wider understanding of global environmental issues and how different cultural values, attitudes and behaviour affect global environmental outcomes. The module introduces students to basic environmental concepts and terminology, helping them understand the main causes for global environmental problems. It also teaches students about the Rio Conventions and provides information on which global environmental problems included in the Rio Conventions require national obligations and actions. Finally, it covers general environmental knowledge focused on their respective region or local community.

This showed several **feasible pathways** for Guyana to integrate environmental issues and topics into the educational curriculum by including this type of module. Different ways of including it across the different curricula and subjects are:

- **Inclusion of environmental content into currently obligatory subjects such as Geography and Environmental Science**, given their comparative advantage with respect to other subjects in terms of adopting an environmental approach;
- Utilisation of content for crafting **Special Projects** assigned to students to meet the criteria of **School Based Assessment (SBAs)**, which involve ongoing assessments conducted by teachers throughout the course of the academic term or year;
- **Distribution of the Module to schools through e-Learning platforms**. In remote areas, such as the hinterlands, local radio stations may serve as an alternative outreach channel.

This module also considers guidelines for teacher's training, including recommendations for teaching professionals to follow to implement and use the proposed module in their corresponding classes and subjects:

- This module is best delivered through team teaching, and it is designed considering that teachers at secondary and post-secondary levels are trained in specific disciplines and conduct their own subjects, thus it is considered essential to form a core team of educators who are specifically trained to deliver this Module. This same approach applies if the Module is used to fulfil the requirements of SBAs;
- If the Module is to be delivered via e-learning channels or via local radio station to grant that it reaches more vulnerable communities, it may be advisable to count with the expertise of an environmental education specialist (who may also be a teacher in one of the institutions) to record the lessons which will also help create a training and educational database;
- Teachers should encourage students to think globally while acting locally. Students must understand the international context while being sufficiently aware of the particular national context of Guyana in terms of environmental education and climate change;
- It is beneficial for teachers to begin incorporating students' own local experiences, knowledge, and everyday life and linking it to environmental concepts and notions to help raise awareness;
- Students should not be regarded as passive learners and educational techniques must aim at involving them in active initiatives. Therefore, teaching and learning activities such as brainstorming, debates, Q&A sessions, role-playing/simulation exercises, YouTube videos, posters, and small group work should be incorporated.

Additionally, a **Public Awareness Implementation Plan** (Bynoe, P., 2018) linked to the Rio Conventions was prepared to mainstream the convention's targets across local communities in Guyana, showcasing the need for official environmental public awareness plans implementation at country level. The document calls for the promotion of broad public awareness as it is an essential part of global education efforts which strengthen attitudes, values, and actions for sustainable development.

Furthermore, a **UNDP study** (Hope, S.A.A., 2016) shows relevant statistical data extracted from surveys conducted with Guyanese population that is key to make an accurate assessment regarding Guyana's level of awareness regarding environmental and climate change topics. Table 5.11 presents key findings from this study.

Table 5.11. Key findings related to the level of awareness regarding environmental and climate change topics.

General understanding on climate change and its causes	
%	**Data**
12%	Of Guyanese population stated they fully understood the term "climate change"
8%	Of those who fully understood the term "climate change" were female
4%	Of those who fully understood the term "climate change" were male
49%	Of Guyanese population stated they understood the term "climate change" to some extent
5%	Of Guyanese population stated they did not understand the term "climate change"
30%	Attributed climate change to Deforestation
26%	Attributed climate change to Carbon Emissions from Vehicles and Large Businesses
25%	Attributed climate change to Burning of Fossil Fuels
74%	Respondents had experienced natural disasters which resulted in loss
Population's attitude towards climate change	
%	**Data**
56%	Stated they were feeling hopeful that some actions can be done to mitigate and adapt to climate change in Guyana
2%	Expressed their scepticism towards mitigating climate change
7%	Felt unsure or confused regarding their feelings towards the topic
49%	Of student respondents stated they were hopeful towards climate change
31%	Of student respondents felt fearful
19%	Of student respondents expressed their confusion regarding the subject, as they were still in the process of learning about climate change overall

Source: Hope, S. A. A. (2016). Knowledge, Attitudes & Practices Study on Climate Change Adaptation & Mitigation in Guyana. UNDP.

Additionally, **five focus group discussions** were conducted in four of the seven communities, held in local community spaces aiming for the group participants to represent a cross-section of the population disaggregated by gender, age, and economic status. The most relevant qualitative findings obtained through those focus group discussions are that respondents from

Region 9 knew the most about climate change. Also, all respondents had heard and understood the concept of climate change, being able to articulate the causes of climate change and to list at least one cause.

Another relevant study (Bynoe & Simmons, 2014) performed a curriculum audit, a survey of a sample of primary school teachers, and a desk review of relevant national policy documents, based on a content analysis and key-words examination in respect of climate change education. The curriculum audit identified the content used in lessons and the main outcomes regarding the subject of climate change in primary schools in Science and Social Studies. Also, a teacher survey collected information regarding the extent of the inclusion of climate change topic into the lessons delivered to primary students and identified recommendations, needs, concerns, gaps, or adequacy of material regarding climate change issues, concepts, and understanding of capacity-building, adaptation, and assistance. Table 5.12 presents the main findings of this study.

Table 5.12. Key findings regarding of climate change education.

%	Data
19%	Of Science teachers surveyed considered that climate change was successfully included in the curriculum from Grade 1-6. The topics included referred to weather, erosion, natural disasters, the water cycle, the environment and forest conservation
81%	Believed climate change should be included and suggested for it to be inserted in the curricula including education on causes and mitigation actions
26%	Of Social Sciences teachers indicated that climate change was included in their curriculum in the form of contents regarding weather conditions and its effects, natural disasters, weather instruments, social adaptation, and global warming, among others.
72%	Of Social Sciences teachers did not include climate change in their curriculum.
83%	Of those who have not included climate change as part of their curriculum felt it should be included

Source: Bynoe, P., & Simmons, D. (2014). An appraisal of climate change education at the primary level in Guyana. Caribbean Geography, 19, 89-103.

One of the main outcomes of this study is that it shows great support from both social studies and science teachers to include climate change topics in primary level education curricula, including the addressing of mitigation and adaptation measures, climate variability, sustainable use of forests, water, and energy resources, as well as lifestyles and consumption patterns. The most common learning outcome across different grades and within both curricula is about knowledge of climate change and its effects, although students from different grades demonstrate to be able to understand and appreciate issues related to water conservation, saving energy, and caring for the environment.

It also conveys an analysis of the use and level of success of diverse educational strategies. Teachers suggested a combination of educational strategies such as class discussions, field exercises and audio-visuals to cover climate change training formally. Also, essay competitions, quizzes and role play exercises can be employed in higher grades to promote an active learning approach. It is key to combine both a non-formal approach and a formal approach towards environmental learning, as lessons should transcend the school curriculum and the delivery of theoretical contents to promote behavioural change that has an actual impact on the lifestyle and sense of individual responsibility towards climate change actions. Paying special attention to educational strategies that promote active skills as opposed to passive skills is essential. For example, by encouraging educational strategies that teach the process of discovery, inquiry, critical thinking, and that teach students skills related to observation, communication, prediction, reasoning, exploration and interpretation, among others. Among the issues identified by teachers are the general need to increase their own academic capacity on the topic, the high dropout rate among teachers due to emigration, and others.

Overall, the **main actions that will enhance Guyana's current needs regarding environmental education and awareness are**:

1. Enhancing **teacher's climate change environmental capacity and knowledge** through broadly accessible and open teacher training through workshops, seminars, and capacitation courses;
2. To develop a **comprehensive policy on ESD** that specifically targets climate change issues by including environmental education as a separate section in the Education Strategy Plans and by involving all stakeholders in the delivery of climate change education through a monitoring and evaluation system that assures coordination among the involved parts to reach effectiveness and long-term sustainability of the proposed initiative;
3. Continuing to involve **climate change education** actions **across all levels** of education through both **formal** and **informal** means, improving climate change material inclusion in the educational curriculums;
4. Improve in the inclusion of foreign language education and continue to involve **vulnerable groups** of children and women, as well as indigenous and at-risk communities to grant **universal** and **inclusive education** throughout **all regions** of the country;
5. Enhancing **distance learning techniques** and **improving digital** and technical **infrastructure** available;
6. Continue to improve **public awareness** throughout **youth people groups** and capacitation programmes for all **civil society**.

Figure 5.7 presents the main actions to enhance Guyana's environmental education.

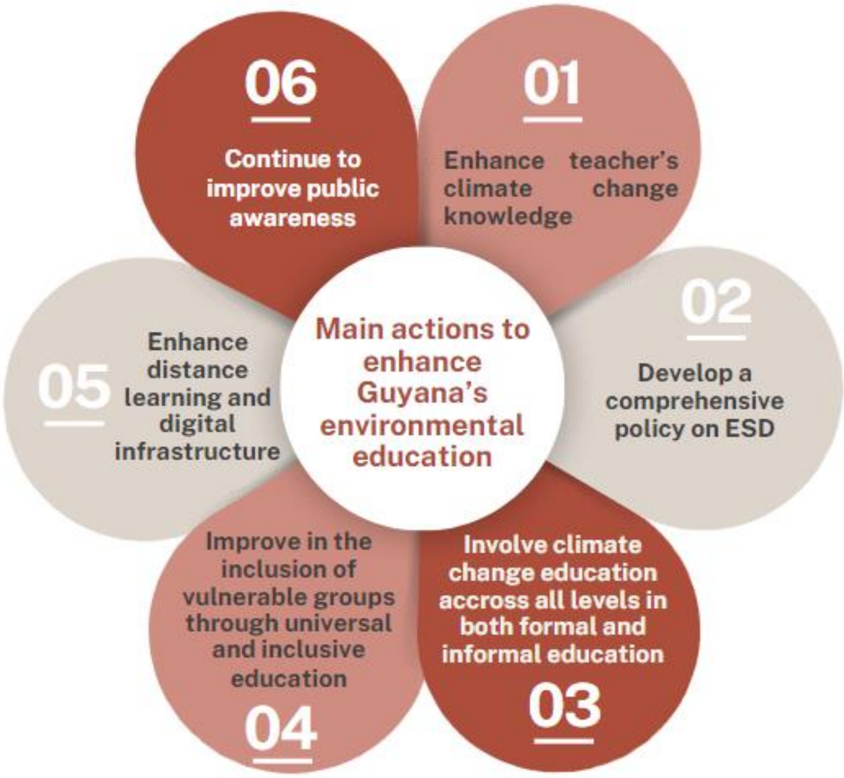

Figure 5.7. Main actions to enhance Guyana's environmental education.

Understanding that education is directly intertwined with social and economic circumstances, thus the success of climate awareness initiatives is dependent on how accessible basic education is for students across the country, as well as on their social and economic circumstances that allow them to attend school or to dedicate time to partake in any non-formal environmental activist actions.

6.8. Main challenges and recommendations

This section presents an outline of the main challenges and associated recommendations for implementation regarding the different areas analysed during this chapter: Transfer of Technologies, Research and Systemic Observation, Capacity-Building, Information and Networking, and Education, Training, and Public Awareness.

As Guyana undergoes a transition towards more sustainable development, climate justice is a guiding concept utilised to ensure fairness and respect for human rights. Climate justice means "ensuring representation, inclusion, and protection of the rights of those most vulnerable to the effects of climate change" through measures that "promote equity, [and] assure access to basic resources", which means having to address social, gender-based, economic, intergenerational, and environmental injustices (UNICEF, 2022). The concept of climate justice directly relates to **Sustainable Development Goal 10: Reduced Inequalities**. In Guyana, an important challenge in this area is the limited use of digital technology by indigenous communities (Elliot, 2020). Indigenous communities are often the first to endure the negative effects of climate change despite their small contribution to greenhouse gas emissions because of their connections to the environment and way of life centred on environmental resources. In Guyana, for instance, in 2017 indigenous Amerindian villages were hit by severe flooding with water rising over 15 feet (4.5 metres) in Regions 7 & 8, affecting 30,000 people, destroying homes, and ruining crops (Lakenarine et al., 2020).

It is important that indigenous Amerindian communities adopt technologies that can increase their resilience, such as the technologies devised to strengthen the agriculture sector. To accomplish this, the Government of Guyana will focus on the adoption of technologies among indigenous people and to facilitate this process through training initiatives and lessening organisational and bureaucratic obstacles to the access of new technology. Assisting indigenous communities in adopting climate smart technologies could help narrow disparities in education levels and access to resources, thus decreasing inequalities.

Regarding the different priority sectors, there are different challenges detected that could be addressed. Within the agriculture sector, research on the Essequibo Coast in Guyana has identified the need to provide farmers and stakeholders in agriculture with capacity-building to face and withstand challenges originating from climate change. For example, on the Essequibo Coast, knowledge gaps have been identified among farmers who, while having heard of climate change, are not fully aware of its implications and the consequences this could have for the sector they depend on, and therefore, on their livelihoods and well-being.

Furthermore, within the coastal zones sector, mangrove monitoring and protection will continue to be an area of focus as these activities align with **Sustainable Development Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development**. Efforts will be taken to keep discussions on the benefits of mangroves to communities and to sustainable development present during decision-making processes affecting coastal zones. Additionally, **Sustainable Development Goal 1: Poverty Eradication** and **Sustainable Development Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture** also relate to mangroves through their provision of ecosystem services. Moreover, given the ability mangroves have to capture carbon and how this contributes to mitigation, further studies are needed that investigate drivers of change for mangroves and how they change over time. For this to be done adequately, a multi-disciplinary approach to monitoring with an eye out for deforestation at regional and local levels is needed, as is the formulation of sound baselines to measure changes more accurately over time (Primavera, J. H et al., 2018). Vulnerability models to simplify the elaboration of measures and strategies are also needed and, while it is recommended that local communities be involved in the monitoring process to improve awareness, Guyana must also consider regional and international support networks to advance the transfer of technologies and the capacity-building needed for these to be successfully adopted.

Going forward, Guyana will continue enabling research in the area of mangrove ecosystems. Additional research is needed to fully grasp the aptitude of mangroves to adequately deliver ecosystem services, and how their potential is conditioned by variables such as geomorphology, forest health, climate change induced extremes, and other human pressures with potential to alter the services provided by mangroves such as pollution or coastal erosion resulting from anthropogenic activities. Further research in this field could assist Guyana with the management and restoration of these precious natural systems by uncovering information on factors (natural and anthropogenic) that influence mangroves which could, for instance, help boost carbon storage. Together with research, monitoring technology needs continue growing in Guyana, providing workshops and capacity-building activities to solidify adoption and retain knowledge in national institutions. Through research and investment and international support for the transfer of technologies, Guyana can continue to take important steps in formulating preservation strategies, as well as restoration and expansion programmes to strengthen carbon storage. Doing this will help Guyana in following its LCDS and associated policies by harmonising stated objectives with measures that advance them.

Guyana could greatly benefit from a continued transfer of remote sensing technology, as these, through the technology's capacity to cover varying resolutions and light spectrums, allow for the collection of detailed information that can ease decision-making for measures relating to restoration, conservation, and for the management of coastal zones. This technology could be further integrated into monitoring systems, allowing for the identification of vulnerable areas and the establishment of appropriate measures that consider both anthropogenic and natural impacts. Through the transfer of technology and the strengthening of local capacities, Guyana can better safeguard itself from climate change.

Within the area of Education and Public Awareness, the main areas of improvement identified are related to teacher's training on climate change contents and climate risk action, the improvement of vulnerable groups inclusion in all areas of education including environmental education and environmental action, the improvement of both physical and digital infrastructure to cover continuous education even during disaster management, the increase of environmental education materials, and resources, as well as the inclusion of these resources in formal education curriculum across the different levels.

According to the National Risk Management Policy for the Education Sector in Guyana (Ministry of Education, 2021b) there are still no measures in place to assist forcibly displaced children in learning and catching up with their standard age within the educational curriculum. Additionally, there is a challenge of language classes to offer for those displaced populations who need support due to differences in language. These two areas of work will be enhanced and considered further, and actions to provide learning and linguistic support for marginalised communities can be designed.

Incorporating indigenous and foreign languages into the school's curriculum and incorporating indigenous and foreign languages in the curriculum of teacher's capacitation at the Cyril Potter College of Education (CPCE) and any other relevant teacher capacitation national programme is also recommended. Studies show that education involvement by both students and their families is directly related to social and economic factors that directly affect absenteeism, educational outreach and coverage. One of the biggest challenges regarding education lies in achieving widespread access to continuous education and in reducing absenteeism levels, granting educational coverage across regions, at all student year levels and regardless of gender or socioeconomic status.

Another area of improvement can be teacher training, in order to further enhance capacities among educators regarding climate change education and environmental awareness. For example, according to the National Risk Management Policy for the Education Sector in Guyana (Ministry of Education, 2021b), teachers and principals are lacking training on relevant natural hazards, conflict risk, or crisis risk reduction. Teachers have not been trained to support displaced children adequately; that could be an area to focus some improvement efforts on.

Digital infrastructure in Guyana for educational technology transfer and use also faces several challenges. Energy and technological devices are not widely available and internet accessibility and connectivity is a challenging service in many areas (Ministry of Education, 2021b).

Furthermore, related to digital infrastructure and digital learning, some teachers in Guyana will require more training regarding online delivery of their classes. Institutions such as NCERD and the CPCE will have to ensure distance learning is adopted and implemented if needed following a disaster (Ministry of Education, 2021b).

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6 Constraints, Gaps and Needs

In this chapter, the constraints, gaps and needs Guyana faces in relation to climate action and climate change transparency are discussed. Furthermore, the financial needs for the country´s ambitious climate agenda are presented and an exhaustive analysis of the international financial, capacity-building and technology support received by Guyana is provided.

1. Introduction

As climate change is impacting terrestrial life at an increasing pace, countries around the globe scramble to limit global warming to more manageable levels and at the same time seek to shelter against the adverse impacts of climate change.

In this endeavour, large amounts of financial resources, strong political and social will and enhanced cooperation and transparency will be required. Harnessing their different economic strengths, nations have begun over the past decades to ramp up their climate agendas and increasingly seek to implement, support and collaborate on climate action. Nevertheless, the financial resources dedicated to climate change continue to fall short of the need, and in particular the most vulnerable countries are already suffering the impacts of rising sea levels, extended heat waves, increased mean temperatures and torrential rainfalls, amongst others.

Therefore, global efforts in the fight against climate change will need to be increased on all fronts, including the accelerated transfer of financial resources, technological solutions and targeted capacitation efforts required to both limit – mitigate the magnitude of and shelter-adapt to the adverse effects of climate change.

Guyana acknowledges both its responsibility and particular role in this effort and has stepped up to protect its invaluable forest resource sequestering vast amounts of CO_2 from the atmosphere. In this regard, innovative solutions for mobilising resources for climate action were brought underway, including first of a kind carbon credits and results-based payments for forest protection. While remaining a carbon sink for the foreseeable future, Guyana recognises that the current economic development trajectory, including the production of oil and gas, will require substantial investment in clean cutting-edge technologies and prudent resource management.

Furthermore, Guyana is committed to transparently communicate climate change information to the United Nations Framework Convention on Climate Change (UNFCCC) to support the global efforts, and, similar to other developing countries requires international support to implement more effective climate monitoring and reporting approaches as well as to implement sustained and effective climate action. In this context, this chapter highlights the key constraints and gaps faced by Guyana in this endeavour and offers a consolidated analysis of the financial, technical, and capacity-building support required and received by the country.

2. Constraints, gaps and related financial, technical and capacity-building needs

This chapter provides a comprehensive analysis of the main constraints Guyana faces for implementing effective and sustained climate action as well as for complying with the international reporting requirements. The analysis is structured along different dimensions such as institutional, technical, capacity-related, as well as financial constraints. The structured analysis relies on the information compiled in Technology Needs Assessment (TNA) completed in 2017, the preliminary Third National Communication (TNC) Report from 2021 and the Biennial Update Report (BUR) from 2024 as well as it synthesises the gaps and constraints identified in the development of the different components of this TNC. As such, the prevalent gaps related to the compilation and reporting of the Greenhouse gas (GHG) inventory, for mitigation and adaption efforts and reporting as well as the financial constraints are compiled to ensure a comprehensive reflexion on the principal challenges and needs of the country.

2.1. Institutional and capacity-building constraints and gaps

Guyana is facing a human resource gap in some areas, particularly affecting monitoring activities. Emigration and staff turnover have exacerbated this issue, resulting in an ongoing need for capacity building and training. Staff turnover in relevant institutions causes disruptions that affect vital aspects of monitoring: continuity and consistency. Failure to guarantee these two aspects can result in important gaps in data collection and analysis. As a form of addressing this challenge, Guyana needs continued investments and support related to training programmes so that the staff in question possess the required skills and knowledge to conduct their activities. Through the prioritisation of training and capacity building in a continuous way, Guyana can begin to mitigate the impacts of high turnover rates, although additional measures like attractive wages need to be considered to avoid the high turnover in the first place.

Guyana faces institutional challenges in some areas, that slow down development. For instance, in a few instances, strategies and workflows are not resulting in the expected completion of initiatives in transportation infrastructure, so a re-evaluation of these is needed in order for Guyana to improve its efficiency in project completion and optimise economic resources. To address these issues, Guyana has identified as important, the need to provide capacity-building and training to overcome these institutional barriers and secure the necessary resources, skills, and knowledge to modernise its infrastructure and thereby enhance its sustainable development.

Constraints have resulted in slower pace of implementation in some areas including education and awareness measures that could help address climate change. For example, there has been moderate to low advancement since the Second National Communication in terms of further integrating climate change considerations into the university curricula, and efforts to create educational materials tailored to the needs of indigenous communities, like specialised booklets, have been insufficient and remain underdeveloped. These two examples point to there being challenges in Guyana´s approach to climate change education and awareness. There is therefore a clear need to continue the work in developing education and awareness measures to engender a more informed, precise, and proactive response to climate change, thus ensuring sustainable development and greater resilience.

Within the areas of capacity building and information and networking, the main challenges Guyana faces are continuing the offer of sectoral capacity building trainings on climate change impacts, measures, and adaptation, as well as engagement sessions involving key actors such as professionals, students, and any other relevant target group. Also, it is necessary that Guyana continues to improve on the use of digital information tools for networking and public awareness spreading purposes. For that means, some recommendations are to continue considering regional and international support networks to advance in terms of transfer of technologies and capacity-building programmes within the country, to continue promoting engagement sessions on different relevant topics, such as institutional management of mangroves and ecosystem services; and to continue to promote these training workshops sessions across the different population sectors, regions, and the different professional groups of employees per sector as well as across the education sector. Additionally, it is important for the country to continue collaborating with key institutions, such as National Agricultural Research and Extension Institute (NAREI) or the Guyana Forestry Commission (GFC), in order to continue implementing trainings in the agriculture and forestry sectors.

Going forward, Guyana will continue to engage with indigenous and hinterland communities and vulnerable groups so plans for technology adoption can fully benefit all groups in the country. Doing this will require extensive capacity-building efforts that can consolidate latest technological developments into Guyana in a way that provides appropriate opportunities for sustainable growth and well-being improvements.

Additionally, Guyana will benefit from improving its preparedness in the face of extreme climate events through emergency alerts like Early Warning Systems to improve disaster response, and this will require concrete actions from national institutions to promote a paradigm shift through mainstreaming, education, and policy development to value caution and preparedness higher than reconstruction alternatives. From an institutional perspective, Guyana is clear on the paramount importance of training and capacity-building to ensure its sustainable development, as diverse stakeholders engaged in different sectors require specialised skills and knowledge to ensure the successful implementation of mitigation and adaptation measures.

A practical institutional approach for maintaining Guyana's status as a net carbon sink, maintaining low emission in all sectors and reducing greenhouse gas emission where this is possible, is an identified priority. Guyana has laid out a structured and actionable framework in which the stakeholders involved clearly understand the commitments in question. Integrating policies is an important need in Guyana, as ensuring the vertical integration of the country's policies creates a coherent thread between the national, regional, and local levels. This will partially require consolidating policies and institutional arrangements and implementing needed follow up actions.

The institutional establishment of clear structures and progress tracking methods for the implementation of measures to tackle climate change has been identified as a necessity for the avoidance of maladaptation. Institutionally driven actions can help in preventing the implementation of policies and measures with the potential to augment vulnerability or worsen the negative impacts from climate change. In line with this, from the institutional perspective the mainstreaming of climate change into planning processes and policy elaboration is a priority need to undergo resilient and sustainable development. To contribute to this, it will be necessary for Guyana to finalise guiding documents like the Draft National Integrated Water Resources Management (IWRM) Policy and Roadmap, and the Draft National Energy Policy as early steps in the process. Finalising these drafts will demonstrate Guyana's commitment to climate action domestically and internationally, and additionally serve as guides to Guyana's actions in relation to climate change, thus enhancing transparency.

Mainstreaming climate change is a multi-sectoral challenge. Looking at agriculture, there is a need for continuously strengthened institutions and greater support for regional councils in order to plan and develop prioritisation strategies for smart investments that will add the most value to the sector given the conditions brought forth by climate change. Continuing with agriculture as an example, the sector will from the relevant institutions support for nutrition education, the popularisation of crop diversification. Yet across all sectors a boost is needed in the areas of research, monitoring, and communication in order to elaborate and disseminate the best available data among the pertinent institutions and stakeholders, including fomenting the development of relevant skills and engraining climate change and nature considerations into planning and management.

2.2. Technical constraints and gaps

Guyana is addressing and working on several technological and technical challenges. While recent efforts pour resources into improvement, parts of the infrastructure require overhaul, such as some irrigation systems. Driven by the Government and by farmers representation, the promotion of workshops and information dissemination as well as investment in necessary infrastructure like water pumps and weed removal tools (Lakenarine et al., 2020), is planned in the near future.

Extreme weather events that are exacerbated by climate change present an important challenge, and Guyana is further constrained by a lack of technological infrastructure and technical expertise that makes it especially challenging to address these changing conditions and slows down the uptake of renewables because there are some limitations in place for the growth of research and development initiatives. For example, water overflows caused by sea level rise are leading to pump systems being overworked, thus placing key infrastructure located in coastal and low-lying areas at high risk due to the population concentrations in these areas.

Guyana's topography and population distribution also act as constraints due to the effect of climate change. Sea level rise, coastal erosion, and shoreline recession significantly constrain Guyana's technical options to address climate change given how a majority number of the population lives along the coast, which makes inland relocation a very difficult task because of the high costs and logistics such a measure would entail.

Data collection and overall data availability are important constraints in Guyana related to technology. Adequate monitoring systems in the face of climate change necessitates high investments, and capacity building and technical skills for the use of technology. The water resource sector is particularly constrained as it is highly relevant across sectors (irrigation, domestic use, commercial use, tourism, and energy through hydropower), but gaps in the availability of data limits effective decision-making and the success of water management centred around sustainable strategies. Since the 1990s, there has been a clear need in Guyana for technical developments for the monitoring of water resources, both for groundwater and surface water. The further development of Geographic Information Systems and remote sensing techniques is therefore needed to advance Guyana's tracking abilities. Together with this technical development, Guyana also needs to work on the information systems employed to monitor and disseminate climate change data, which is needed to ensure an informed decision-making process. While vital, monitoring needs to be accompanied by improved capacity-building and trainings that build on previous knowledge and skills, aligning with stakeholders' specific needs and supporting practical experience using the necessary technologies.

Guyana's water sector also needs to address flood protection and water management due to the risks posed by sea level rise and erosion. To account for this, Guyana will require the development of strong flood protection measures for its coastal zones, together with an integrated water management system for infrastructure to address the risks presented by water overflows and therefore protect vital assets located in flood prone areas.

As Guyana develops, it will require a modern and low-emission transportation sector. Transportation infrastructure requires large investments to improve the transport network's connectivity through the use of climate-sensitive transportation alternatives. Guyana's transport connections and the country's topography with low population density in hinterland regions results in limited distribution and accessibility to efficient modes of transportation. Additionally, the road conditions cause added losses as the work that needs to be done to periodically rehabilitate road infrastructure in poor conditions reroutes resources that could have gone to other areas, some perhaps in critical need of adaptation measures, such as coastal communities requiring sea defences.

Likewise, the agriculture sector faces challenges which require new research on crop varieties to enhance crop resilience and transfer of technologies to adapt to climate change. The access that farmers have to public services can be improved, and development plans need to be drawn to address issues with drainage and irrigation systems to improve productivity and a better use of resources.

In sum, large scale investments and transfer of modern technologies enhancing the monitoring and management of resources are required in Guyana. Further, revamping the transport sector well as implementing protective shoreline infrastructure under a lens of climate resilience will be paramount in the coming years.

2.3. Financial constraints and support needed

In this section, the main financial constraints and the support needed to implement Guyana´s ambitious climate change objectives are discussed. Financial constraints are highly linked to resource availability and to the ability to mobilise national as well as external resources from international and private sector sources and as such correlate strongly with the national economic outlook and the economic relationships to other countries and to the international donor community.

In Guyana, the economic outlook suggests rapid economic growth in the short to medium term linked to the recently begun and ongoing exploration of oil and gas and significant increases in national and foreign investments in the country. As a result, the economy is expected to double in size by 2028.

Proceeds from the oil and gas exploration are expected to grow over time as the upfront investment costs are increasingly recovered, thus releasing a larger share of the revenue to the Government of Guyana. The government intends to harness this additional source of income to drive major infrastructure and social sector projects with the objective to elevate the living standard and economic capabilities of the country and thus to pave the way for sustained economic growth. In particular, the road transportation network and the energy sector, but also the housing sector and the built and natural environment of the shoreline are targeted by increasing investment.

However, Guyana has stated that economic development will follow an even distribution pattern by which all groups and areas gain as proportionately as possible from the growth. Therefore, investments for economic development measures in hinterland and indigenous communities as well as in the urban fringes shall be prioritised to allow for sustained and equitable development. Furthermore, community strengthening, and development is especially relevant for the adaptive capacity and resilience to the adverse impacts of climate change as hinterland and indigenous communities figure among the most vulnerable segments of the population. The current adaptation measures implemented in rural areas likely will improve aimed at sheltering vulnerable communities against the impacts of climate change, thus necessitating increased financial support.

Linked to the national development trends, the energy sector is a crucial sector for climate change mitigation in Guyana as the country currently navigates the exploration of oil and gas, a potentially relatively cheap source of energy, as well as the expansion of renewable energy sources driven by the national potential in hydropower, solar power and wind power production. While Guyana´s forest resource maintains the negative GHG emissions ratio for the country, the GHG emissions in the energy sector are expected to remain flat or decrease due to Guyana's plans to scale up renewable energy development. To do so however, substantial financial resources are required, which can partially be sourced from the national budget, but may also require large external investments.

Underlining the financial needs, the updated Low Carbon Development Strategy (LCDS), reflecting Guyana´s development priorities from 2021 to 2030, highlights the path to achieve long-term low carbon national development. While the energy and forestry sector are identified as the two key sectors for mitigation efforts, the LCDS presents a number of key themes in which investment will be required until 2030. The estimated costs by theme are summarised in Table 6.1.

Table 6.1. Estimated costs for implementation of the LCDS 2021-2030.

LCDS 2030 Theme & Programme	Total cost 2021-2030 (US $ million)
Ecosystem services (including water management)	320
Blue Economy	295
Clean energy	3.014
Climate Adaptation and Resilience	1.2
Amerindian and Hinterland Development	450
Transportation	957
Digital infrastructure	325
Total	**6.561**

As a caveat, it is to note that the LCDS also drives the development of projects which potentially reach beyond the classification of climate change mitigation and adaptation finance. However, due to the focus of the strategic directions, sectoral priorities and envisioned actions, the costs displayed in the table are, while not perfectly representative of the exact financial needs for climate change mitigation and adaptation, highly indicative of the climate related development needs of Guyana.

In addition, in its 2016 Nationally Determined Contribution (NDC), Guyana set out its unconditional and conditional pledges for both climate change mitigation and adaptation. While the mitigation pledge is not quantified, as the costs are determined following annual estimations, the actions foreseen have crucially determined the strategic themes and prioritised sectors of the LCDS.

The other strategic directions, in part include climate change adaptation or wider development objectives, however mitigation co-benefits are expected from the implementation of these directions. Guyana is capitalising on the proceeds from the sale of forest ART-TREES to finance the development of measures across the LCDS themes as well as to mobilise funding through public-private partnerships and through other private sector investment. About $1.045 billion are envisioned to be mobilised from the ART-TREES, while $1.166 billion are earmarked to be raised from private sources.

Comparing this to the current level of committed funding, in particular from the ART-TREES credits, a substantial funding gap is identified. This may be addressed by the increased sales of credits to private corporations. Similarly, private investments in Guyana´s energy sector and in the infrastructure are increasing, with the largest inflows recorded for the development of major gas-to-power installations to move away from dependence on heavy fuel oil, and with the next wave of funding targeting the further ramp up renewable energy sources.

Regarding climate change adaptation, the NDC estimates costs for implementing conditional adaptation measures at a total of 1.6 billion USD which is additional to the financial need for mitigation. Measures are envisioned to be implemented for the following adaptation themes:

- *Sea defence enhancement and maintenance.*
- *Strengthening drainage and irrigation systems.*
- *Mangrove restoration and ecosystem protection.*
- *Implement adaptation measures and build resilience in hinterland areas.*
- *Development and implementation early warning systems.*
- *Enhanced weather forecasting including microclimate studies and localised forecasting.*
- *Building climate resilient agricultural systems through water resource management, a diversified and integrated approach to agri-business, sustainable farm management systems, and capacity building.*
- *Development and introduction of crop varieties which are:*
    - *Flood resistant*
    - *Drought tolerant*
    - *Disease resistant*
- *Development of environmental and climate change awareness programmes at all levels.*
- *Development of innovative financial risk management and insurance measures.*

Conditional in this context refers to Guyana pledging to implement these actions in the case of receiving of international financial support. It is to highlight that the current level of support committed for climate change adaptation does not cover the estimated costs for implementing the conditional NDC adaptation measures.

In the following, a concise overview of the institutional, capacity-related, technological and financial needs is provided and the pertinent gaps relating to the GHG inventory development, climate change mitigation, adaptation and support needed and received are underscored.

2.4. Consolidated overview of constraints and gaps

In Table 6.2, a concise overview of the key challenges and gaps by dimension is provided. Further, measures to address the challenges are proposed and the respective priority of each gap to be addressed is defined.

Table 6.2. Consolidated overview of constraints and gaps by dimension.

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
GHG Inventory	Need for centralised institutional and technical capacity to develop GHG inventories on a continuous basis and fulfil the reporting obligations under the UNFCCC.	Capacity	Enhance the stakeholder capacity in the key institutions such as the DECC and other ministries for which funding is required to employ adequately skilled persons, to provide training and to acquire material.	High
	It needs to be ensured the data collected for the inventory is complete to enable adequate quality checks.	Technical / Capacity	Implement an effective and centralised MRV system to guide thorough data collection procedures in line with the reporting cycles under the UNFCCC. To do so, harness existing sectoral MRV system approaches to streamline the procedures.	High
	Need for enhanced sharing of data across potential data providers.	Capacity	Accelerate sectoral outreach as well as inter-institutional data-sharing agreements and memoranda of understanding.	High
	Need for enhanced quality of	Technical	Enhance key national statistics such as the Energy Balance, customs data, as well as	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	databases and national statistics to facilitate the inventory development process.		forestry and agricultural statistics and develop effective databases to draw from for the inventory development.	
	Need for increased incentives for improving national research on sectoral GHG emissions.	Financial / Capacity	Establish cooperation with national research universities and institutes to develop a strong knowledge basis in the country.	Medium
Mitigation	Need for enhanced technical capacity to thoroughly estimate the mitigation impact of the key actions.	Capacity	Enhance the stakeholder capacity in the key institutions responsible for reporting and for implementation of sectoral mitigation actions through training and adequate material.	High
	Need for increased national resources to achieve renewable energy targets.	Financial	Mobilise additional funding for renewable energy projects through private sector investments and through grant-based finance.	High
	Need for additional resources to achieve forestry sector actions.	Financial	Mobilise additional funding for forestry sector projects.	Medium
	Need for more resources to support research	Financial / Capacity	Establish cooperation with national research universities and institutes to develop a	Medium

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	and guide the development and implementation of mitigation actions.		strong knowledge basis in the country and to inform adequate policy decisions.	
	Additional sectors such as agriculture, transport, IPPU and waste should be further prioritised for mitigation actions.	Technical / Capacity	Conduct sectoral analyses to assess the potential for emissions reduction in these sectors in view of the respective GHG emissions profiles and available funding opportunities.	Medium
	Need for improved transmission and distribution grid infrastructure.	Technical/Financial	Enhance the grid capacity in the country and ensure its reliance through substantial investment	High
	Need for decrease in reliance on fossil fuels for electricity production and transport.	Technical/	Foster the fast ramp-uo of renewables to increase the share of renewable sources in the energy mix and thus reduce the need for fossil fuels. This further helps to outweigh some of the increasing emissions from the oil and gas exploration.	High
	Strengthened institutional framework for streamlined mitigation planning	Technical/Capacity	Rework the key mandates of national government and other institutions to enable a guided process of identifying prioritizing and implementing as well as monitoring mitigation efforts. Leverage initial improvement reached	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
			through the MRV system for forestry to expand across sectors.	
Adaptation	Need for comprehensive Monitoring and Evaluation (M&E) system for climate change adaptation	Technical / Capacity	Improve the inter-institutional coordination and set up a robust M&E system by which all involved actors are aware and capacitated to provide and manage the relevant data.	High
	Enhanced access to reliable, centralised, and updated information for adaptation planning and mainstreaming	Technical / Capacity	Set up a central knowledge repository supported by permanent staff and sustained funding that is easily accessible through mobile phone to ensure coverage in rural areas	High
	Need for mainstreaming of climate change into national and sectoral policies, programmes, projects and budgets	Technical / Capacity	Prioritise climate change adaptation in national, sectoral and regional planning processes through defining key budget items and markers gauging the degree to which adaptation is considered.	High
	Need for additional national resources to address the funding need for the implementation of required adaptation measures	Financial	Mobilise the private sector and innovative investment schemes to address the funding gap. Devote a larger share of national resources on adaptation in vulnerable segments of society.	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	Need to have more extensive uptake of digital technology by indigenous communities to increase climate change resilience.	Technical / Capacity	Continue to engage with indigenous communities and other vulnerable groups to expand technology adoption	Medium
	Need to address accelerated adoption of new technologies within the agriculture sector.	Technical/ Capacity	Training initiatives and reduction of organisational obstacles. Strategic allocation of resources and funds for increased effectiveness.	Medium
	Need for more awareness and capacities to address climate vulnerabilities across sectors	Capacity	Roll out a large-scale awareness campaign to enhance the understanding of climate vulnerabilities in the general public and to adopt household level adaptation measures	High
	Need for continuously improved mangrove monitoring and protection in coastal zones.	Technical/Financial	Foster the development of monitoring centers along the coastline and create enhanced public awareness to coastal communities.	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	Need for improved drainage and irrigation infrastructure hampering effective water resource management	Technical/Financial	Mobilise substantial funding from private sector and the national budget to modernise the drainage and irrigation system and adopt new technologies	High
Institutional dimension	Need for enhanced institutional coordination to effectively realise priority climate change mandates.	Capacity	Revise the necessary sector policy arrangements to enable more effective climate change mandates of the key actors.	High
	More effective streamlining climate change effectively into specific strategies and plans across institutions.	Capacity	Enhance the policy response to climate change by leveraging key national strategies such as the LCDS and the NDC and streamlining the key objectives into sectoral development plans.	High
	Need for enhanced effectiveness of budgetary expenditures for climate change action.	Financial / Capacity	Develop a stronger policy framework to facilitate budgetary allocations for climate action including an effective budget tagging mechanism to identify and quantify climate finance spending.	High
	More effective coordination and collaboration among agencies.	Technical / Capacity	Improve inter-institutional coordination through an effective MRV system and increased awareness activities.	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	Some reliance on donor finance for implementation of climate action.	Financial	Further enhance private sector contribution to climate action through 1) incentive mechanisms and public-private partnerships, 2) leveraging the proceeds of the oil and gas production and 3) improving the MRVS framework to enable increased sale of the highly innovative ART-TREE carbon credits.	Medium
	Improved sectoral policy to tackle climate change building from LCDS 2030 strategic guidance.	Technical / Capacity / Financial	Elevate the climate change agenda to a central consideration in governance processes and drive needed policy setting and implementation across sectors that allow for setting clear targets, timelines, and responsibilities.	High
Research and observation	Further studies needed on drivers of change for mangroves and their progression and changes over time.	Technical/ Capacity	Development of vulnerability models to simplify the elaboration of measures and strategies. Capacity building initiatives should follow a strategised plan based on learning objectives so that knowledge and skills are built based on the specific needs of the trained personnel.	Medium
	Engender a multidisciplinary approach to monitoring with a special focus on deforestation	Technical/ Capacity	Conduct further studies on effective strategies. Analyse policy application results via surveys and research. Promote further research and investment and international	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	at regional and local levels.		support for the transfer of technologies.	
	Requiring additional research needed to investigate mangroves in relation with health, climate change impacts, human impact and results from anthropogenic activities.	Technical/ Capacity	Enabling research in the area of mangrove ecosystems and continuing to formulate preservation strategies and restoration and expansion programmes. Capacity building initiatives need to ensure that the appropriate technology is made available for personnel to receive practical experience.	Medium
Information and networking	Improve on the use of digital information tools for networking and spreading public awareness.	Technical/ Capacity	Continue to promote Public Awareness and Networking events while providing general and open public initiatives and workshops to provide the general public with climate change capacitation.	Medium
Education, training, and public awareness	Develop language classes for displaced population students with a language barrier, representing a need improvement in providing specific linguistic learning support to communities.	Capacity	Incorporate indigenous and foreign languages into the school's curriculum and into the teacher's capacitation curriculum. Indigenous youth groups and communities' public awareness campaigns through activities such as: • Quizzes • Competitions/races • Fund raising activities • Special days commemorations	Medium

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
			• Workshops and courses	
	Implementing measures for addressing displaced children in learning at a standard age within the educational curriculum.	Capacity/ Financial	Improve distance learning methods and capacitation to be implemented if needed following a disaster and as a means to reach displaced population, if needed.	Medium
	Need for improved teacher training and capacitation regarding to climate change education, ESD and environmental awareness across all different Need for increased training regarding natural hazards, conflict risk, climate crisis risk reduction. Need for increased training to teachers regarding the delivery of high-quality online classes.	Capacity	Continue to develop climate change specialised modules within the different educational level's curricula. Develop more training workshops for teachers. Allocate specific time within teacher's working hours dedicated to environmental training and digital teaching adaptation through: • Teacher training workshop • Online webinars • Open training resources • Digital learning workshops	High

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
	Incorrect and/or insufficient school building infrastructure to grant certain level of safety and resilience towards climate hazard exposure. Widespread use of educational facilities as refuges in climate disaster situations which is an obstacle for continuing with daily classes as usual.	Technical/ Financial	Develop certain policies on educational and school sites and locations to establish that educational facilities need to be constructed in areas of less exposure to hazardous environmental risks. Develop of different building facilities used for climate disaster emergency use through: • Public awareness campaigns towards families and students. • Climate risk training workshops.	High
	Lack of technological devices availability and connectivity/service across some regional areas.	Technical/ Capacity	Digital infrastructure, accessibility, and service improvements. Teacher's and student's online learning methods capacitation. Improvement of digital resources and materials to use in online learning sessions through: • Capacitation workshops. • Training courses. • Online materials and tools workshop. • Educational online tools and Apps presentation forums.	High

3. Support received by Guyana

In the following, the support received by Guyana is presented for the main mitigation and adaptation sectors, thus reflecting the support received for the priority themes for climate action in the country. Moreover, the key cross-cutting activities are considered.

3.1. Introduction

The analysis of the support received was carried out compiling extensive information from a wide array of sources, classifying all financial flows according to nine main steps outlined in Figure 6.1.

1 Analysis Level
- Support received is analysed at the project level

2 Purpose classification
- Support is classified as mitigation, adaptation or cross-cutting

3 Sectors
- In line with the purpose classification, the support is grouped in priority sectors

4 Scope
- Support is characterised as targeting a national or regional project

5 Status and implementation
- The implementation timeframe, the current status and the responsible national body for project development are identified

6 Funding Sources
- All financial flows from multilateral, bilateral and private sector sources including identification of the funding institution

7 Funding instrument
- Financial flows are categorised by the relevant instrument such as grant or loan

8 Disbursement
- Committed financial flows are considered and distinguished in support disbursed or anticipated as a share of the total sum committed by project

9 Support Type
- By funding flow, it is determined whether it is only financial support or whether it also contributes to capacity-building and technology transfer

Figure 6.1. Classification of support received.

In total 85 identified projects are included in the analysis of financial flows committed to climate change mitigation, adaptation or cross-cutting action in Guyana. In line with the classification steps, all identified projects are treated as representing a unique set of characteristics in terms of project implementation, committed funding, funding type, instrument and source and capacity-building and technology transfer support

In Table 6.3, a brief overview of the number of projects by climate change area and sector for which support is received is provided.

Table 6.3. Number of projects receiving international support in Guyana by climate change area and sector.

<table>
<tr><th>Climate change theme</th><th>Sector</th><th>Total nº of actions supported</th></tr>
<tr><td rowspan="3">Mitigation</td><td>Energy</td><td>24</td></tr>
<tr><td>Forestry</td><td>4</td></tr>
<tr><td colspan="2">28</td></tr>
<tr><td rowspan="11">Adaptation</td><td>Agriculture and food security</td><td>6</td></tr>
<tr><td>Water Resources</td><td>8</td></tr>
<tr><td>Coastal Zones</td><td>6</td></tr>
<tr><td>Health</td><td>1</td></tr>
<tr><td>Ecosystems and biodiversity</td><td>8</td></tr>
<tr><td>Disaster Risk Management</td><td>2</td></tr>
<tr><td>Land Use</td><td>2</td></tr>
<tr><td>Infrastructure</td><td>4</td></tr>
<tr><td>Settlements and Services</td><td>1</td></tr>
<tr><td>Cross-sectoral</td><td>3</td></tr>
<tr><td colspan="2">41</td></tr>
<tr><td rowspan="3">Cross-cutting</td><td>General cross-cutting</td><td>9</td></tr>
<tr><td>Readiness and reporting</td><td>7</td></tr>
<tr><td colspan="2">16</td></tr>
<tr><td colspan="3">85</td></tr>
</table>

A full list, providing funding and implementation details on all projects for which funding is committed, is included in Annex IV to the Third National Communication.

- **Methodological note 1:** Support received is considered as committed funding which can either be disbursed fully or only to an extent, in which case, the remainder is considered anticipated. Further, cent amounts are rounded.
- **Methodological note 2:** As regards the split between funding disbursed and anticipated, please note that there is a certain degree of uncertainty with regard to partially incomplete information on actual disbursement of project funds, in particular for ongoing projects.
- **Methodological note 3:** The support received for mitigation, adaptation and cross-cutting measures presented in this TNC differs slightly from the support received presented in the First BUR (2024) due to the new inclusion or progression of certain projects as well as due to improved classification methodologies. Moreover, the overall amount of support received is higher because of the inclusion of adaptation measures which were not accounted for in the First BUR but were included in Guyana's first BTR..

3.2. Consolidated overview of the support received in Guyana

In this part, a consolidated overview of the international financial support committed to Guyana is provided. The overview, presented in the five subsequent tables and graphs, reflects the analysis of:

1. The total support received, split by climate change theme and by the level of disbursement.
2. The distribution of projects supporting A: capacity-building and B: technology transfer
3. The prevalence of funding sources by sector.
4. The support disbursed and anticipated by financial instrument.
5. The consolidated funding received by theme, sector, funding instrument and funding source disaggregated by level of disbursement.

1. Total support received, split by theme and by the level of disbursement

Figure 6.2 provides a consolidated overview of the level of disbursement of the funding received. The information is disaggregated by climate change theme. The results show that the highest amount of support is provided for climate change mitigation, making up 83% of the total, followed by adaptation with 13% and cross-cutting with 4%. Moreover, most of the funding committed is yet to be disbursed, which suggests the ongoing implementation of numerous projects and linked to this, increasing amounts of international funding flowing into Guyana.

Figure 6.2. Share of disbursed and anticipated funding by climate change area.

2. A: Distribution of projects supporting capacity-building

In Figure 6.3, the distribution of projects by sector supporting capacity-building and training of institutions and individuals in Guyana is displayed. The results suggest that capacity-building is most relevant in climate change adaptation, followed by mitigation and cross-cutting. Indeed, for the adaptation actions implemented in Guyana, training of individuals in relation to climate resilience and sustainable resource management is a highly important factor to ensure sustained reduction of vulnerabilities.

Figure 6.3. Distribution of projects supporting capacity-building by sector.

2. B: Distribution of projects supporting technology transfer

In Figure 6.4, the distribution of projects by sector supporting technology transfers in Guyana is displayed. The results suggest that technology transfer is fairly evenly distributed between mitigation and adaption, however considering the number of projects analysed, the relative share of the technology support for mitigation is higher. For cross-cutting projects, very few support is dedicated to technology transfer due to the nature of projects supported being geared toward community support, readiness and transparent reporting.

Figure 6.4. Distribution of projects supporting technology transfer by sector.

3. The prevalence of funding sources by sector

In Figure 6.5, for each sector the relative distribution of funding sources is presented, indicating a trend for receiving funding from multilateral sources, including development funds, banks and climate funds in the adaptation and cross-cutting sectors, while mitigation is by a larger margin supported by bilateral and private sector sources. Note, the graph displays the prevalence of project support by funding source and does not show the relative weights of the funding.

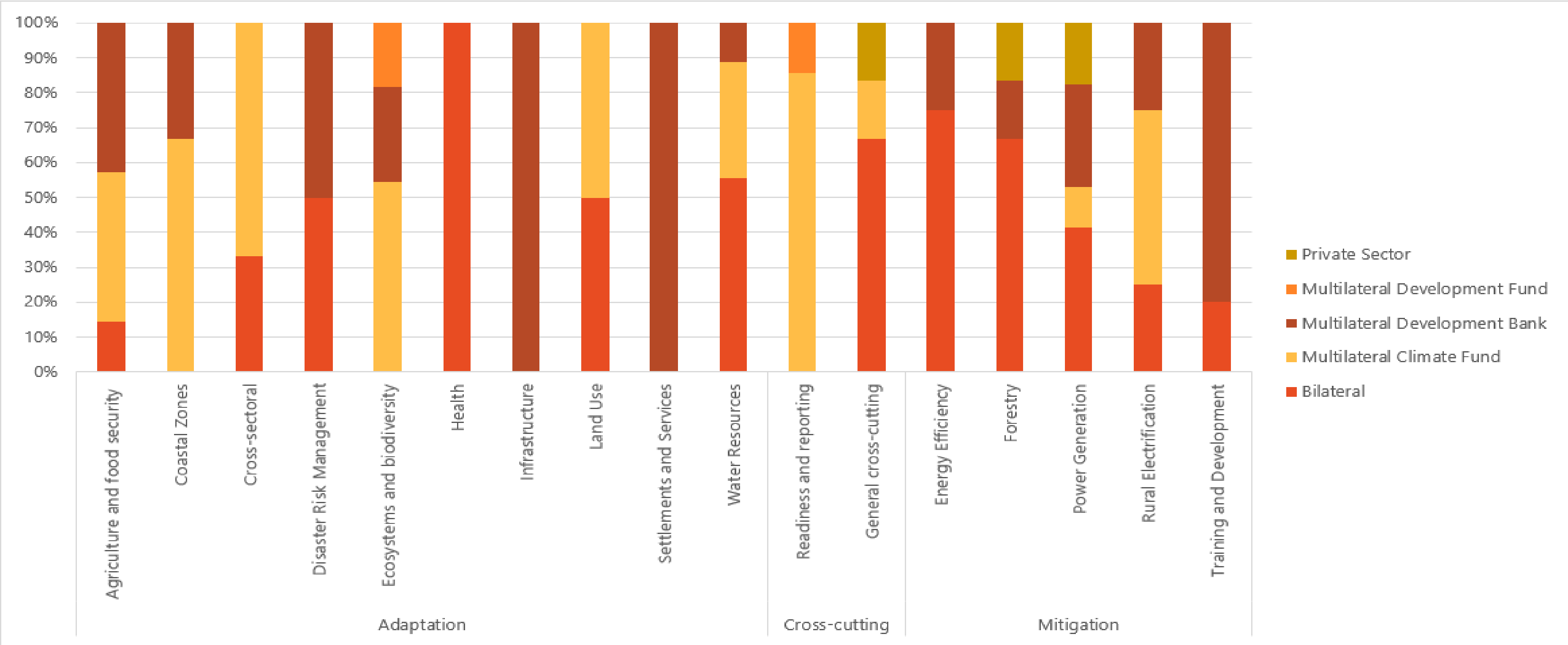

Figure 6.5. Prevalence of funding sources by sector.

4. Support disbursed and anticipated by financial instrument.

Figure 6.6 and Figure 6.7 display the relative share of the financial instruments employed for providing financing to Guyana. The first graph shows the displays the share of the funds that are already disbursed and the second the funds anticipated. The percentages indicate the nominal amount of the funding committed.

The results show that the funds disbursed where mostly financed through results-based payments, grants and concessional loans, while the anticipated funds show a tendency toward increased equity funding and market loans. While the anticipated funding is strongly driven by a few large projects in the energy sector, the overall trend suggests a gradual move away from grant support to more market-based financing options including a stronger involvement of the private sector.

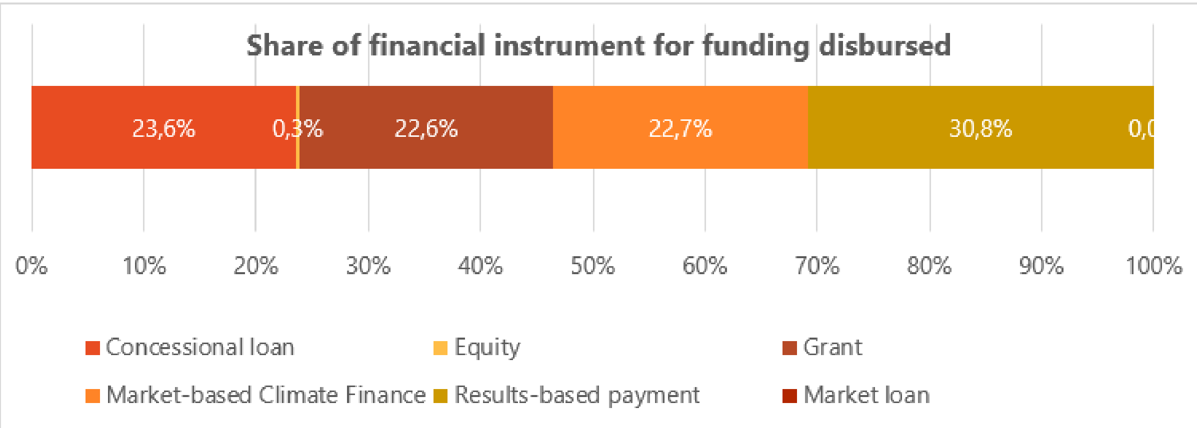

Figure 6.6. Share of financial instrument for disbursed funding.

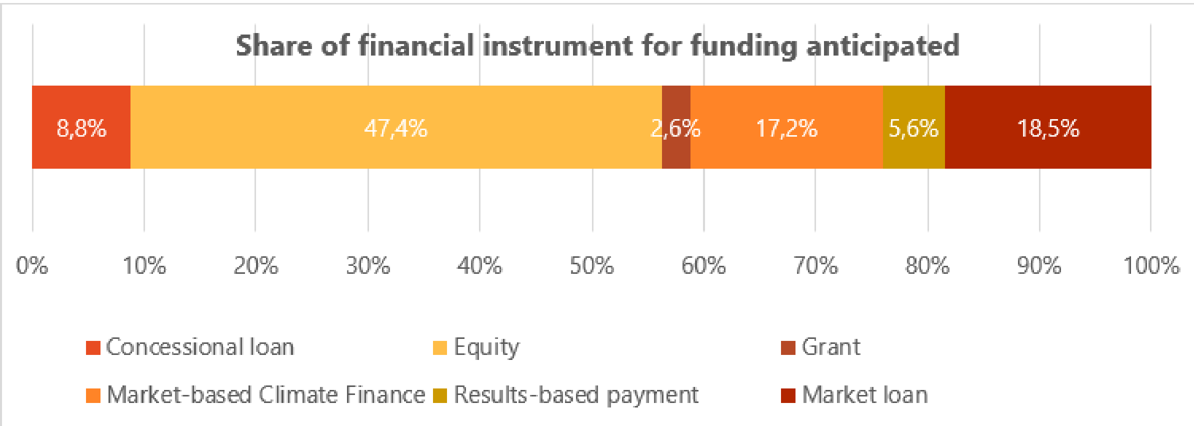

Figure 6.7. Share of financial instrument for anticipated funding.

5. Consolidated funding received by theme, sector, funding instrument and funding source disaggregated by level of disbursement.

Table 6.4 shows support received, disaggregated by source, quantifying the disbursed and anticipated amounts by bilateral, multilateral, and private sector sources, and by type. Further it is distinguished between funding instrument such as loans, grants, investments, results-based payments or others as applicable.

Table 6.4. Consolidated overview of funding received disaggregated by source and instrument.

Funding Source and Instrument	Support Disbursed ($)	Support anticipated ($)
Bilateral	**323.557.954,00**	**860.109.964,35**
European Union Caribbean Investment Facility (CIF)	**21.965.250,00**	
Grant	21.965.250,00	
EXIM Bank of India	**4.000.000,00**	
Concessional loan	4.000.000,00	
Export and Import Bank US (EXIM)		**646.000.000,00**
Market loan		646.000.000,00
Government of Canada	**513.817,00**	**193.752,00**
Grant	513.817,00	193.752,00
Government of India	**7.352.126,00**	**2.710.000,00**
Concessional loan	7.290.000,00	2.710.000,00
Grant	62.126,00	
Government of Italy	**1.275.000,00**	**3.045.000,00**
Grant	1.275.000,00	3.045.000,00
GRIF (NORAD)	**272.060.212,00**	**208.161.212,00**
Grant	68.181.639,00	13.804.349,00
Results-based payment	203.878.573,00	194.356.863,00
Japanese International Cooperation Agency (JICA)	**9.423.575,00**	
Grant	9.423.575,00	
UK - Foreign, Commonwealth Development Office (FCDO)	**4.667.974,00**	
Grant	4.667.974,00	
United Arab Emirates Caribbean Energy Development Fund (UAE-CREC)	**2.300.000,00**	
Grant	2.300.000,00	
Multilateral Climate Fund	**29.901.673,00**	**70.860.547,00**
Caribbean Regional Resilience Building Facility (RRB)	**503.409,00**	
Grant	503.409,00	

Conservation International Guyana	**2.254.829,00**	
Grant	2.254.829,00	
Global Climate Change Alliance Plus (GGCA+)	**5.537.113,00**	
Grant	5.537.113,00	
Global Environment Facility (GEF)	**19.616.189,00**	**6.739.204,00**
Grant	19.616.189,00	6.739.204,00
Green Climate Fund (GCF)	**1.990.133,00**	**63.400.457,00**
Grant	1.990.133,00	63.400.457,00
World Wildlife Fund Guianas (WWF)		**720.886,00**
Grant		720.886,00
Multilateral Development Bank	**154.561.454,00**	**307.659.321,00**
Caribbean Development Bank (CBD)	**12.500.000,00**	**12.500.000,00**
Concessional loan	12.500.000,00	12.500.000,00
Inter-American Development Bank (IDB)	**80.332.454,00**	**119.108.321,00**
Concessional loan	74.199.881,00	117.314.321,00
Grant	6.132.573,00	1.794.000,00
International Fund for Agricultural Development (IFAD)	**5.409.000,00**	**3.051.000,00**
Concessional loan	5.133.040,00	2.826.960,00
Grant	275.960,00	224.040,00
Islamic Development Bank (IsDB)	**14.630.000,00**	
Concessional loan	14.630.000,00	
World Bank	**41.690.000,00**	**173.000.000,00**
Concessional loan	37.890.000,00	173.000.000,00
Grant	3.800.000,00	
Multilateral Development Fund	**772.383,00**	
World Wildlife Fund Guianas (WWF)	**672.383,00**	
Grant	672.383,00	
United Nations Development program (UNDP)	**100.000,00**	
Grant	100.000,00	
Private Sector	**152.100.000,00**	**2.256.210.850,00**
ExxonMobil		**955.500.000,00**
Equity		955.500.000,00
Hess Corporation	**150.000.000,00**	**600.000.000,00**
Market-based Climate Finance	150.000.000,00	600.000.000,00
Private Sector Guyana	**2.100.000,00**	
Equity	2.100.000,00	
Protected Areas Commission		**710.850,00**
Grant		710.850,00
Public-private Partnership (to be determined)		**700.000.000,00**
Equity		700.000.000,00

Grand Total	660.893.464,00	3.494.840.682,00

3.3. Support received by area and sector

In the third part, the support committed by priority sector shall be listed in a comprehensive manner, presenting detailed information on each project or activity funded. This information will include the funding institution, the amount disbursed and outstanding, the temporal scope, the responsible national institution for implementing the activity, the regional scope as well as a classification of the support as financial support, technological support and or capacity-building support.

The three climate change areas mitigation, adaptation and cross-cutting are presented separately, with each area split into the priority sectors for which support is received in Guyana. Note, the support received to develop and implement readiness programs and to conduct the reporting under the UNFCCC is included in cross-cutting. By sector, a brief paragraph underlining the primary focus of the support is provided followed by a concise table displaying the total funding committed and the share of the funding that is already disbursed or anticipated. To do so, the identified projects by sector receiving funding are summed in the two categories disbursed and anticipated.

Further, it is indicated whether the projects for which funding is received, support capacity-building and technology transfer objectives in each of the sectors. This is determined by categorising the individual projects as financial support, capacity-building or technology transfer or a mix thereof. It is important to mention that all projects at the minimum are classified as financial support, while capacity-building and technology transfer support depend on the respective project objectives.

3.3.1. Mitigation actions

The first climate change area or theme addressed is the support received by Guyana for the implementation of mitigation measures. In line with the LCDS and NDC, the two priority sectors for the country are the energy and forestry sectors as they crucially influence the GHG emissions trends in the country, albeit with distinct dynamics. While the energy sector is the highest emitting sector in the country, which due to the increasing exploration of oil and gas is expected to grow further in the coming years, the forestry resource is a major carbon sink, sequestering far more CO_2 than the country emits. Therefore, Guyana sets a focus on implementing mitigation measures in the energy sector, for instance through the ramp-up of renewables and in the forestry sector in which reforestation measures are implemented and carbon credits are sold in return for extensive protection of the natural forest resources.

Energy Sector

Guyana´s energy sector is characterised as the highest emitting sector yet also provides a major source of income supporting national economic development. As such, Guyana prioritises the energy sector in its development and climate change mitigation efforts, aiming to secure substantial funding to implement targeted actions to reduce emissions while pursuing its development interests. This includes renewable energy projects, supporting technology transfer particularly in the solar photovoltaic (PV) and hydropower domains, along with significant initiatives leveraging gas exploration to replace heavy fuel oil in electricity production. The development of an advanced gas-to-power infrastructure is currently in progress to facilitate this transition.

Furthermore, numerous actions within the energy sector specifically target remote and hinterland communities, aiming to provide secure and clean energy across the entire country. To support the development and adoption of cleaner energy sources and ensure effective integration, Guyana implements projects that enhance institutional and technical capacities within communities. As such, a substantial portion of the actions implemented in the energy sector involve targeted capacity-building to enable the utilisation of new technologies in the renewable energy sector and to enhance the effectiveness of energy efficiency actions in communities.

The funding sources for the energy sector actions and projects are diverse. While large energy infrastructure projects tend to receive support in the form of private sector investment, beneficial loans mobilised through the large multilateral banks or bilateral support, preparatory activities, small to mid-scale projects, and capacity-building initiatives are often backed by project grants from major multilateral climate funds.

The energy sector in Guyana is split in four subsectors, which are presented in continuation:

- Power Generation
- Energy Efficiency
- Rural Electrification
- Training and Development

In continuation the sectors are presented individually, with a brief table of the funding received provided just below to consolidate the energy sector in one concise overview (Table 6.5).

Table 6.5. Overview of the total funding committed in the energy sector.

Energy sector ($2.529.904.184)	Subsector	Funding disbursed ($)	Funding anticipated ($)
	Power generation	34.401.492	2.396.895.452
	Energy efficiency	29.750.000	3.045.000
	Rural electrification	13.603.240	2.710.000
	Training and development	76.274.000	0

- <u>Power Generation</u>

The power generation sector is the single largest recipient of international support, largely driven by the investment provided for the commissioning of a 300MW Gas-to-Power Plant and by the planned installation of the Amaila Falls hydropower station. These two major projects are accompanied by numerous renewable energy projects, primarily solar PV, which receive international support (Figure 6.8).

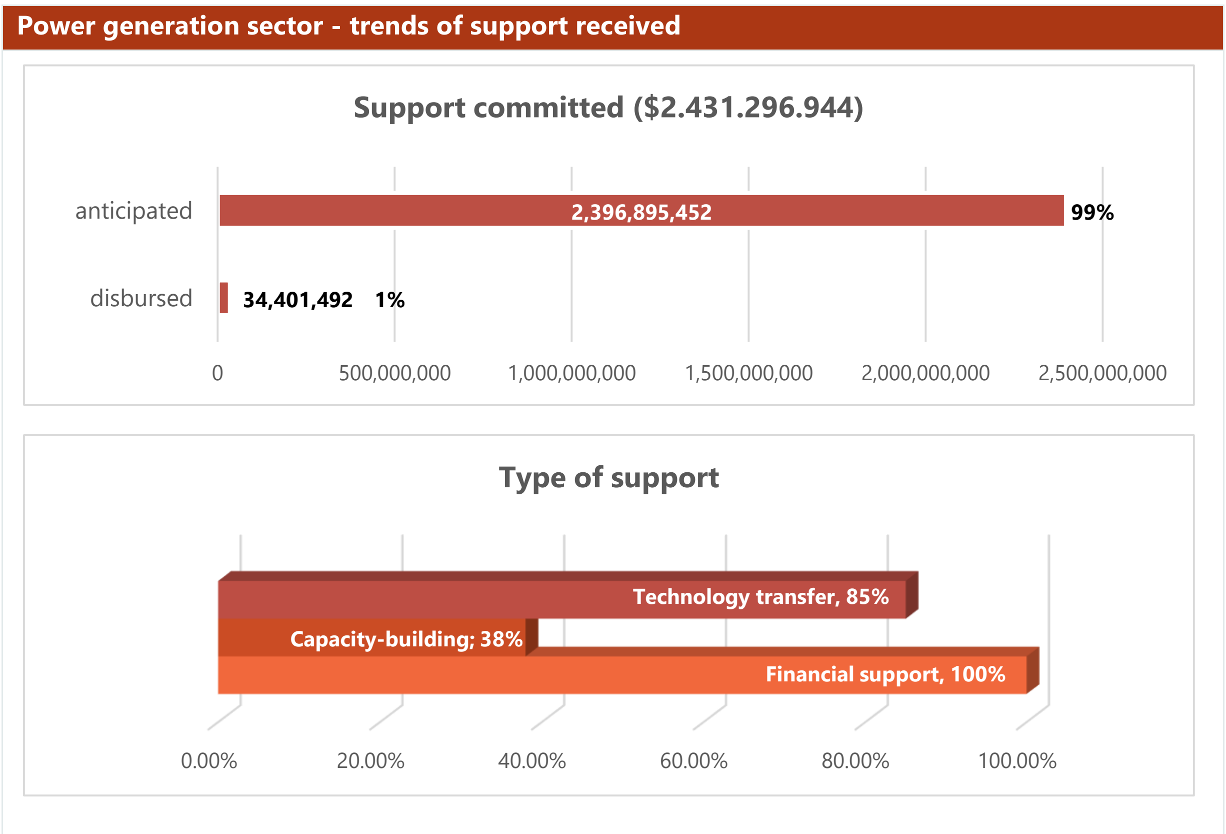

Figure 6.8. Power generation sector trends.

- <u>Energy Efficiency</u>

Energy efficiency measures comprise a set of important activities aiming to reduce GHG emissions by reducing the need for energy in different processes. In Guyana, a range of different projects receive grant support to improve the energy efficiency in the manufacturing sector, in the power system as well as for a model green town project (Figure 6.9).

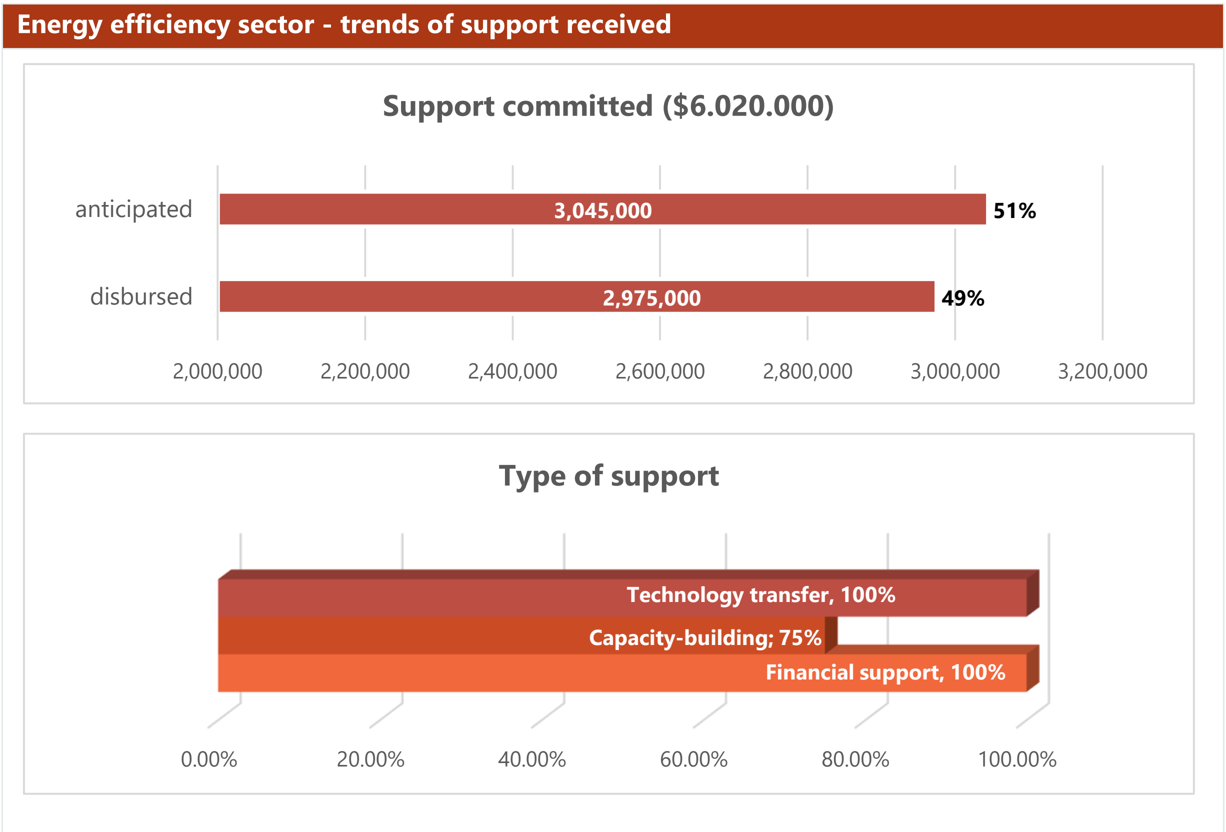

Figure 6.9. Energy efficiency sector trends.

- <u>Rural Electrification</u>

Rural electrification forms part of Guyana´s efforts to develop the Hinterland areas of the countries and provide rural populations better access to services and improve economic participation. Several projects receive support in this subsector which are aimed at implementing a sustainable energy program in Hinterland areas, improve solar systems in homes and to explore effective business models for electrification (Figure 6.10).

Rural electrification sector - trends of support received

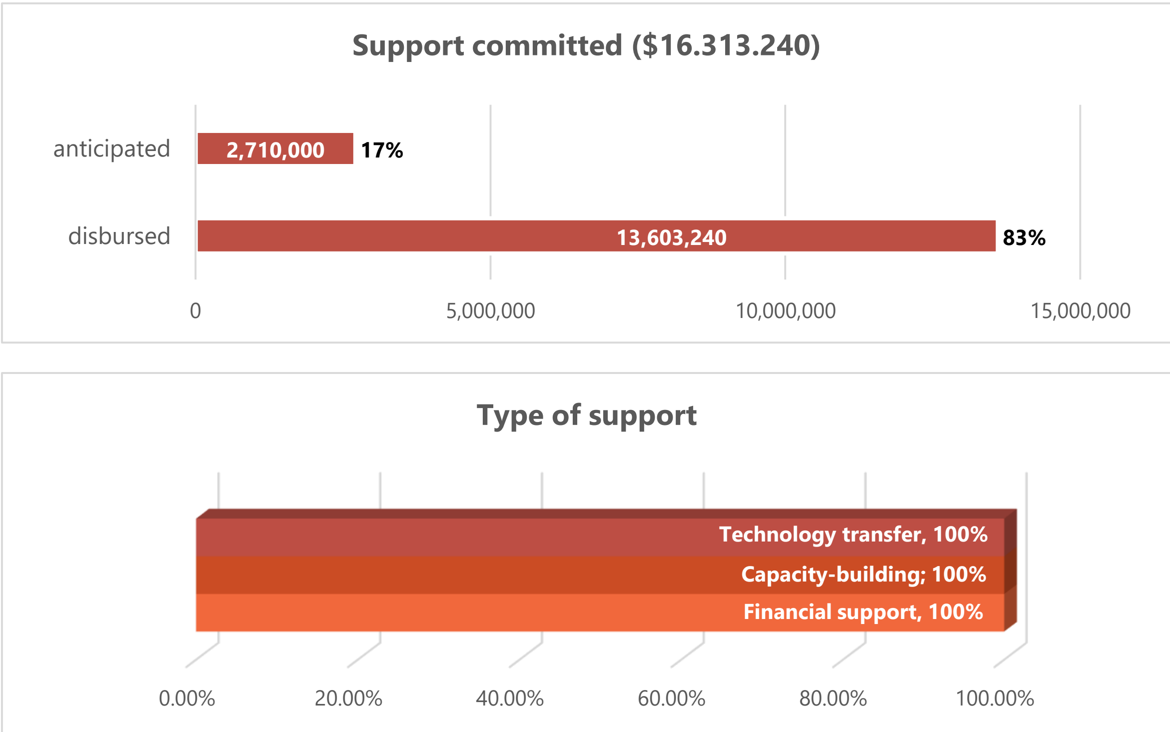

Figure 6.10. Rural electrification sector trends.

- Training and Development

A last group of projects for which support is received drives the training and development in the energy sector which includes upgrading and training of services for enhanced quality of utility provision, energy planning, supervision and energy management. Projects are supported primarily by the IDB through both concessional loans and grants (Figure 6.11).

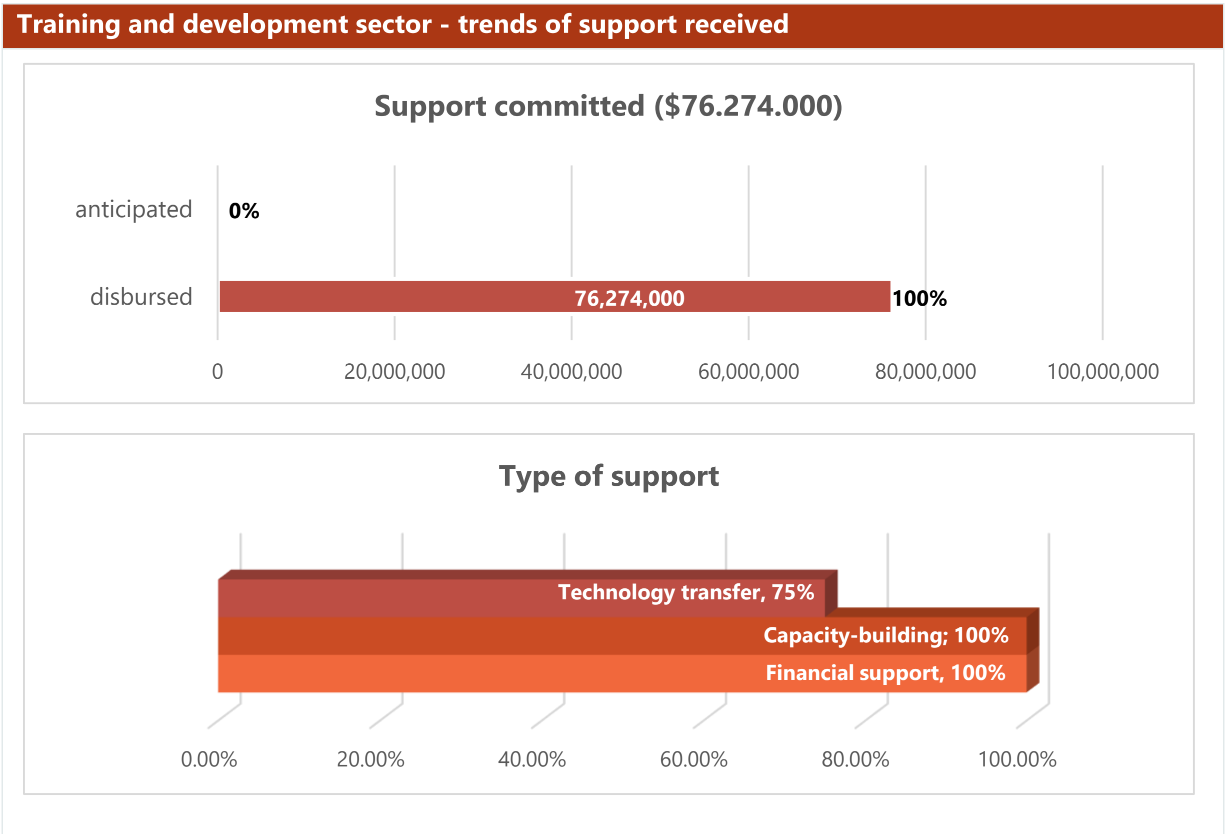

Figure 6.11. Training and development sector trends.

Forestry

The forestry sector is an important economic sector in Guyana and with 18 million hectares of forest cover an even more important carbon sink for the world. Recognising both its national and global importance, Guyana is committed to protecting its forest resources with strong protective measures, with the international community supporting this endeavour through the provision of financial resources.

In fact, the primary source of funding for climate change mitigation in the forestry sector is the Guyana REDD+ Investment Fund (GRIF), designed to reduce GHG emissions by minimising deforestation and forest degradation through maintaining forest cover. The GRIF was established in 2010 under the Guyana-Norway Partnership, signed by the two countries as a bilateral agreement in 2009. This partnership fosters the provision of results-based payments, released upon the successful completion of specified forestry sector mitigation actions.

Initially conceptualised as a multi-donor fund, the GRIF relied solely on NORAD, extending payments for results across agreed outcomes. Earnings from the Guyana Norway Bilateral Partnership, in part assisted Guyana in preparedness activities that supported Guyana's engagement in ART-TREES which led to Guyana being issued carbon credits through ART-TREES, tailored for both voluntary and compliance carbon markets. This was aimed at the specific goal of preventing forest loss and degradation. Notably, Guyana stands as the first country globally with the opportunity to sell these credits to international enterprises, generating extensive additional financial resources. To accelerate climate change action in Guyana, proceeds from ART-TREES are being used to finance additional climate change mitigation projects across various sectors. The GRIF, along with carbon trading activities, constitutes key components of the LCDS and serves as a major funding source in Guyana.

The international support received for climate change mitigation in the forestry sector shows the trends depicted in Figure 6.12.

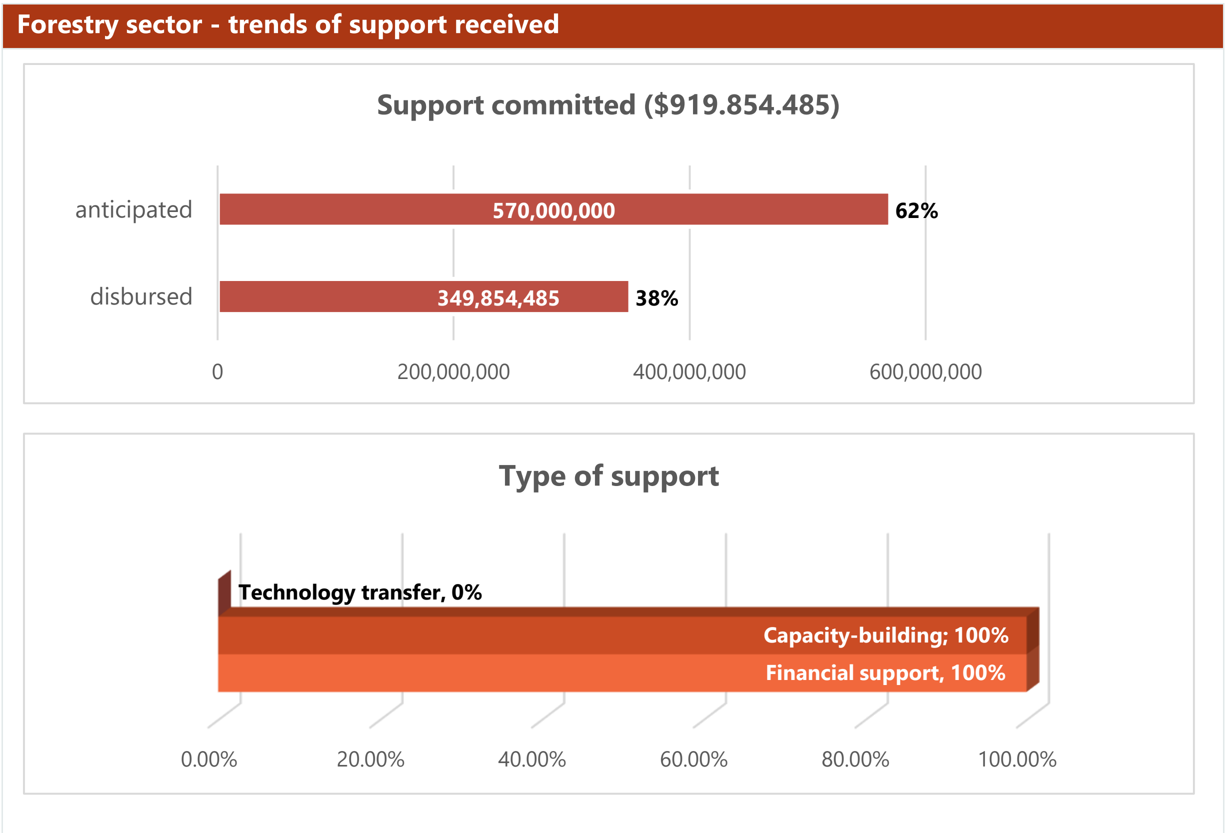

Figure 6.12. Forestry sector trends.

3.3.2. Adaptation actions

In this subchapter, the support received by adaptation priority sector as set out in chapter 3 of the TNC is presented and the main adaptation measures by sector are laid out. The NDC of Guyana has estimated the total costs for implementing all envisioned adaptation measures at around $1.6 billion, a number the international support currently still falls short of. Nevertheless, substantial progress has been made through the implementation of targeted measures resulting in resilience gains across sectors. A wide range of funding sources support adaptation measures in Guyana, which are strongly geared toward enhancing resilience in the water resources and coastal zones sectors as well as in ecosystems, infrastructure and agriculture.

Agriculture and Food Security

The support received for the adaptation actions in the agriculture and food security sector in Guyana (Figure 6.13) primarily addresses institutional strengthening and support for local and regional councils as they plan and prioritise climate-resilient investments in local value chains. Moreover, research, monitoring and communication to produce high-quality data for the agriculture sector are fostered. Regarding adaptative capabilities, climate-resilient technology adoption, including improving farmers' access to public services, crop diversification for food security, as well as climate-resilient skills development, including planning and natural resources management are supported.

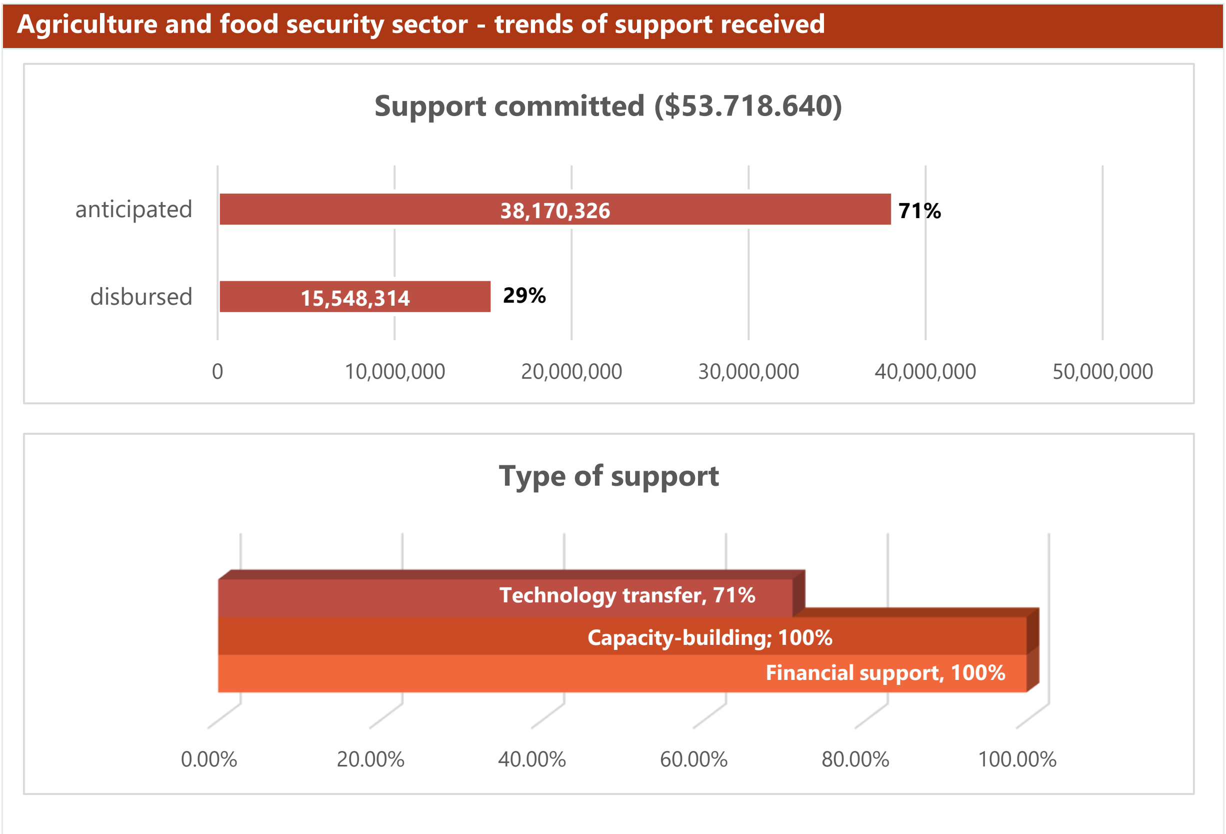

Figure 6.13. Agriculture and food security sector trends.

Water Resources

The supported projects in the water resources sector comprise a series of sequential and complementary projects specifically seeking to enhance climate adaptation and reduce pluvial flood risk in urban and rural areas in the coastal plain of Guyana by improving water drainage infrastructure. Moreover, water resource management projects in hinterland communities are implemented to enhance the efficient use and protection of aquifers. An overview of the trends of support received is provided in Figure 6.14.

Water resources sector - trends of support received

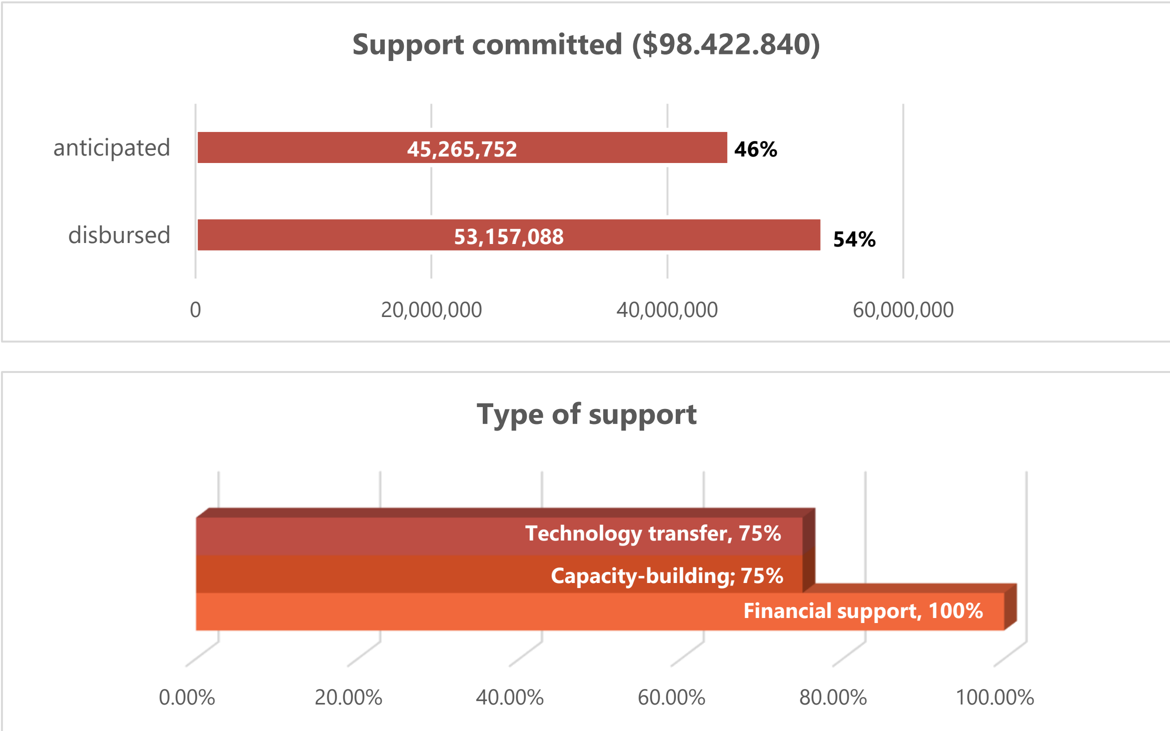

Figure 6.14. Water resources sector trends.

Coastal Zones

Climate change adaptation in the coastal zones is primarily driven by green infrastructure projects seeking to restore and improve the health of the mangrove zones, including mangrove forest expansions and community-led restoration. Further, a major grey infrastructure implemented in the coastal zones sector, sought to strengthen sea and river defences against the adverse impacts of climate change. An overview of the trends of support received is provided in Figure 6.15.

Coastal zones sector - trends of support received

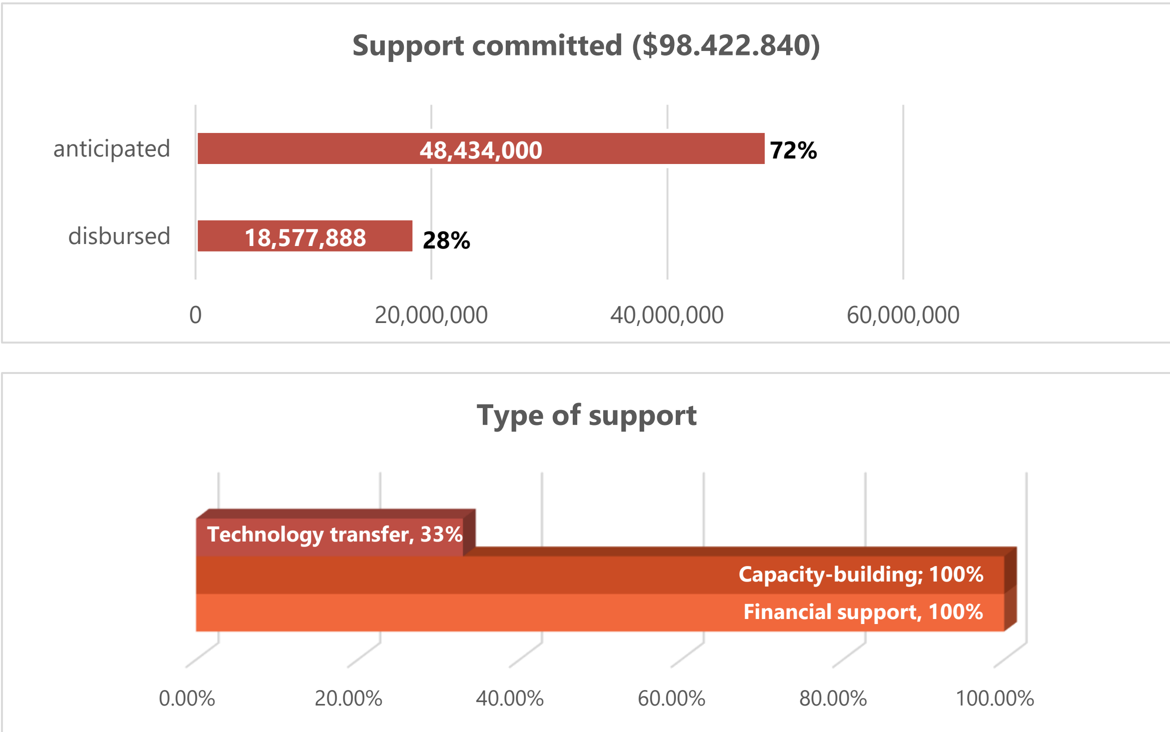

Figure 6.15. Coastal zones sector trends.

Health

Numerous projects are implemented by the government to enhance the resilience and energy autarky of health centres across the country. International support was received for a targeted project to retrofit five existing healthcare facilities in Guyana to become safer, greener, and more resilient to natural disasters and climate change. An overview of the trends of support received is provided in Figure 6.16.

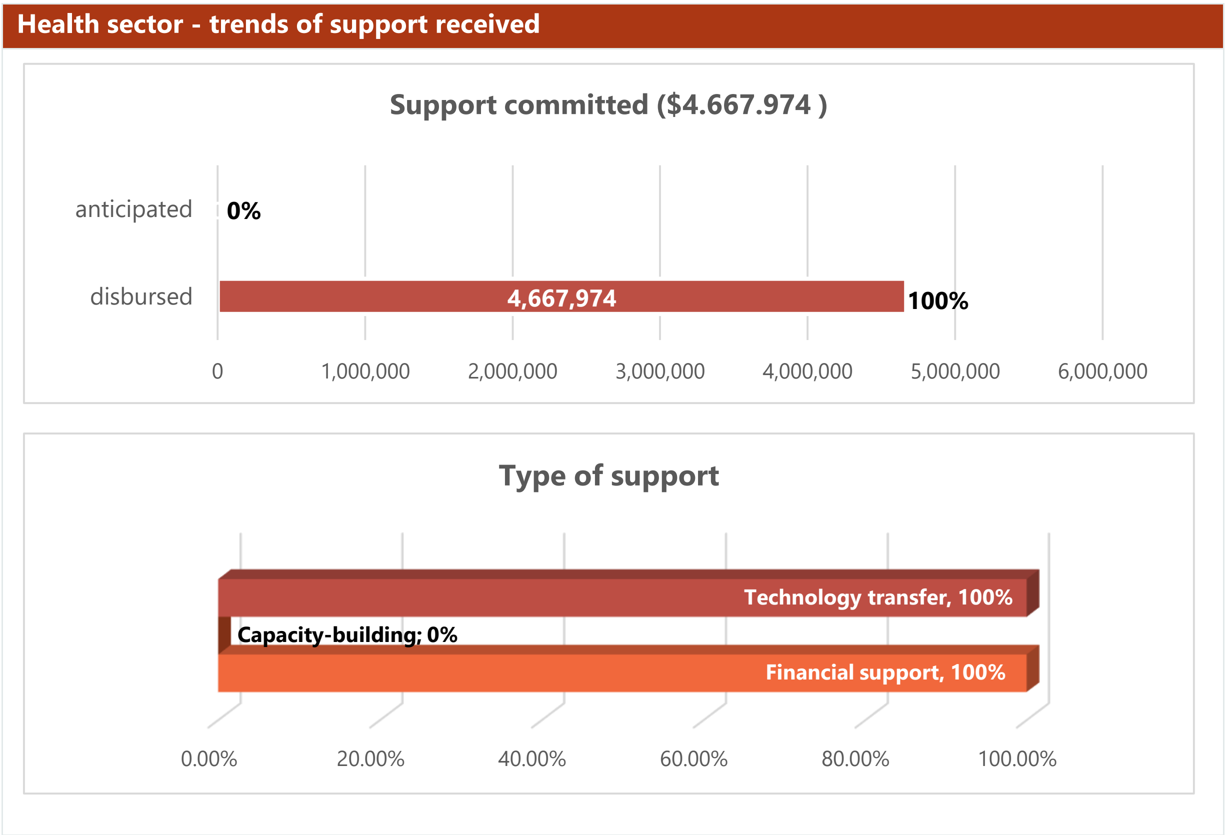

Figure 6.16. Health sector trends.

Ecosystems and Biodiversity

The primary focus of adaptation efforts in the ecosystems and biodiversity sector implemented are targeted in two main areas: improving gold mining techniques to protect biodiversity and maintain ecosystem functionality and improving the bioeconomy and ecosystem services in the Amazon rainforest. A series of synergic projects are being implemented seeking to improve gold mining techniques to protect biodiversity and maintain ecosystem functionality for the benefit of all Guyanese livelihoods and health by shifting towards a mercury-free gold mining sector by 2025 under the Minamata Convention through a strengthened regulatory framework and institutional capacity-building, with a particular focus on artisanal, small and medium-scale gold mining operations. An overview of the trends of support received is provided in Figure 6.17.

Ecosystems and biodiversity - trends of support received

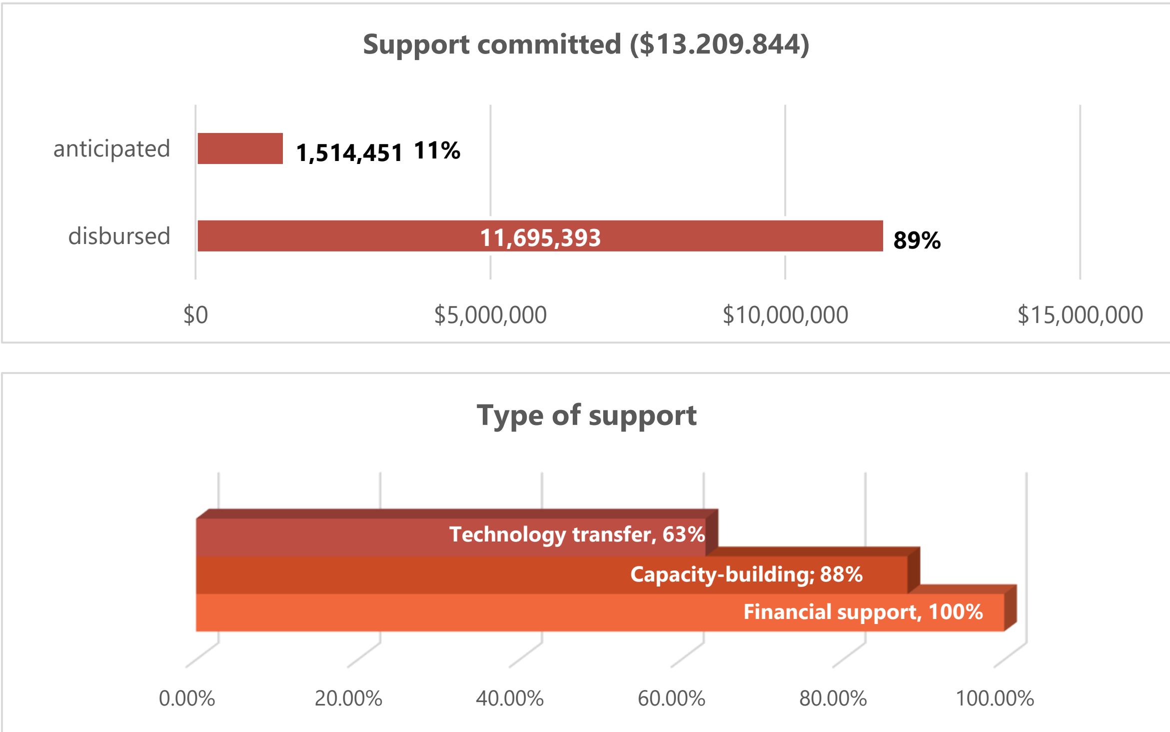

Figure 6.17. Ecosystems and biodiversity sector trends.

Disaster Risk Management

Guyana is committed to improving its disaster preparedness and risk management capacities. Numerous projects are implemented at the national and regional scale. Notably, international support was received for the development and implementation of the National Integrated Disaster Risk Management Plan and Implementation Strategy (NIDRMP). The strategy is built around five components: risk identification, prevention and mitigation, financial protection and risk transfer, preparedness and response, and recovery. These components are further strengthened through projects supporting monitoring and systemic observation, which however are largely nationally financed. Another project that received support sought the strengthening of disaster management capacity of women in Guyana as they present the most affected group by natural disasters. An overview of the trends of support received is provided in Figure 6.18.

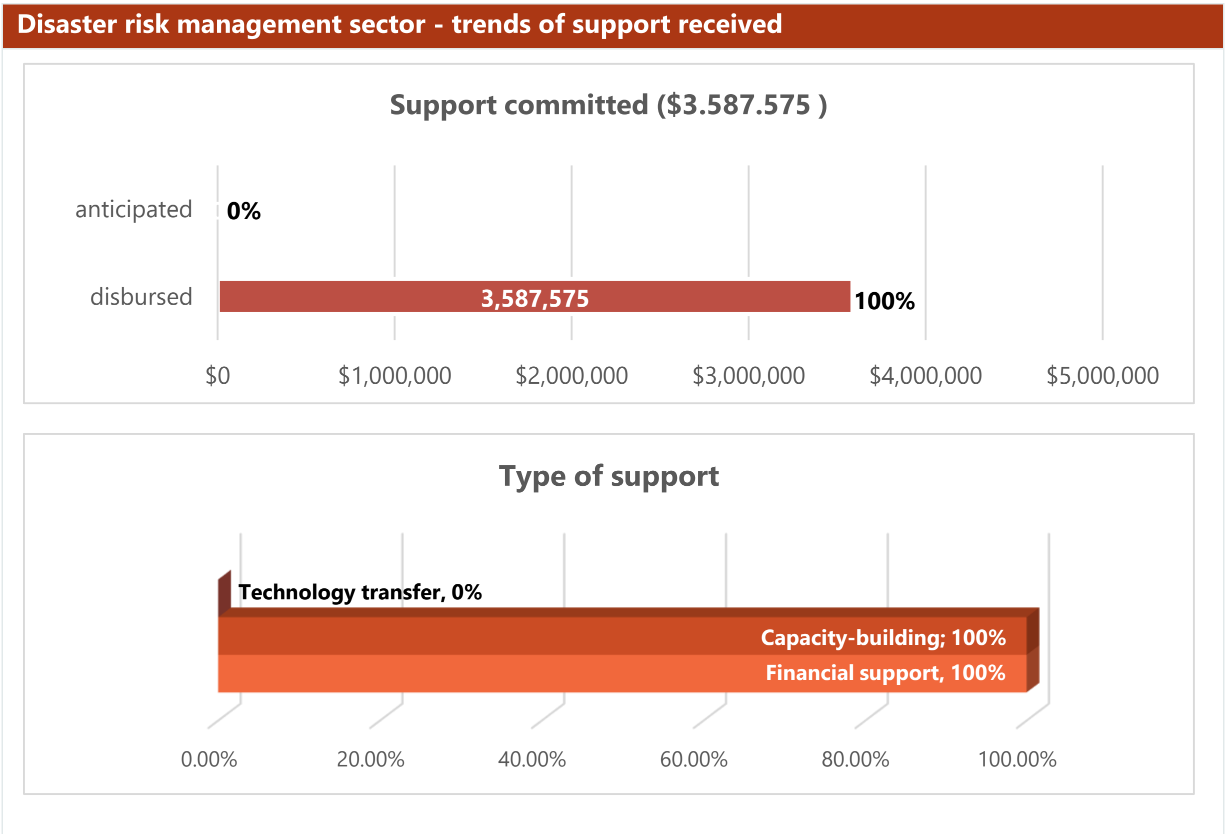

Figure 6.18. Disaster and risk management sector trends.

Land-use

The adaption efforts in this sector englobe projects that receive financing to streamline the provision of land services to land-users and decision-makers and to foster long-term economic, social and environmental development in Guyana. Institutional strengthening and capacity-building projects have been implemented to establish an enabling environment to combat and reverse land degradation while fostering sustainable climate-resilient territorial planning and urban development. An overview of the trends of support received is provided in Figure 6.19.

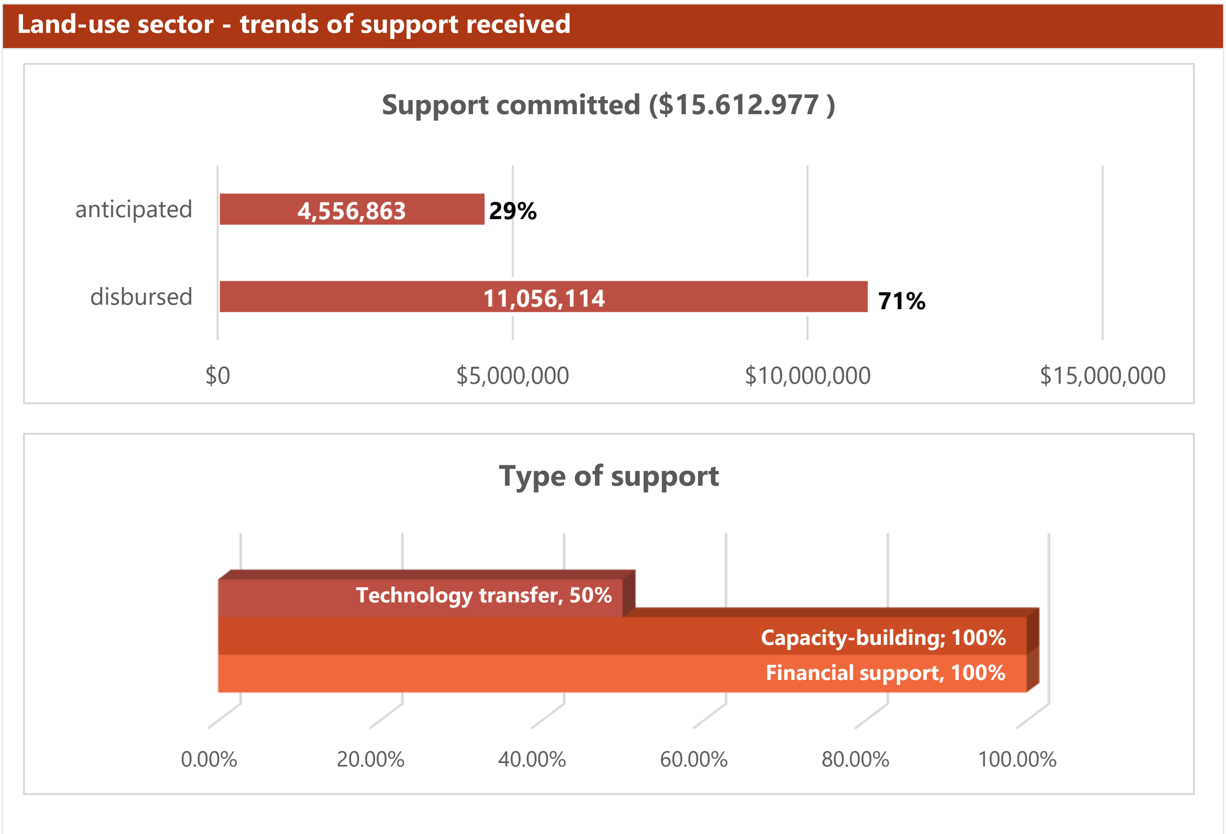

Figure 6.19. Land-use sector trends.

Settlements and Services

Interventions are underway to upgrade the drainage and irrigation system across the capital, and major public and private sector investments are being made in new building stock across the area. Notably, international support was received for the Climate-Resilient Adequate Housing and Urban Accessibility in Georgetown project, through which Guyana aims to improve the quality of life in urban and peri-urban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility service. An overview of the trends of support received is provided in Figure 6.20.

Settlements and services - trends of support received

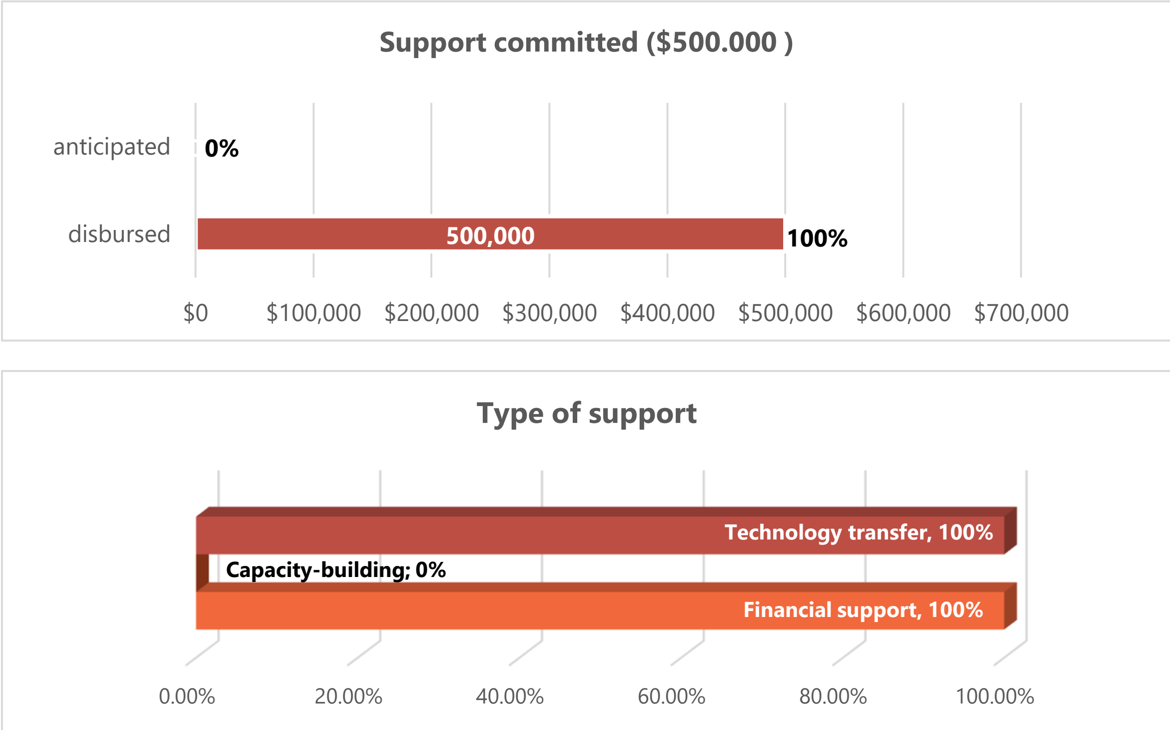

Figure 6.20. Settlements and services sector trends.

Infrastructure

The Government of Guyana has embarked on a large investment effort to upgrade and revamp transportation infrastructure in the country, which consists of interventions to expand critical coverage and capacity and to rehabilitate and conserve the existing road network, as well as to strengthening the capacities of the authorities to reinforce climate-resilient mobility within the country. Furthermore, the transport network linking Guyana to neighbouring countries is to be upgraded under a lens of climate change resilience. An overview of the trends of support received is provided in Figure 6.21.

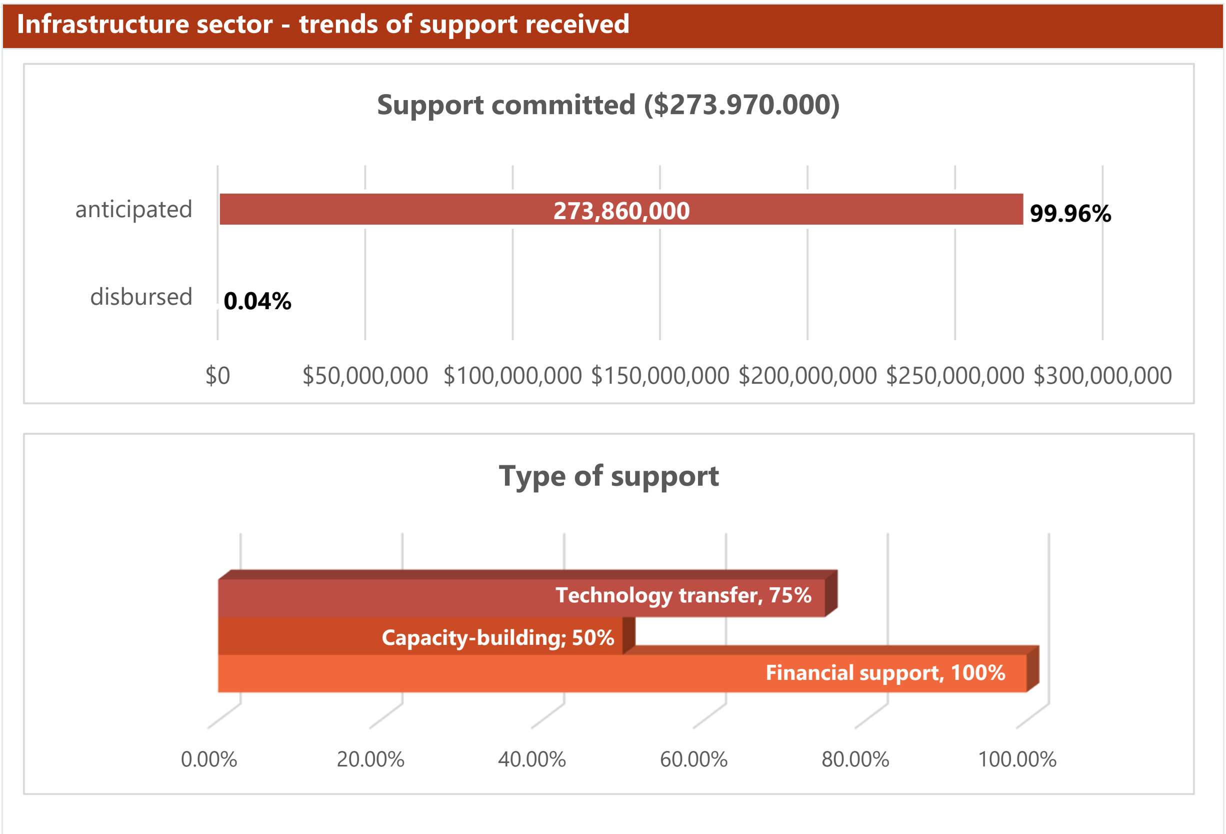

Figure 6.21. Infrastructure sector trends.

Cross-sectoral

The cross-sectoral category of adaptation project comprises a range of overarching strategies and plans which relate to several key adaptation sectors. Among these, the CRSAP - Climate Resilience Strategy and Action Plan, the National Action Plan for Land Degradation and effort to strengthen policy coordination and the monitoring of the Rio Convention receive international support which are accounted as climate finance. An overview of the trends of support received is provided in Figure 6.22.

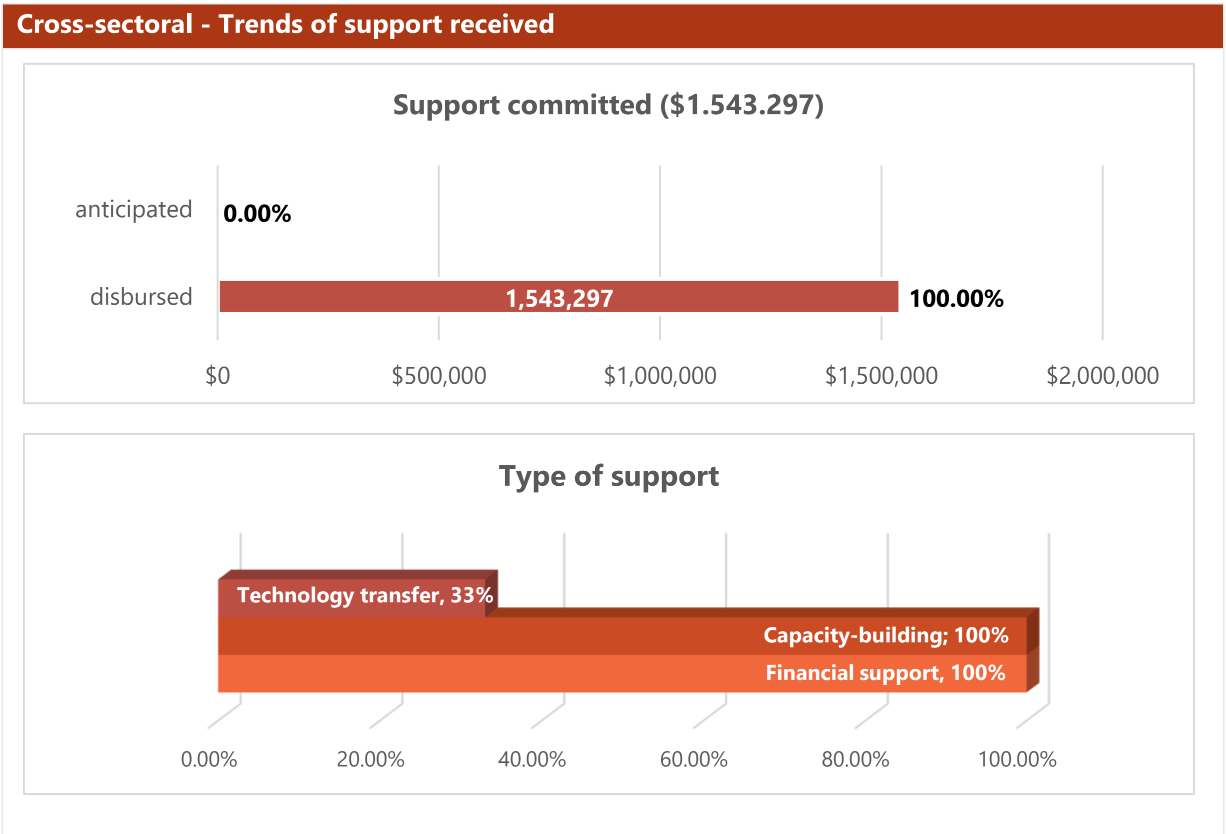

Figure 6.22. Cross-sectoral trends.

3.3.3. Cross-cutting actions

In this section, the trends for support received for cross-cutting actions and projects are presented. The category cross-cutting englobes support received for projects with clear co-benefits for mitigation and adaptation. Support received for the preparation of reports under the UNFCCC and other preparatory support, such as readiness support programs and the like, are also included in the cross-cutting category. This includes NCs, BURs and NDCs.

Reflecting these two types of projects for which support tis received, this section is split in general cross-cutting support and readiness and reporting support

General Cross-cutting

This category includes support received for Amerindian and other village and community development as well as support for the development of a national climate finance strategy and a technological needs assessment. Projects geared toward Amerindian and community development yielding both mitigation and adaptation benefits that are supported aim to, amongst others:

- Support Climate-resilient community energy and water infrastructure and communications
- Create sustainable livelihood opportunities including ecotourism and climate-resilient agricultural opportunities to ensure both food security and income generation. Sustainable management of nature, environment, ecosystems, and biodiversity.
- achieve community-driven sustainable development that maintains and enhances the value of their resources while fostering environmental integrity and building climate resilience.
- Ensure equal access to local climate-compatible education.
- Enhance healthcare, encompassing access to safe, and affordable drinking water, access to adequate and equitable sanitation and hygiene for all, and access to sexual and reproductive health care services.

Moreover, improvement of the bioeconomy and ecosystem services in the Amazon rainforest in Southern Guyana is fostered with mitigation and adaption co-benefits.

The support received to a large part derives from the sale of forest carbon credits obtained to the Hess Corporation, of which a substantial part is allocated to the development of village sustainability plans.

An overview of the trends of support received is provided in Figure 6.23.

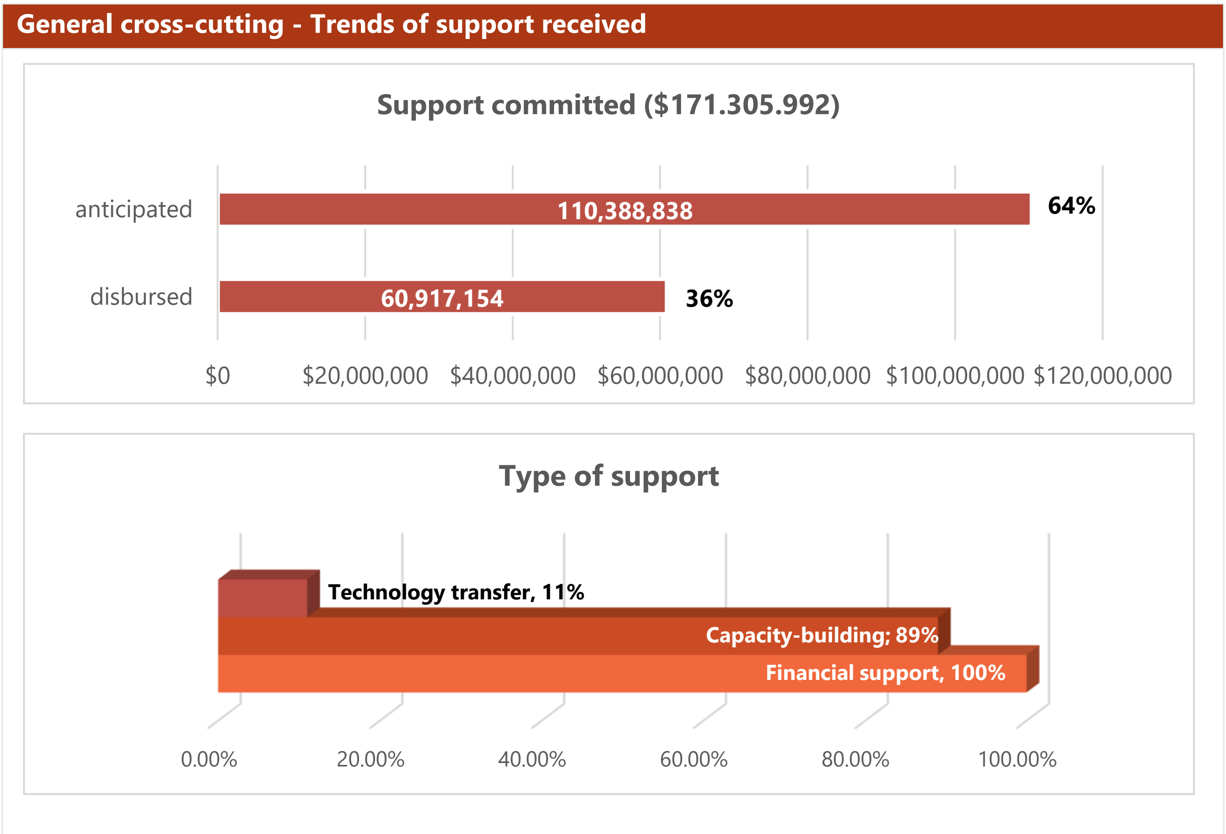

Figure 6.23. General cross-cutting sector trends.

Readiness and Reporting

Readiness support and financial transfers received for the preparation of the reports required under the UNFCCC are accounted for in this category. The support for the first, second and third NC, the first BUR, the second NDC and country programme support under the CCCCC are included. An overview of the trends of support received is provided in Figure 6.24.

Readiness and reporting - Trends of support received

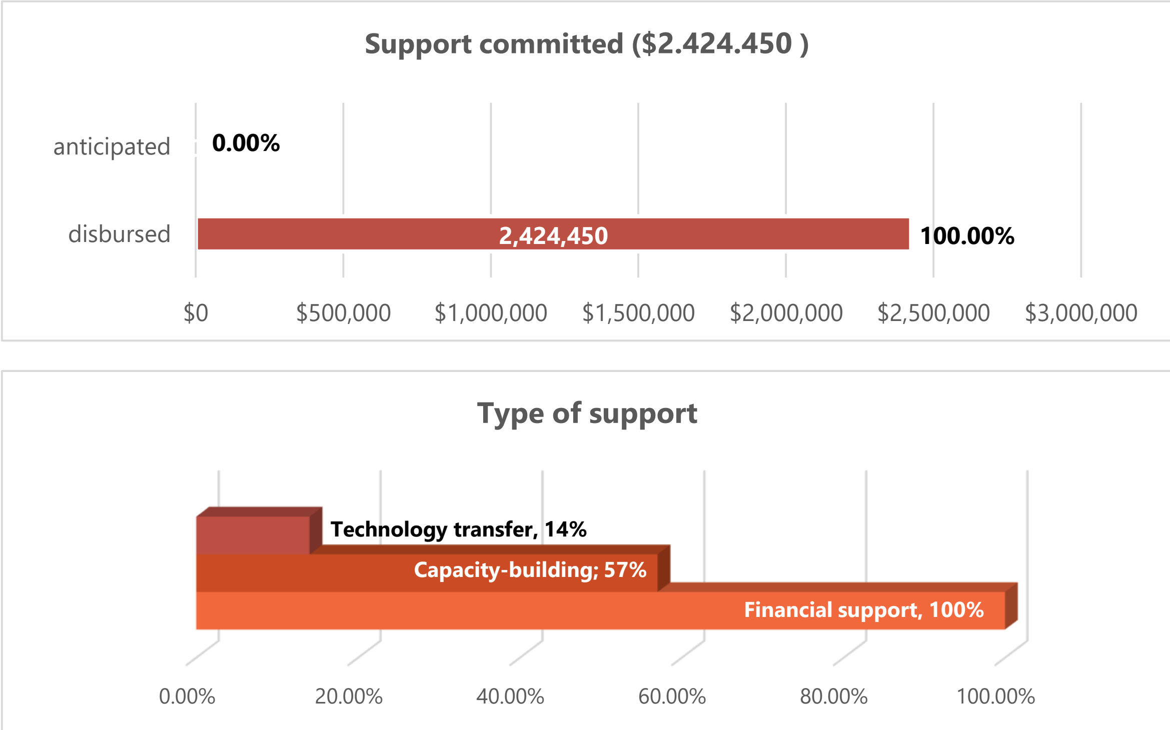

Figure 6.24. Readiness and reporting sector trends.

4. Conclusion

In the last section of this chapter, the key insights drawn from the analysis of main constraints and gaps and associated funding needs as well as the funding received by sector and type, are consolidated to provide a concise picture of the current trends in international support for climate action in Guyana.

Over the past decades, Guyana has accelerated its climate change efforts and substantial gains across sectors have been made. Most notably, the first of a kind ART-TREES carbon credits developed for the protection of the forest resource represent a climate change mitigation measure of global scale. However, with climate change impacts increasing, next to the forestry sector, specific vulnerabilities of the coastal zones, the agricultural sector and the water resources become apparent. Efforts are increasingly guided toward improving the resilience in key sectors, but to reduce these vulnerabilities further extensive resources will be required.

In this regard, financial flows from international donors have decreased in recent years, while flows from the private sector have increased. Moreover, while Guyana due to its exploration of oil and gas is economically in a better position than it was some decades ago, the financial need for effective climate change mitigation and adaptation outweighs the national capacities and the international support received, thus requiring increased funding.

Related to the financial support, capacity-building is strongly considered in the funding received thus far but will continue to present an ongoing need to ensure sustained implementation and adoption of climate measures in the country. Technology transfer is prevalent in sectors such as power generation, energy efficiency, electrification, energy and transport infrastructure as well as ecosystems management. However, Guyana will require increased support to advance its climate resilience in the essential sectors agriculture and water resources as well as for protective grey and green infrastructure on the coastal zones.

As regards the funding sources, the analysis suggests increasing private sector involvement and an associated trend to market-based funding instruments and innovative investments. This is further underlined by the fact that grant support, often correlated with low-to medium technical readiness, is highly prevalent in the projects which have found completion and is decreasing for ongoing projects, thus showing a clear progression toward a diversified mobilisation of financial resources. This positive trend however is more pronounced for projects aimed at climate change mitigation, with adaption measures still largely being financed through grants and loans. It will thus be important to further extend the private sector involvement for more effective adaptation measures. Moreover, while improving in recent years, the investment landscape still requires major improvements for the private sector to become a sustainable and reliable source of income for climate action.

While the overall trend shows that Guyana is continuously advancing on mobilising resources for climate action, current support committed falls short of the estimated costs for implementing Guyana´s ambitious climate change agenda. In particular, the energy, and infrastructure sectors require continuous investment and enhanced measures for climate change adaptation in various key sectors including water resources, agriculture, coastal zones and health will be key needs in the future.

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Annex I | Key Category Analysis

Table AI.1. Key category analysis with FOLU – level assessment for 2022.

IPCC Category	Gas	Emissions year 2022 (Gg CO_{2e}) *	Absolute value of emissions year 2022 (Gg CO_{2e})	Contribution for year 2022 (%)	Cumulative contribution total for year 2022 (%)	KCA order 2022
3B1a – Forest Land Remaining Forest Land	CO_2	-148,875.77	148,875.77	90.9	90.9	**1**
3B6B – Land Converted to Other Land	CO_2	5,534.47	5,534.47	3.4	94.2	**2**
1B2a – Oil	CH_4	1,540.15	1,540.15	0.9	95.2	**3**
*Positive values correspond to emissions, while negative values correspond to removals.						

Table AI.2. Key category analysis with FOLU – level assessment for 1990.

IPCC Category	Gas	Emissions year 1990 (Gg CO_{2e}) *	Absolute value of emissions year 1990 (Gg CO_{2e})	Contribution for year 1990 (%)	Cumulative contribution total for year 1990 (%)	KCA order 1990
3B1a – Forest Land Remaining Forest Land	CO_2	-152,319.30	152,319.30	93.1	93.1	**1**
3B6B – Land Converted to Other Land	CO_2	7,716.75	7,716.75	4.7	97.8	**2**
*Positive values correspond to emissions, while negative values correspond to removals.						

Table AI.3. Key category analysis with FOLU – trend assessment for 1990-2022.

IPCC Category	Gas	Trend assessment	Contribution to the trend (%)	Total cumulative trend contribution (%)	KCA order trend
3B1a – Forest Land Remaining Forest Land	CO_2	0.068	87.7	87.7	**1**
3B6B – Land Converted to Other Land	CO_2	0.011	14.2	101.9	**2**

Table AI.4. Key category analysis without FOLU – level assessment for 2022.

IPCC Category	Gas	Emissions year 2022 (Gg CO_{2e})	Absolute value of emissions year 2022 (Gg CO_{2e})	Contribution for year 2022 (%)	Cumulative contribution total for year 2022 (%)	KCA order 2022
1B2a – Oil	CH_4	1,540.15	1,540.15	18.1	18.1	**1**
1A3b – Road Transport	CO_2	1,094.72	1,094.72	12.9	31.0	**2**
1A4 – Other Sectors	CO_2	878.97	878.97	10.4	41.4	**3**
1B2a – Oil	CO_2	873.44	873.44	10.3	51.7	**4**
1A1 – Energy Industries	CO_2	838.97	838.97	9.9	61.6	**5**
3C7 – Rice Cultivations	CH_4	708.62	708.62	8.3	69.9	**6**
1B2b – Natural Gas	CH_4	648.52	648.52	7.6	77.6	**7**
3A1 – Enteric Fermentation	CH_4	535.68	535.68	6.3	83.9	**8**
3C4 – Direct N2O Emissions from Managed soils	N_2O	299.92	299.92	3.5	87.4	**9**
4A3 – Uncategorized Waste Disposal Sites	CH_4	159.25	159.25	1.9	89.3	**10**
4A1 – Managed Waste Disposal Sites	CH_4	147.73	147.73	1.7	91.0	**11**
3C5 – Indirect N2O Emissions from Managed soils	N_2O	139.06	139.06	1.6	92.7	**12**
3C1 – Biomass Burning	CH_4	111.48	111.48	1.3	94.0	**13**
4D1 – Domestic Wastewater Treatment and Discharge	CH_4	110.44	110.44	1.3	95.3	**14**

Table AI.5. Key category analysis without FOLU – level assessment for 1990.

IPCC Category	Gas	Emissions year 1990 (Gg CO_{2e})	Absolute value of emissions year 1990 (Gg CO_{2e})	Contribution for year 1990 (%)	Cumulative contribution total for year 1990 (%)	KCA order 1990
3A1 – Enteric Fermentation	CH_4	381.22	381.22	13.9	13.9	**1**
1A1 – Energy Industries	CO_2	332.98	332.98	12.2	26.1	**2**
1A2 – Manufacturing Industries and Construction	CO_2	301.18	301.18	11.0	37.1	**3**
3C4 – Direct N_2O Emissions from Managed soils	N_2O	269.75	269.75	9.8	46.9	**4**
1A4 – Other Sectors	CO_2	242.31	242.31	8.8	55.7	**5**
1A3b – Road Transport	CO_2	231.33	231.33	8.4	64.2	**6**
3C7 – Rice Cultivations	CH_4	227.31	227.31	8.3	72.5	**7**
4A3 – Uncategorized Waste Disposal Sites	CH_4	215.51	215.51	7.9	80.3	**8**
4D1 – Domestic Wastewater Treatment and Discharge	CH_4	108.28	108.28	4.0	84.3	**9**
3C5 – Indirect N2O Emissions from Managed soils	N_2O	103.71	103.71	3.8	88.1	**10**
1A4 – Other Sectors	CH_4	76.20	76.20	2.8	90.9	**11**
3C1 – Biomass Burning	CH_4	63.16	63.16	2.3	93.2	**12**
3A2 – Manure Management	CH_4	36.75	36.75	1.3	94.5	**13**
1A3a – Domestic Aviation	CO_2	34.56	34.56	1.3	95.8	**14**

Table AI.6. Key category analysis without FOLU – trend assessment for 1990-2022.

IPCC Category	Gas	Trend assessment	Contribution to the trend (%)	Total cumulative trend contribution (%)	KCA order trend
1B2a – Oil	CH_4	0.562	20.3	20.3	**1**
1B2a – Oil	CO_2	0.319	11.5	31.8	**2**
1A2 – Manufacturing Industries and Construction	CO_2	0.313	11.3	43.0	**3**
1B2b – Natural Gas	CH_4	0.237	8.5	51.6	**4**
3A1 – Enteric Fermentation	CH_4	0.235	8.5	60.1	**5**
3C4 – Direct N2O Emissions from Managed soils	N_2O	0.195	7.0	67.1	**6**
4A3 – Uncategorized Waste Disposal Sites	CH_4	0.185	6.7	73.8	**7**
1A3b – Road Transport	CO_2	0.138	5.0	78.8	**8**
4D1 – Domestic Wastewater Treatment and Discharge	CH_4	0.082	3.0	81.7	**9**
1A4 – Other Sectors	CH_4	0.082	3.0	84.7	**10**
1A1 – Energy Industries	CO_2	0.070	2.5	87.2	**11**
3C5 – Indirect N2O Emissions from Managed soils	N_2O	0.066	2.4	89.6	**12**
4A1 – Managed Waste Disposal Sites	CH_4	0.054	1.9	91.6	**13**
1A4 – Other Sectors	CO_2	0.047	1.7	93.3	**14**
3C1 – Biomass Burning	CH_4	0.031	1.1	94.4	**15**
1A3a – Domestic Aviation	CO_2	0.025	0.9	95.3	**16**

Annex II | Adaptation actions by sector and their effects

1. Agriculture and food security

Name of Action	Sustainable Livelihoods and Community Economic Growth				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2012-2020	Ministry of Agriculture (MoA)	National	Agriculture and food security
Description, Objective, and Progress					
The general objective of this project is to provide sustainable livelihood opportunities for low-income households in rural and coastal communities in Guyana by engaging small scale producers in hydroponic and natural/organic cultivation of vegetables for domestic and export markets. The project contributes to building local food security through climate-resilient agricultural techniques for self-production and self-consumption of fruits and vegetables in low-income households.					
Name of Action	Hinterland Environmentally Sustainable Agricultural Development Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2016-2024	Ministry of Agriculture (MoA)	Regions 1, 9	Agriculture and food security
Description, Objective, and Progress					
This project supports the climate resilience of 6,000 families from 80 indigenous and rural communities in Regions 1 and 9 of Guyana by promoting the links between economic diversification, productive transformation, environmental protection and family nutrition. It also seeks to improve small-scale farmers' access to public services, knowledge and technologies through training and technical assistance in the areas of planning and natural resources management (water, soil, renewable energy, agro-diversity). It supports local and regional councils as they plan and prioritize investments in local value chains and strengthens their resilience, enabling communities to identify economic					

opportunities as well as the risks resulting from climate change. The project also aims to improve food security and nutrition through the promotion of crops, fish, and forest products that can sustainably improve household diets. This involves nutrition education and behaviour change activities, including the elaboration of dietary guidelines. Paying special attention to the segments of the population most affected by poverty, about 15% of beneficiary households are headed by women and at least 75% of beneficiaries are Indigenous.					
Name of Action	Sustainable Agricultural Development Programme				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Programme	Completed	2017-2024	Ministry of Agriculture (MoA)	Regions 9, 10	Agriculture and food security
Description, Objective, and Progress					
Small farmers produce most of the fruits and vegetables grown in Guyana, and as such, agriculture remains largely a subsistence activity in the country, with the exception of a few key export crops, presenting comparatively low production rates to adjacent countries. This places the agriculture sector further at risk from climate change, considering the elevated needs for agricultural technical adaptive capacity development and access to climate-resilient infrastructure. The principal objective of this programme is to increase the productivity of the agricultural sector in Regions 9 and 10, while maintaining a sustainable and climate-resilient use of natural resources in Guyana. Impacts on enhanced agricultural productivity are being achieved through a combination of institutional strengthening, research, and extension and support to farmers for technology adoption and climate-resilient skills development. Specific activities aim to: (i) produce high quality data for the agricultural sector; (ii) increase productivity, especially for medium and small farmers; and (iii) increase sanitary and phytosanitary standards and access to meat processing facilities. It is expected that higher productivity will also reduce pressure on forest and fragile ecosystems, and at the same time, increase incomes for small and medium-sized farmers, all while supporting food security in the face of risks posed by climate change. The programme concentrates in Regions 9 and 10, where agricultural potential and availability of natural resources is greater. More than 3,500 farmers, including Amerindian communities, which represent more than 89% of the population of Region 9, are benefiting from this programme.					
Name of Action	Caribbean Small Island Developing States (SIDS) Multicounty Soil Management Initiative for Integrated Landscape Restoration and Climate-Resilient Food Systems				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2021-TBD	Guyana Lands and Surveys Commission (GLSC)	Regions 1, 5, 10	Agriculture and food security
Description, Objective, and Progress					
This project lies at the nexus of climate change and land degradation, supporting the implementation of a Driver-Pressure-State-Impact-Response (DPSIR) framework to Strengthen Caribbean SIDS with the necessary tools for adopting policies, measures and reforming legal and institutional frameworks to achieve land degradation neutrality and climate resilience. In Guyana, the project in being implemented in three sites as follows: The first site, Arakaka, seeks to address the drivers of land degradation through the rehabilitation of land and soil degraded areas, the promotion of integrated landscape management and restoration, and the identification and implementation of livelihood alternatives for communities. The second site, Liittle Biabu seeks to build resilience to land, degradation, natural disasters, and climate change through climate-smart agriculture and drought risk management. The third site, Kimbia, seels to enhance resilient food systems and alternative livelihoods through the promotion of innovations in agriculture and livestock production systems and mobilization of the private sector.					
Name of Action	RE-ACT (Resilient Action Guyana)				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**

Project	Planned	TBD	Ministry of Agriculture (MoA)	Regions 2, 3, 4, 5, 6	Agriculture and food security
Description, Objective, and Progress					
Since 2020, Guyana has been developing a concept note with the Green Climate Fund (GCF) seeking to increase resilience in highly vulnerable agricultural communities along Guyana´s productive coastal zones (Regions 2 through 6) to build adaptive capacity to ongoing and projected impacts of floods and droughts induced by climate change, with special attention to women, youth and Amerindian communities Activities will be implemented in the most vulnerable, populated, and productive regions located in Guyana´s coastal areas through a participatory stakeholder process with a two-fold objective. First, to build capacity and technology transfer to improve information availability and dissemination of good practices for climate-resilient agricultural production and agricultural water resources management at farm and landscape scale. Second, to strengthen institutional capacities to provide effective climate-related information services and support water management and the implementation of climate-resilient agricultural systems.					
Name of Action	Building Resilience through Climate Smart Agriculture while Promoting a Healthier Environment				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Ongoing	N.D.	Mainstay Whyaka Village Council	Region 2	Agriculture and food security
Description, Objective, and Progress					
The project aims to mitigate threats of climate in Mainstay/Whyaka while contributing to national and international efforts of reducing emissions from deforestation and degradation by practicing forest conservation, developing alternative livelihoods and climate-smart agriculture.					
Name of Action	Safeguarding Food Security in Kwakwani by Adopting Vlimate Smart Agricultural Practices				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Ongoing	N.D.	Women Revolutionaries Cooperative Society Limited	Region 10	Agriculture and food security
Description, Objective, and Progress					
The project is aimed at implementing climate smart agricultural activities and alternative livelihoods in Kwakwani, Berbice River, in an effort to achieve food security, increase climate-smart practices and promote alternative livelihoods to safeguard the well-being of the residents of the community.					
Name of Action	Capacity Building and Protected Agriculture Demonstration for Farmers in Guyana				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Completed	N.D.	Guyana Agricultural Producers Association	Regions 2, 3, 4, 5, 6	Agriculture and food security
Description, Objective, and Progress					
The project sought to address climate change impacts on the agriculture sector by building capacity amongst poor, rural, and vulnerable vegetable farmers in Regions 2, 3, 4, 5, and 6. This was achieved by providing training and setting up demonstration facilities in Hydroponics and Grow Box/Shade Houses.					
Name of Action	Climate Resilient Actions for Food Security for Persons with Disabilities				

Type of Action	Status	Duration	Implementing Entity	Geographic Scope	Sectoral Scope
Community-based initiative	Ongoing	N.D.	Guyana Council of Organisations for Persons with Disabilities	National	Agriculture and food security
Description, Objective, and Progress					
The project aims to improve the livelihoods and food security of persons with disabilities through employment opportunities and sustainable agriculture by developing climate resilience through enhancing agricultural sustainability and reducing the environmental footprint made by traditional agricultural practices.					
Name of Action	Grow Up Internship through Sustainable Agricultural Practices in Region 10				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Completed	N.D.	LFU Guyana Inc.	Region 10	Agriculture and food security
Description, Objective, and Progress					
The project uses a multi-pronged approach to address and minimise the effects of climate change on farmers in Region 10 and promote food security while engaging university students as technical and labour support to local farmers. The project intends to help farmers and community members grow in their knowledge and techniques as it relates to climate-smart practices, help second and third-year tertiary students based in Region 10 grow their practical knowledge, and grow the food production levels of the region, all under the objective to support and strengthen sustainable agricultural productivity in region 10 through the adaptation of climate-smart agricultural techniques.					
Name of Action	Restoring the Productivity of Cash Crop Farmers in Fyrish/Gibraltar, Region 6 to their Pre-flood Levels				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Ongoing	N.D.	Guyana Small Business Association Limited	Region 6	Agriculture and food security
Description, Objective, and Progress					
The project is aimed at resuscitating 5.3337 acres of farmlands in Gibraltar / Fyrish through capacity building, partnerships, and implementing climate-smart technologies to increase the yield of cash crops, safeguard food security, and create employment in combatting the effects of climate change.					
Name of Action	Climate Smart Agriculture for Food Security- Vertical Farming in Plaisance Village				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Community-based initiative	Completed	N.D.	Seventh-Day Adventist Church, Plaisance	Region 3	Agriculture and food security
Description, Objective, and Progress					
The objective of this project is to introduce a system of vertical farming in the Plaisance community which will contribute to enhancing local food security, reduce the use of chemicals and fertilisers which endanger marine life and biodiversity, and utilize solid waste materials which oftentimes are dumped by the locals in the waterways, contributing to flooding.					
Name of Action	Improving Farming in Mahaicony River by Adapting to Climate Change and the Environment				

Type of Action	Status	Duration	Implementing Entity	Geographic Scope	Sectoral Scope
Community-based initiative	Completed	N.D.	Mora Point/Goverlyte Community Development Council	Region 5	Agriculture and food security
Description, Objective, and Progress					
The project seeks to introduce alternative farming techniques, which can be used to introduce new crops into the farming community.					

2. Water resources

Name of Action	Conservancy Adaptation Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2007-2013	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Regions 3, 4, 5, 6	Water resources
Description, Objective, and Progress					
The Conservancy Adaptation Project was the first step undertaken to conceive a master plan for upgrading the East Demerara Water Conservancy (EDWC), including the necessary infrastructure investments aimed at increasing the conservancy´s drainage capacity in light of projected climate change. The project consisted of a series of studies strengthening Guyana´s understanding of the existing EDWC system and coastal plain drainage regimes and the increased drainage demands imposed by climate change, identifying key intervention areas to enhance adaptive capacity. The project also strengthened institutional capacity of the Government of Guyana to manage water levels in the EDWC and to guide interventions aimed reducing the country's vulnerability to floods.					
Name of Action	Rehabilitation of the EDWC Dam				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2012-2016	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Region 4	Water resources
Description, Objective, and Progress					
The Rehabilitation of the EDWC Dam project was a two-phase initiative that procured equipment and conducted the construction and rehabilitation of 6 of the EDWC Dam´s 33 intake and relief structures to protect the EDWC Dam from overtopping and collapse during rainy seasons, namely the Shaks, Hope, Nancy, and Annandale intakes, and the Sara Johanna and Maduni sluices.					

Name of Action	Flood Risk Management				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2014-2024	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Region 4	Water resources
Description, Objective, and Progress					
The Flood Risk Management (FRM) Project is the ongoing most comprehensive initiative to reduce the risk of flooding in the low-lying areas of the East Demerara. The project has two interrelated components. First, the project involves priority infrastructure rehabilitation and development work to upgrade critical sections of EDWC dams, as well as carrying out priority flood risk reduction investments in the EDWC drainage system network. The second component involves institutional strengthening for flood risk reduction by enhancing access to quality data, skills, tools, and sensing technologies for flood (hydraulic and hydrological) modelling to best monitor and plan for flood control. The project was financially supported by the World Bank with technical and capacity-building support from the Canada-Caribbean Resilience Facility and the European Union Caribbean Regional Resilience Building Facility (CRRBF). The CRF provided technical assistance aimed at strengthening Guyana's ability to efficiently implement the FRM Project by strengthening the legal and regulatory framework for managing disaster risk financing and enhancing financial management controls and processes for flood recovery and resilience building. This also included a review and refinement of the dredging and soil-handling methodologies implemented in the FRM Project. The CRRBF is supporting building climate and flood resilience in the Georgetown metropolitan area and expansion zones by reducing flood risk within the Liliendaal and Ogle drainage basins, including routine inspection and maintenance of existing drainage systems while strengthening Guyana's hydrometeorological, flood forecasting and early warning systems, as well as Guyana's overall disaster risk management capacities.					
Name of Action	Cunha Canal Rehabilitation Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2015-2017	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Region 4	Water resources
Description, Objective, and Progress					
Further enhancing the infrastructure work, the Cunha Canal Rehabilitation Project increased the canal´s discharge capacity to reduce the risks of the embankment overtopping and flooding to improve dam stability in the south-western section of the EDWC, as well as to support enhancing productivity of local agricultural areas surrounding the canal. The sluices at the outlets of the Cunha Canal and the East Demerara Water Conservancy were both rehabilitated, a public road bridge across the canal was constructed, the canal was widened and deepened and rerouted along its original alignment. The Cunha Canal Rehabilitation Project was a major adaptation project to increase the capacity of the canal to drain the EDWC, as well as local agricultural areas surrounding the canal. The project aimed to support a more climate resilient economy in Guyana, reduce the vulnerability of catastrophic flooding in Guyana's low-lying coastal area, and prevent significant losses to human lives, crops, and livestock.					
Name of Action	EWDC Drainage Pump Installation				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2019-2021	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Regions 2, 3, 4, 5, 6	Water resources
Description, Objective, and Progress					

Fixed and mobile pumps and associated structures and spares were acquired and installed throughout the EDWC including Hampton Court, Devonshire Castle, Den Amstel, Hope, Nootenzuil, Mora Point, and Rose Hall to further increase the efficacy of drainage capacity.					
Name of Action	Resilient, Green and Inclusive Flood Investment Baseline for Georgetown				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2020-2023	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Region 4	Water resources
Description, Objective, and Progress					
he Resilient, Green and Inclusive Flood Investment Baseline for Georgetown Project was launched to assist the Government of Guyana in designing a new master plan to guide future investments in climate-resilient flood-risk management infrastructure based on natural solutions for the Georgetown Metropolitan Area (GMA), considering its continuing expansion and population growth. As such, Guyana is developing a comprehensive mapping of the GMA's current and future hydrological regime and planning priority resilient, green, and inclusive interventions for the GMA based on these results. Relevant stakeholders are also undergoing training and operational capacity-building to better manage existing and future flood-risk infrastructure in the GMA.					
Name of Action	Guyana Coastal Adaptation and Resilience (CARe) Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Planned	2024-TBD	Ministry of Agriculture (MoA) // National Drainage and Irrigation Authority (NDIA)	Regions 3, 4, 5, 6	Water resources
Description, Objective, and Progress					
The Guyana Coastal Adaptation and Resilience (CARe) Project is in its final planning stages to further advance climate change adaptation progress made in reducing pluvial flood risks in Guyana´s coastal area. The Government of Guyana currently has a Concept Note on a proposed grant in the amount of US$45 million for the CARe project, expected to be approved by June 2024. The approach is three-fold as follows. First, infrastructure investments for the replacement, and construction of drainage structures. Second, the elaboration of guidelines for preventive flood risk reduction measures in new developments. Lastly, training Ministry of Agriculture's NDIA on flood prevention infrastructure operation and maintenance.					
Name of Action	Water Resource Management in Hinterland Communities to Protect Aquifer Recharge Zones in the Upper Takatu Region				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2020-2024	Hydrometeorological Service (Hydromet)	Regions 6, 9	Water resources
Description, Objective, and Progress					
Guyana has been working with the Amazonian Countries Treaty Organization (ACTO) since 2019 to enhance Water Resource Management in Hinterland Communities to Protect Aquifer Recharge Zones in the Upper Takatu Region, seeking to ensure integrated and sustainable management of the transboundary water resources of the Amazon River Basin between Guyana and Suriname, considering climate variability and climate change. This will be achieved by improving governance models and monitoring and evaluation schemes for integrated water resource management (IWRN), while building local capacities for community resilience to address the impacts of floods and droughts in the Amazon Basin in order to reduce socio-economic and ecosystem damages from extreme climactic events.					

3. Coastal zones

Name of Action	Sea and River Defence Resilience Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2014-2020	Ministry of Public Works	Regions 2, 3, 4, 6	Coastal zones
Description, Objective, and Progress					
The Sea and River Defence Resilience Project sought to combat marine flood risks posed by sea level rise onto Guyana´s coastal region around the delta of the Essequibo River by strengthening sea and river defence systems. The key outputs included (1) marine flood protection infrastructure, comprised of civil works for the reconstruction and improvement of approximately 5.4 kilometres of sea and river defences, (2) enhanced shoreline change monitoring and analysis, and (3) implementing a coastal flooding defence community awareness and education programme.					

Name of Action	Guyana Mangrove Restoration Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2010-2014	National Agricultural Research and Extension Institute (NAREI)	Regions 4, 5, 6	Coastal zones
Description, Objective, and Progress					
Guyana's NAREI spearheaded the Guyana Mangrove Restoration Project. This project allowed for the establishment of national administrative capacity to manage mangroves in Guyana and focused efforts on mangrove restoration, community-based mangrove management, as well as public awareness, whereby women were empowered to be environmental leaders through the establishment and operation of sustainable businesses benefitting from mangrove ecosystem services. The initiative made commendable achievements, including the monitoring and protection of 500 hectares of mangroves through a community-based management approach along the East Coast of Demerara, West Coast of Berbice, and Corentyne Coast.					

Name of Action	Community led Mangrove Restoration: Towards Sustainable Management of Guyana´s Mangrove Forest				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2014-2021	Guyanese Women in Development	Region 5	Coastal zones
Description, Objective, and Progress					
The project contributed to abating climate change (carbon sequestration through reforestation and forest preservation) and mitigate its effects using mangrove sea defences, through the restoration of a one-kilometre span (0.5km of mangroves seedlings and 0.5km of Spartina grass) along the coastline from Columbia to Aberdeen, by October, 2021. The project addressed the rehabilitation, protection, and sustainable use of mangroves, monitoring and the enforcement of forest legislation and established Code of Practice for mangrove management, and public awareness and education.					

Name of Action	Conservation of Coastal Mangrove Forest Resource to Support Brackish Water Aquaculture for Enhancement of Community Socio-economic Nenefit and Food Security				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2021-2024	Ministry of Agriculture (MoA)	Regions 1, 2, 3, 4, 5, 6	Coastal zones
Description, Objective, and Progress					
This project is implemented through the Intermediary MoA framework with the University of Guyana, Department of Environmental Studies as the intermediary organisation. This project addresses the issue of mangrove depletion, the reduction of marine fish/shrimp catches, and sustainable livelihoods for communities and families. The project also aids in capacity building, climate change adaptation, regaining biodiversity, gender equality, food security, and the reduction of poverty.					
Name of Action	Securing the Future of the Barima Mora Passage Mangrove Ecosystems and its Peoples				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2022-2027	Guyana Marine Conservation Society (GMCS)	Region 1	Coastal zones
Description, Objective, and Progress					
The Barima Mora passage located on Guyana's Region 1 coastline, close to the Venezuelan border, hosts the most intact and mature mangrove ecosystem in the country. The mangroves and surrounding systems are under threat due to various external and local factors which include climate change, land speculation in coastal areas, contamination from extractive sectors, increased levels of land clearing for farming and housing, as well as unsustainable wildlife trapping, hunting, and fishing. The project objective is to develop a framework to secure and finance protection of the Barima Mora's unique ecosystem while working with indigenous people and migrants that live within or near this site to build awareness of the importance of the mangrove for climate resilience, in addition to providing training and support for engagement of community members in climate-resilient sustainable livelihoods and green jobs that respect ecosystem services and biodiversity. The solution proposed has four interlocking elements: (i) the recognition of the Barima Mora area as UN World Heritage site, (ii) promoting local community awareness on the importance of mangroves and their ecosystem services, (iii) training and support in new, green livelihoods such as research tourism, bee keeping, and eco- services and (iv) a framework to attract financing, via a blue carbon compensation mechanism, which can be managed and invested at community levels to sustain local delivery of eco services conservation, monitoring, and sustainable management of the ecosystem.					
Name of Action	Unlocking the Potential of Guyana's Mangrove Forests to Build Resilience to Climate Change				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Planned	TBD	Guyana Forestry Commission (GFC)	Regions 1, 2, 3, 4, 5, 6	Coastal zones
Description, Objective, and Progress					
Since 2018, Guyana has a Concept Note for the Green Climate Fund (GCF) focusing on integrated coastal zone management and the expansion of ecosystem-based adaptation measures through mangrove restoration aiming to reduce coastal flooding and make 465,000 people more resilient to floods. Key outputs include (1) addressing gaps in the understanding of bio-physical processes on Guyana's coastline and to strengthen integrated coastal zone management to address threats from rising sea levels, (2) restoring mangroves as green infrastructure for coastal flood prevention through a building with nature approach, and (3) increasing capacity of coastal communities to mainstream adaptation.					

4. Health

Name of Action	SMART Health Care Facilities Caribbean Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	201-2022	Ministry of Health (MoH)	National	Health
Description, Objective, and Progress					
The SMART Health Care Facilities Caribbean Project sought to retrofit existing healthcare facilities in Guyana to become safer, greener, and more resilient to natural disasters and climate change. Between 2021 and 2023, five healthcare facilities were retrofitted, namely the Paramakatoi Health Centre, the Diamond Diagnostic Centre, the Lethem Regional Hospital, the Leonora Cottage Hospital, and the Mabaruma District Hospital. Retrofits sought to improve resilience of these facilities when faced against extreme weather events in a low-carbon manner by improving the undisturbed energy and water self-sufficiency of the facilities. As such, retrofits included: installation of more efficient cooling methods, repairs and upgrade to rainwater harvesting systems and stormwater drainage, introduction of LED lighting, and installation of solar water heaters and PV electricity generation with battery back-up.					
Name of Action	Expansion of Healthcare Service Delivery Network				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	N.D.	Ministry of Health (MoH)	Regions 2, 3, 4, 5, 6	Health
Description, Objective, and Progress					
Committed to its promise to build a world-class healthcare system in Guyana, the government is moving ahead with the construction of seven new hospitals that will deliver quality health service to Guyanese in all regions. The aim is to meet increased climate-induced demand for healthcare services throughout Guyana. Hospitals are being constructed at Anna Regina in Region 2, De Kinderen in Region 3, Diamond and Enmore in Region 4, Bath in Region 5, New Amsterdam and Skeldon in Region 6.					

5. Education

Name of Action	Development of the National Risk Management Policy for the Education Sector				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Completed	2019-2021	Ministry of Education (MoE)	National	Education
Description, Objective, and Progress					
To mitigate the impact of future climate change-induced crises and ensure the continuity of education, the Ministry of Education launched its National Risk Management Policy for the Education Sector. The Policy conducts region-specific comprehensive analysis of the risks posed by climate change to schools (including floods, drought, erosion, disease outbreak, water pollution, forest fires, high winds, sea level rise, and heat waves), as well as an assessment of the current and needed risk management capacities in the education sector. Through the Policy, adaptive capacities will be increased through a combination of climate-resilient infrastructure improvements/rehabilitations, improvement of management systems, and enhancing professor/teacher/staff capacities for enhancing resilience in times of climate-induced emergencies. This Policy also aims to reinforce the Ministry of Education´s capacities at central and sub-national levels to be prepared for and prevent the impacts of crises and ensure educational continuity during and after a crisis hit.					

6. Ecosystems and biodiversity

Name of Action	Sustainable Gold Mining and Mercury Reduction to Enhance Biodiversity and Reduce Land Degradation				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2014-TBD	Ministry of Natural Resources and the Environment (MNRE) // Environmental Protection Agency (EPA) // Conservation International Guyana // Guyana Minamata Working Group	National	Ecosystems and biodiversity
Description, Objective, and Progress					
A series of synergic projects seeking to enhance gold mining techniques so as to enhance biodiversity and maintain ecosystem functionality for the benefit of all Guyanese´s livelihoods and health by shifting towards a mercury-free gold mining sector by 2025 under the Minamata Convention through a strengthened regulatory framework and institutional capacity-building, with a particular focus on artisanal, small and medium-scale gold mining operations. The series of projects include: 1. 2014-2017: Undertaking a Initial mercury assessment to identify the national mercury challenges and the extent to which policy and regulatory framework can enable Guyana to implement obligations under the Minamata Convention.					

2. 2014-2018: Strengthening monitoring, enforcement, and uptake of environmental regulations in Guyana´s gold mining sector, focused on biodiversity and ecosystem services protection.
3. 2018-2023: Adopting a supply chain approach for eliminating mercury in the artisanal and small-scale gold mining sector by empowering profit-motivated business enterprises to engage in sustainable jewellery branding and supply chains.
4. 2019-ongoing: Developing National Action Plan for the Artisanal and Small-Scale Gold Mining (ASGM) sector and building implementation capacities to adopt sustainable gold mining practices an reduce mercury use in the sector to achieve commitments under the Minamata Convention.
5. 2020-ongoing: Strengthening the regulatory framework and institutional capacity for the management of small- and medium- scale gold mining and to promote greater adoption of environmentally responsible mining techniques in Guyana to protect globally significant biodiversity, reduce mercury contamination, enhance local livelihoods and human health.

Name of Action	Measurement of Climate Change Impacts and Ecosystem Services in Iwokrama				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2009-2013	Iwokrama International Centre (IIC)	Region 8	Ecosystems and biodiversity

Description, Objective, and Progress

The objective of the project was to contribute to the long-term effort of Guyana in the formulation and establishment of a science-based research programme for the Iwokrama forest aimed at reducing Iwokrama's vulnerability to climate change, while demonstrating how forests such as Iwokrama can continue to be used in a sustainable way to generate income for government and local communities, whose livelihoods depend on the forest. The project intended to close the existing gap between climate science and policy. Specifically, the hydro-meteorological and geochemical data generated from the project will be used to establish essential baseline datasets and to better assess the potential impacts of climate change or anthropogenic change in the Iwokrama rainforest and nationally. A more comprehensive and homogeneous set of forestry-related historical datasets together with projected values of key variables will facilitate the identification of vulnerable components of the timber production system in Iwokrama. The information generated will be used to better design sustainable timber production schemes in the near future and generate the blueprint of a carbon-bond.

Name of Action	Leveraging Natural Capital in Guyana's Rupununi				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2012-2018	Department of Environment and Climate Change (DECC)	Region 10	Ecosystems and biodiversity

Description, Objective, and Progress

This project sought to downscale the Guyana´s Low Carbon Development Strategy to agricultural and tourism operators in the Rupununi region by strengthening climate-resilient and environmentally sustainable businesses in the Rupununi that apply best practices for the management and long-term safeguarding of ecosystems services sustaining sustainable socioeconomic growth in the region. The project sought to strengthen 9 tourism and 14 agricultural community-based businesses for planning and implementing low-carbon, climate-resilient and pro-conservation strategies whereby options for mainstreaming climate change adaptation and ecosystem conservation action in the Rupununi region were identified, described, and agreed upon by local communities. Furthermore, overarching agriculture and tourism climate-resilient development plans were developed, and a Rupununi Community Tourism Syndicate was created and rendered operational, both with the aim to continue empowering ecosystem- and biodiversity- friendly ecotourism and sustainable agricultural development in the region.

Name of Action	Developing a Sustainable Tourism Circuit in South Rupununi

<table>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Ongoing</td><td>2020-2025</td><td>Guyana Tourism Authority (GTA)</td><td>Region 9</td><td>Ecosystems and biodiversity</td></tr>
<tr><th colspan="6">Description, Objective, and Progress</th></tr>
<tr><td colspan="6">This project seeks to formalise the South Rupununi Tourism circuit to develop a package of official tourism products and to build local capacities to foster inclusive and sustainable economic development in the region that meet the needs for cultural and environmental sustainability while safeguarding ecosystem services and biodiversity. The project also seeks to integrate climate change adaptation measures to ensure a formalized and climate-resilient ecotourism sector in the Rupununi region.</td></tr>
<tr><th>Name of Action</th><td colspan="5">Amazon Bioeconomy Fund</td></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Programme</td><td>Ongoing</td><td>2021-2029</td><td>Department of Environment and Climate Change (DECC)</td><td>Regions 6, 9</td><td>Ecosystems and biodiversity</td></tr>
<tr><th colspan="6">Description, Objective, and Progress</th></tr>
<tr><td colspan="6">In 2021 the Amazon Bioeconomy Fund was launched by the Green Climate Fund aimed at unlocking private capital by valuing bioeconomy products and services with climate change adaptation results in the Amazon. Operating in six countries, namely Brazil, Colombia, Ecuador, Peru, Suriname, and Guyana, the fund is delivering sustainable solutions to reduce the impacts of climate change in the Amazon biome by prioritizing natural capital and delivering climate benefits, seeking to encourage private investment in six key areas of the bioeconomy: sustainable agroforestry, native palm cultivation, non-timber natural forest products, growing native species timber, aquaculture, and community-led nature tourism.</td></tr>
<tr><th>Name of Action</th><td colspan="5">Securing a Living Amazon through Landscape Connectivity in Southern Guyana</td></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Ongoing</td><td>2022-2027</td><td>Environmental Protection Agency (EPA) // Protected Areas Commission (PAC)</td><td>Region 9</td><td>Ecosystems and biodiversity</td></tr>
<tr><th colspan="6">Description, Objective, and Progress</th></tr>
<tr><td colspan="6">In 2022, the Securing a Living Amazon through Landscape Connectivity in Southern Guyana project was approved for implementation, seeking to address the cumulative negative ecological and hydrological impacts of unplanned land-use changes and unsustainable natural resource extraction activities in the Kanuku Mountains Protected Area and North Rupununi Wetlands, encompassing infrastructure development, logging, large-scale agriculture, and wildlife harvesting. Consequential resource depletion and habitat fragmentation compromise the area´s ability to deliver ecosystem services which sustain livelihoods and provide economic and subsistence opportunities for the area´s local and Indigenous communities, notably biodiversity maintenance, water supply and quality maintenance, and ensure resilience to potential impacts from climate change. Key project components are four-fold:
• To fortify integrated protected landscape management, whereby focus is placed on the Kanuku Mountains Protected Area to strengthen its management together with the Indigenous communities who utilize resources of the protected area.
• To fortify integrated productive landscapes, whereby focus is placed on strengthening the management of the North Rupununi Wetland.
• To strengthen policies and incentives for protected and productive landscapes, including the revision of the Protected Areas Act in consultation with all key stakeholders.
• To build capacities and cooperation including monitoring and evaluation, communications, and cooperation with similar initiatives among the broader Amazon region.</td></tr>
</table>

7. Energy security

Guyana strives to find the right balance between energy security and climate security. While the LCDS 2030 envisions investment in clean energy primarily in the aim to achieve greenhouse gas (GHG) reduction targets, significant ongoing investments in expanding and diversifying Guayama's electricity supply through hydro, solar, and wind technologies also contribute to build resilience in terms of energy access and reliability.

Ongoing investments in reinforcing climate-resilient transmission and distribution infrastructure for the main public grids will help bring undisrupted power by enhancing tolerance levels to extreme weather events. Furthermore, the ongoing diversification of isolated grids introduces further redundancies to the energy system to provide reliable and back-up power to previously energy-insecure communities.

Lastly, the rural electrification programme and the solar home system programme and mini grid programme further enables previously unconnected homes and communities to reliably access clean and affordable energy. Extensive details on the completed, ongoing, and planned projects linked to energy security in Guyana is detailed in Chapter 4 – Mitigation.

8. Disaster risk management

Name of Action	Preparation of the National Integrated Disaster Risk Management Plan (NIDRMP)				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2009-2013	Civil Defence Commission (CDC)	National	Disaster risk management
Description, Objective, and Progress					
This project supported the Government of Guyana to design and subsequently implement the National Integrated Disaster Risk Management Plan (NIDRMP) and Implementation Strategy, within the framework of comprehensive disaster management. Under this project, climate-related disaster risk in Guyana was evaluated, the national and local capacity for integrated disaster risk management (IDRM) was strengthened, and an investment program in flood prevention and mitigation was developed.					
Name of Action	Strengthening Disaster Management Capacity of Women in the Cooperative Republic of Guyana				

Type of Action	Status	Duration	Implementing Entity	Geographic Scope	Sectoral Scope
Project	Completed	2018-2023	Hydrometeorological Service (Hydromet)	Regions 5, 6, 7, 8, 9	Disaster risk management

Description, Objective, and Progress

This project sought to support vulnerable groups, especially women, in hazard-prone hinterland and coastal indigenous communities across Regions 5, 6, 7, 8, and 9 in Guyana to strengthen disaster and climate risk resilience towards enhancing sustainable livelihoods within such communities. This was attained through the following outputs:

- Incorporate community-based early-warning systems (EWS) in community-based disaster risk management efforts and provide training to maintain and secure EWS instruments.
- Develop of Guyana's national flood EWS for localised and timely early warning for informed decision-making and build capacities for implementation.
- Conduct public awareness and education of the public, government, and the media on the availability and use of the improved national EWS.
- Conduct Participatory Integrated Climate Services for Agriculture (PICSA) to empower women´s role in EWS for DRM in the agriculture sector.

Name of Action: Climate Risk and Early Warning (CREWS)

Type of Action	Status	Duration	Implementing Entity	Geographic Scope	Sectoral Scope
Project	Completed	2019-2021	Hydrometeorological Service (Hydromet)	National	Disaster risk management

Description, Objective, and Progress

Guyana is included in the World Meteorological Organization (WMO)-led Climate Risk and Early Warning (CREWS) project for the Caribbean region, aimed at streamlining capacities related to weather forecasting, hydrological services, multi-hazard impact-based warnings, and service delivery for enhanced decision-making at regional, national, and local level. Under the CREWS Project, Guyana developed a national roadmap to strengthen and streamline multi-hazard early warning and hydrometeorological services. In addition to institutional strengthening, a Risk Information Exchange repository was also developed and piloted to support the transition to impact-based forecasting.

Name of Action: Early Warning for All Initiative (EW4A)

Type of Action	Status	Duration	Implementing Entity	Geographic Scope	Sectoral Scope
Project	Ongoing	2023-2027	Hydrometeorological Service (Hydromet)	National	Disaster risk management

Description, Objective, and Progress

Guyana is partaking in the first batch of countries to pilot the Early Warning for All Initiative (EW4A), which aims to ensure universal protection from hazardous weather, water, or climate events through life-saving early warning systems by the end of 2027. The EW4A is built on four pillars to deliver effective and inclusive multi-hazard early warning systems, namely:

- Collecting data and undertaking risk assessments to increase knowledge on hazards and vulnerabilities and trends.
- Developing hazard monitoring and early warning services for detection, observation, monitoring, analysis, and forecasting.
- Communicating and disseminating risk information to all those who need it.
- Building national and community response capabilities.

9. Land use, infrastructure, settlements, and services

Name of Action	Capacity Development and Mainstreaming for Sustainable Land Management in Guyana				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2004-2012	Guyana Lands and Surveys Commission	National	Land use
Description, Objective, and Progress					
The overall goal of this project is to contribute to maintaining and enhancing of ecosystem health, integrity, stability, and functions by strengthening the enabling environment for sustainable land management (SLM) at the institutional and systemic levels through increased and enhanced national capacity to respond to issues related to SLM. The project objective is to establish an enabling environment to combat and reverse land degradation through a participatory process of capacity building; mainstreaming of SLM into national development strategies and processes; broad stakeholder participation; and resource allocation for SLM.					
Name of Action	Mainstreaming Sustainable Land Development and Management				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2017-TBD	Guyana Lands and Surveys Commission	National	Land use
Description, Objective, and Progress					
The Mainstreaming Sustainable Land Development and Management project seeks to transform current land management practices in Guyana to ensure sustainability in land management systems and streamline the provision of land services to land-users and decision-makers and to foster long-term economic, social and environmental development in the country.					
Name of Action	Climate-Resilient Adequate Housing and Urban Accessibility in Georgetown				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2017-2022	Ministry of Public Works	Region 4	Settlements and services
Description, Objective, and Progress					
The objective of this project is to improve the quality of life in urban and peri-urban Georgetown through better access to adequate housing and basic infrastructure for low-income populations, and through improved accessibility and mobility services. This objective has two main components: First, the "Delivery of Housing and Basic Infrastructure Solutions" component aims to provide subsidies to cover the costs of basic home improvements and new core home construction for low-income households, as well as to construct and rehabilitate infrastructure and services of government-sponsored housing sites in the Georgetown area. The second component, "Enhancement of Urban Road Network and Road Safety," comprises the rehabilitation and expansion of Georgetown's main road axis, the Sheriff-Mandela Road, as well as a National Road Safety Action Plan. In both cases, the Government of Guyana is committed to identifying and implementing climate-ready designs, and exploring the potential for complementary sustainable infrastructure solutions, including green infrastructure. To achieve this, the Government of Guyana needs updated and granular information on the vulnerability profile of					

Georgetown's territory, and to develop locally appropriate plans and design proposals based on this information. As such, under this project, the Government of Guyana is conducting urban growth and risk assessment studies and development planning proposals and associate technical studies for embedding climate change adaptation in the construction of housing and urban accessibility infrastructure in Georgetown.

Name of Action	Program to Support Climate Resilient Road Infrastructure Development				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2022-2026	Ministry of Public Works	Region 4	Infrastructure
Description, Objective, and Progress					
The objective of this project is to support the mainstreaming of climate resilience in ongoing road infrastructure developments in Guyana to advance Guyana's safe, efficient, and climate-resilient road and associated infrastructure. The specific objectives are to improve road service quality and utility service along the East Bank Demerara corridor through road and corresponding utility infrastructure improvements incorporating climate-resilient solutions and enhancements to infrastructure. This corridor supports key value-chains including fertilizers, manufacturing, food-processing, construction materials, mining, and forestry, which comprises the first section of the integration corridor that connects Georgetown to Brazil via Lethem. As such, increasing the climate resilience of this corridor will be crucial to reinforce Guyana's economic and trade connectivity of goods and services and its continued service despite expected impacts of climate change.					
Name of Action	Support for Climate Resilient Road Infrastructure				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2023-2026	Ministry of Public Works	National	Infrastructure
Description, Objective, and Progress					
The Government of Guyana has embarked on a large investment effort to upgrade and revamp transportation infrastructure in the country, which consists of interventions in improving critical coverage, capacity and quality upgrades of its road network through actions for rehabilitation, improvement, conservation, as well as strengthening the capacities of the authorities. The objective of this project is to support the development of road infrastructure and regional development in Guyana such that it is conducted in a climate-resilient manner and by strengthening the capacity of the public sector to embed socio-environmental and climate resilience aspects in transportation infrastructure project planning and implementation processes, as well as to manage a growing public infrastructure investment agenda aligned with climate resilience objectives.					
Name of Action	Paris Agreement Alignment Studies for the Guyana-Brazil Integration Corridor for Sustainable Development				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Ongoing	2023-2026	Ministry of Public Works	National	Infrastructure
Description, Objective, and Progress					
Since the turn of the century, Guyana has been in the process of constructing of a land transport link with through Lethem in the South border and a new Deep-Water Port along Guyana's coast in the North. This transport corridor will support Guyana's connectivity with Brazil with the aim of opening foreign markets to Guyana's exports, improve transportation costs, while at the same time, increasing competitiveness through increased economies of scale, and, increasing the flexibility of labour supply which will result in less unemployment. Nevertheless, the construction of such extensive infrastructure may both contribute to, and be significantly impacted by, climate change, and as such,					

the Government of Guyana is seeking to develop the corridor in a sustainable low-carbon and climate-resilient manner. Under this context, this activity seeks to develop robust mitigation, adaptation, and climate resilience studies to verify the alignment of the Guyana-Brazil Integration Corridor for sustainable development with the Paris Agreement.					
Name of Action	Integrated Transport Corridors Project				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Planned	2025-TBD	Ministry of Public Works	Regions 3, 4, 5, 6	Infrastructure
Description, Objective, and Progress					
The proposed Integrated Transport Corridors Project is in its planning stages, seeking to provide climate resilient and safe transport connectivity in the North-Eastern part of Guyana, financing the rehabilitation and upgrade of selected road corridors/sections, and strengthening the Government of Guyana´s institutional capacity in the road transport sector with consideration of climate change, road safety, citizen engagement, and gender. The project will support regional integration, inland and coastal connectivity, and expand the agricultural sector for food security by improving safe and climate-resilient connectivity. Guyana has already pre-identified potential road corridors to be financed under the project, including a 40km corridor from New Amsterdam to Mara and an 8km section of the Corentyne corridor from Moleson Creek to El Dorado. Further, the project will develop a maintenance strategy for the existing road network, based on evolving patterns of climate change.					

10. Amerindian and Hinterland development

Name of Action	Village Sustainability Plans				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Programme	Ongoing	2021-2025	Ministry of Amerindian Affairs (MoAA) / National Toshaos Council (NTC)	National	Amerindian development
Description, Objective, and Progress					
Under the LCDS 2030, Guyana aims to lead sustainable development at village level with clear strategy in a continuous, predictable, and sustained manner. A dedicated 15% of all revenues earned from forest carbon markets in Guyana (under the ART-TREES mechanism) are made available for bottom-up investments in the implementation of community-led low-carbon development programmes for Amerindian communities who choose to opt in to access these funds through the development and implementation of their own Village Sustainability Plans (VSP) under the principle of free prior and informed consent (FPIC). Significant feedback was received back on the proposed revenue sharing approach, and the resulting opt in mechanism is anticipated to start in July 2022. The National Tosahos' Council, the constitutional body representing Indigenous Villages in Guyana, and represented by Village Toshaos, passed a resolution at the July 2022 Conference, endorsing this approach. As of September 2023, 241 of the 243 Amerindian villages in Guyana have submitted plans. While the structure and content of each of these plans vary, as they are self-determined by each community, these include climate change adaptation efforts such as: • Climate-resilient community energy and water infrastructure and communications. • Sustainable livelihood opportunities including ecotourism and climate-resilient agricultural opportunities to ensure both food security and income generation. • Sustainable management of nature, environment, ecosystems, and biodiversity.					

- Ensuring equal access to local climate-compatible education.
- Enhanced healthcare, encompassing access to safe, and affordable drinking water, access to adequate and equitable sanitation and hygiene for all, and access to sexual and reproductive health care services.

To date, US$150 million has been received thus far from the sale of Guyana's first commercial sale of carbon credits to Hess Corporation of which a total of US$22.5 million was disbursed to Amerindian communities in 2023 to implement their VSPs.

Name of Action	Support to Village Planning and Implementation as part of Guyana's REDD+ Programme				
Type of Action	**Status**	**Duration**	**Implementing Entity**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2021-2027	Ministry of Amerindian Affairs (MoAA) / National Toshaos Council (NTC)	National	Amerindian development

Description, Objective, and Progress

The Government of Guyana, in collaboration with the National Toshaos Council, aim to support Indigenous Peoples and Local Communities (IPLCs) in Guyana to successfully implement, monitor, evaluate, and improve their recently elaborated VSPs to achieve community-driven sustainable development that maintains and enhances the value of their resources while fostering environmental integrity and building climate resilience. As such, the Government of Guyana and the NTC currently have the project proposal Support to Village Planning and Implementation as part of Guyana's REDD+ Programme, seeking financing from payments earned under the Guyana-Norway Bilateral Cooperation Agreement. The proposed project also seeks to build institutional capacities of the NTC and the Ministry of Amerindian Affairs to fulfil their mandate and to support IPLCs across the country to effectively plan, implement, and monitor their VSPs.

Annex III Mitigations actions by sector and their effects

1. Energy

Power Generation

Name of Action	Energy Matrix Diversification and Institutional Strengthening of the Department of Energy (EMISDE)					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2019-2024 (Component I) 2019-2026 (Component II)	Guyana Energy Agency (GEA) Components I and III and Guyana Power & Light Inc (GPL) Component II	CO_2	National	Power Generation
Description and Objective						
The main objective of the program is to support Guyana's evolving energy sector by: (i) investing in sustainable/cleaner energy solutions to diversify the energy matrix in the Hinterland while contributing to climate change mitigation; (ii) investing in the reinforcement of transmission infrastructure to improve reliability and stability of the Demerara-Berbice Interconnected System (DBIS); and (iii) strengthening the Department of Energy (DE) to develop a regulatory framework and improve institutional capacity and governance of the Oil and Gas (O&G) sector. The project is structured around three main components. Under component 1 'Renewable Energy Solutions for the Hinterland' of the project, the Government of Guyana, Ministry of Public Infrastructure facilitates the development of grid connected Solar Photovoltaic (PV) systems with a total installed capacity of 3.15 MW to supply the regional grids of the communities of Mahdia (0.65MW), Lethem (1MW), and Bartica (1.5MW). The diversification of the energy matrix and energy security in these three communities aims to promote socioeconomic development through the supply of reliable and affordable electricity to the three communities						

as well as reduce CO_2 emissions from the power generation sector by utilising a renewable energy source and will support Guyana's evolving energy sector with investment in sustainable and reliable energy solutions along the path to a cleaner and diversified energy matrix, beginning with innovative solutions for energy security and reliability for hinterland townships. The project incorporates a pilot smart metering initiative that is considered an important step forward as it will provide a technological advancement in the operation of the distribution grid. Furthermore, the introduction of solar energy presents a great opportunity to implement a women's economic empowerment program at the community level, contributing mainly to the development of productive uses of electricity and community engagement. Under component 2 'Reinforcement of Transmission Infrastructure' of the project, Guyana reinforced the transmission infrastructure to improve the reliability and stability of the Demerara-Berbice Interconnected System (DBIS) in the Kingston-Sophia transmission section with: (i) reinforcements of the new Sophia substation; and (ii) investments in transmission system redundancy. This includes the installation of a reactive compensation system, a Volt-Ampere-Reactive (VAR) at the New Sophia substation, installation of a 69-kV bay or equivalent, construction of an additional transmission line between Kingston and Sophia, and upgrading of the existing transmission line. The conductor under the current configuration is operating almost to its maximum capacity so the new one will provide the grid the possibility to operate at higher amps consequently reducing the risk of trips and outages. This will reduce outages by reducing the level of emergency maintenance and allowing the system to operate under a regular maintenance schedule. The component incorporates the development of standards for the storage and disposal of unused electric equipment in the company, providing a guideline for GPL improvement in management and operation of the substations. Under component 3 'Institutional Strengthening and Governance of the Department of Energy' of the project, it includes consultancies for capacity building initiatives and a best-practice organizational structure; and technical support for the design of a new oil and gas legislative and regulatory framework.		
Quantitative Goals		
• The project is expected to generate approximately 4,299 MWh of electricity annually (Mahdia – 892 MWh/yr, Lethem – 1,457 MWh/yr, and Bartica – 1,950 MWh/yr) at an average cost (weighted average levelized cost of electricity - LCOE) of US$0.15 per kWh. • It will contribute to an estimated 69% reduction in electricity generation cost and an estimated annual cost savings of US$1,932,992 for the hinterland utilities. • The addition of renewables to the energy mix will reduce approximately 1,815,015 litres of diesel consumption and 3.67 tCO_2e per year. • The project is expected to lead to an improvement of unserved electricity demand. • It will contribute to a reduced number of outages in the DBIS. • It will improve the reliability and stability of the DBIS.		
Steps Taken or Envisaged to Achieve Action		
The GEA within the Ministry of Public Infrastructure (MoPI) is responsible for the execution of the project components I and III and overseeing the provision of the policy support, technical planning, and the development of operating codes and regulations while the Hinterland Electrification Company Inc. (HECI) is in charge of the implementation and operation of projects via local utilities of small grids and solar systems installed in rural areas. Throughout the project implementation, GEA and HECI work in close collaboration due to some overlap in responsibilities. Lethem's solar PV system was completed and fully commissioned on August 5, 2022 while Bartica is was completed by the end of March 2023. The Mahdia solar PV system was scheduled for completion in September 2023. Furthermore, the project involved the installation of 800 AMI compatible smart meters at Bartica, which were completed on 15 December 2022. GPL as the state electricity utility company is responsible for executing component II of the project. Throughout the project implementation, the transmission system of the DBIS has been reinforced and upgraded to attend to the increasing electricity demand estimated over the next years, reach international operating standards by replacing aged and unreliable equipment, integrate new generation sources (such as solar and wind), improve quality of service, and ensure a constant electricity supply that can adapt to variation due to seasonal or daily flows.		
Estimated Outcomes	**Estimated GHG Emission Reductions**	**Methodologies and Assumptions**
• Decrease in electricity generation costs. • Avoidance of CO_2 emissions. • Electricity generation in the three townships is diversified. • Renewable energy solutions are introduced.	3.67 tons CO_2e / yr	The combined annual power generation of 4,299 MWh/yr in the three communities Mahdia, Lethem, and Bartica was multiplied by an emission factor of 0.854 (tons CO_2/MWh) to estimate the annual GHG

• Incorporation of a smart metering initiative. • Electricity demand is attended. • Reduction of Controlled and Monitored electricity service outages. • Decrease in voltage fluctuations. • Reinforcement of transmission infrastructure.		emission reductions in tons CO_2e per year. Grid emission factors for the Bartica Isolated system of Guyana (tons CO_2/MWh) from report Standardized baseline: Grid Emission Factors of Guyana Version 01.0, ASB0045-2019

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Price for electricity production per kilowatt hour.	$ USD/kWh	0.50	0.15	0.50
Tons of emissions per year reduced in the townships of Bartica, Mahdia and Lethem.	tons CO_2e/yr	0	3.147	0
Electricity not supplied due to system failures.	MWh	3,591	2,714	5,387.45
Share of electricity produced with Solar PV technology is introduced in the three townships.	%	0	27	2
Women beneficiaries of economic empowerment initiatives.	#	0	200	249
Controlled and monitored electricity service outages.	#/yr	6	1	3
Percentage of voltage variation.	%	5	1.06	4.85
Strengthened Oil and Gas Sector Framework.	#	0	1	1
Procedures for Public Service Announcement (PSA).	#	0	1	1

Name of Action	Expanding Bioenergy Opportunities in Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Completed	2008-2010	Inter-American Development Bank (IDB)	CO_2	National	Power Generation

Description and Objective

The general objective of the program is to provide assistance that will allow the Government of Guyana (GOG) to develop the bioenergy sector. The specific objectives of the program are: (i) improving the capacity of the GOG to identify and evaluate viable investment opportunities in the bioenergy production chain; (ii) develop a financial vehicle or instrument to promote investment opportunities and develop a strategy to harness Guyana's potential for bioenergy production; (iii) increase capacity building and the transfer of technology in order to build a critical mass of bioenergy technicians, operators, and demonstration Programs; and (iv) institutional strengthening to support Agro-energy Policy of Guyana; support for small scale bioenergy demonstration Programs and dissemination of results.

Quantitative Goals

- Development of a competitive, integrated agro-energy industry.
- Reduced CO_2 emissions through the use of bioethanol and biodiesel substituting for gasoline and diesel respectively, cogeneration with bagasse and methane abatement from biofuel wastewater treatment processes.

Steps Taken or Envisaged to Achieve Action

To achieve the objectives of the program it was structured in the following components:

- Component 1 – Development of a methodology for identifying viable investment opportunities, knowledge transfer, and preliminary identification of potential bioenergy programs.
- Component 2 – Design of a financial vehicle or instrument to develop viable investment opportunities and pilot implement a Strategy to promote Guyana's potential for bioenergy production.
- Component 3 – Capacity building and transfer of technology.
- Component 4 – Institutional strengthening to support the Agro-energy Policy of Guyana, support for small-scale bioenergy demonstration projects and dissemination of results.

Achieving these goals will provide Guyana with a platform from which to launch the industry and to support the development and financing of viable investment opportunities.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Lowered costs of sugar production for the development of a competitive, integrated agro-energy industry. • Production of biofuels with the surplus energy sold to the grid. • Reduced CO_2 emissions.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of developed standard methodologies for program screening and evaluation including the design of the basic structure of a bioenergy program-evaluation unit within the Agro-energy Board of Guyana.	#	0	1	1
Number of assessments to determine the requirements to upgrade technical, operative, and managerial skills in relation to bioenergy production.	#	0	1	1

Number of assessments of program developers interested in investing in bioenergy programs in Guyana.	#	0	1	1
Number of designed financial investment instruments appropriate for Guyana including a comparative analysis of proven financial structures.	#	0	1	1
Number of designed sustainable strategies to promote Guyana's potential to attract private investment in bioenergy production.	#	0	1	1
Number of pre-investment studies (pre-feasibility studies, feasibility studies and/or environmental impact assessments) for identified programs.	#	0	5	5
Number of designed and implemented bioenergy training programs at technical, operative, and managerial levels.	#	0	1	1
Number of lectures, field visits, seminars, theoretical and practical courses related to bioenergy production in Guyana.	#	0	4	4
Number of institutions strengthened and support for the preparation and execution of the Agro-energy Policy of Guyana.	#	0	NA	NA
Number of designed, constructed and started demonstration plants for ethanol.	#	0	1	1
Number of conducted works shops or events to disseminate the findings of the program.	#	0	2	2

Name of Action	Enhancing Guyana’s Access to GCF to Transition to Renewable Energy					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Completed	2019-2020	Global Green Growth Institute (GGGI)	Not Applicable	National	Power Generation

Description and Objective

Guyana renewable energy market is still at an early stage and power supply remains heavily dependent on imported fuels. To incentivize the deployment of renewable energy the Government is providing tax incentives to ensure that prices for renewables remain competitive with conventional imported resources. The objective is to support the development of potential utility scale renewable energy projects for public-private partnership and Green Climate Fund (GCF) funding. To facilitate the implementation of renewable energy projects, and ultimately the Country Programme being developed, potential national accredited entities from the energy sector will be assessed and the nomination by national designated authority (NDA) of two entities will be supported, while raising their awareness on GCF funding opportunities. As key Government partner, the private sector will be engaged in the process of prioritizing utility scale renewable energy projects and made aware of potential access to GCF through Private Sector Facility. Addressing barriers to scale up and make use of the country’s abundant natural energy resources would help reduce the cost of power and pave the way for sustainable access to renewable energy.

Quantitative Goals

- Analysis of renewable energy solutions for the 12 main grids in Guyana and provided support to the government of Guyana in shortlisting 3-4 grids to prepare a pre-feasibility analysis of the viable renewable energy options.
- Strengthening of the project Public-Private Partnership (PPP) policy framework adopted by Guyana in 2018 to be able to work on energy projects.
- Provided support by GGGI Guyana to GEA in the design and tender of three PV-tied systems in the township of Bartica, Lethem and Mahdia.
- Support for the nomination of GCF accredited entities, recommendations to strengthen PPP policy to enable energy projects, and recommendations on changes in legislation to enable independent power producers (IPPs).
- Catalysed green investments: total of $10.90 million USD green investments catalysed ($8.6 million USD concessional loan from Inter-American Development Bank and executed by GEA and $2.3 million USD awarded by United Arab Emirates-Caribbean Renewable Energy Fund (UAE-CREF), to provide energy at 15% cheaper than business as usual (BAU).
- Provision of two capacity building activities in the form of GCF capacity building workshop to private sector and technical capacity building for GPL and GEA engineers.

Steps Taken or Envisaged to Achieve Action

The activities under this enabling activity are complementary with each other and builds on deliverables of approved readiness projects under the GCF. Furthermore, it will make use of awareness-raising and information materials developed through completed/ongoing readiness activities to be updated/improved appropriately to fit for use of potential national accredited entities from the energy sector and private sector stakeholders. Moreover, it will benefit from the GCF Accredited Entities Committee to be created under the readiness project being implemented by the Food and Agriculture Organization (FAO) as well as lessons learned from experience so far in supporting national agriculture entities for accreditation.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Developed country program by preparing a pipeline of renewable energy utility scale projects and pre-feasibility analysis for the shortlisted projects and preparing relevant concept notes. • Nominated Direct Access Entities and prepared gap assessment.	Not Applicable	Not Applicable

• Leveraged private sector investment into renewable energy projects: reviewed and recommended changes in regulation and proposal for innovative business models that leverage the private sector investment in renewable energy. • Increased awareness of GCF and its Private Sector Facility.				
Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Number of assessments for the feasibility of selected climate technologies for mitigation and adaptation and incorporated into planning process.	#	0	1	1
Number of NDA entities nominations.	#	1	2	2
Number of concept notes prepared for prioritised utility scale renewable energy projects and integrated in the Country Programme.	#	0	2	2
Number of proposals for levering private sector investments in renewable energy.	#	0	1	1

<table>
<tr><th>Name of Action</th><th colspan="6">Guyana Utility Scale Solar Photovoltaic Program (GUYSOL)</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Ongoing</td><td>2022-2027</td><td>Guyana Power and Light Inc. (GPL)</td><td>CO_2</td><td>Regions 2, 5, 6, 10</td><td>Power Generation</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">The Guyana Utility Scale Solar Photovoltaic Program (GUYSOL) aims to support the diversification of Guyana's energy matrix towards the use of climate-resilient renewable energy sources in the electricity generation matrix. The specific objectives of the program are to: (i) avoid CO_2 emissions with the development of solar photovoltaic (PV) generation plants; (ii) lower the cost of electricity generation while supporting the country´s transition towards renewable energy-based generation; and (iii) improve the operation and management of the isolated systems of Essequibo and Linden and develop local skills for services related to solar PV generation systems. The GUYSOL program will install 33MWp of solar PV in 3 public grids: 15MWp in Linden, 8MWp in Essequibo coast and 10MWp in Berbice. The isolated grids in Linden and Essequibo will be upgraded with an Energy Management System. The program also aims to narrow the gender and diversity gaps in the renewable energy industry by implementing training and apprenticeship programs for women and people with disabilities.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Installation of 8 utility-scale solar PV systems totalling 33MWp of renewable power in 3 public grids as follows: 15MWp of Solar PV with a minimum of 22MWh (11MW, 2h) of battery storage for the Linden Isolated System; 8MWp of Solar PV with a minimum of 12MWh (6MW, 2h) of battery storage for the Essequibo Coast Isolated System; and 10MWp of Solar PV for the Demerara-Berbice Interconnected System, specifically in Berbice.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">In 2022, the government of Guyana successfully obtained funding for the project through the Guyana-Norway Partnership, channelled through the Interamerican Development Bank (IDB), a planning workshop was held to update and validate the execution plan for the project, and the first request for proposals were developed and published for the execution of the eight solar farms; the preparation for environmental-social-governance analysis, and disaster risks evaluation/planning, and capacity building for GPL. As of mid-2023, the GPL published the first project summary documents, detailing the installation characteristics and socioeconomic and environmental risks and benefits of the project. In August 2023, the Energy Apprentices Programme was launched under the GUYSOL programme, recruiting eligible Guyana residents to fulfil 12-month apprenticeship positions in various roles, including civil engineers, electrical engineers, environmental/social officers, procurement and finance officers, and monitoring officers, contributing to the planning, execution, and operation of the solar projects.</td></tr>
<tr><th colspan="4">Estimated Outcomes</th><th colspan="2">Estimated GHG Emission Reductions</th><th>Methodologies and Assumptions</th></tr>
<tr><td colspan="4">• Diversification of local economies and employment creation in renewable energies.
• Increased resilience to the volatility of the global fuel market.
• Enhanced energy security and affordability through decreased energy costs for local communities and a diversified climate-resilient and market-resilient electricity grid.
• Significant reduction in government spending electricity subsidies which can be used for investment in other sustainable development initiatives, including system upgrades, digitisation, reliability, and the resilience of GPL's Transmission and Distribution networks.
• Enhanced local technical capacities on renewable energies.</td><td colspan="2">37,500 tons CO_2e / yr</td><td>According to the GUYSOL Project Summary Document, Linden is purposed to conserve 17,259 tons CO_2/yr (at 22,500 MWh/yr in power generation), Essequibo to conserve 9,390 tons CO_2e/yr (at 12,800 MWh/yr power generation), and Berbice to conserve 10,671 ton CO_2e/yr (at 16,000 MWh/yr power generation), assuming Berbice´s grid emission factor of approximately 0.661 tons CO_2e/MWh.</td></tr>
</table>

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Number of utility-scale solar PV systems installed and operational.	#	0	8	0
Capacity of solar PV systems installed and operational.	MWp	0	33	0
Number of people with access to enhanced renewable, affordable, and reliable electricity.	#	0	265,000	0
Quantity of annual GHG emissions avoided.	tons CO_2e/yr	0	37.5	0
Avoided cost of power generation by 2027.	$ million USD	0	5.53	0
Proportion of women employed in new solar PV jobs.	%	0	70	0

Name of Action	Pilot Rice Husk Biogas Power Plant					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2018-2021	Guyana Energy Agency (GEA)	CO_2, CH_4, N_2O	Regions 5 and 6	Power Generation

Description and Objective

This project comprised the installation of a pilot 32kW rice husk biogas generator to displace electricity consumed in rice mill as part of the Guyana Energy Agency´s Strategic Planning Framework starting in 2014. Rice husk, the outer most layer of the paddy grain, is a form of biomass and accounts for about 20% of the paddy's weight. Unlike the other by-products, rice husk is mostly seen as a waste disposal problem for many mills and is usually burnt as a form of waste disposal resulting in environmental concerns. In 2014, an estimated 184,052 tonnes of rice husk with an energy value of 212,021 boe was generated based on Guyana's rice production of 635,238 tonnes. Based on information collected in 2013, about 47% of the rice husk is used for paddy drying, parboiling and electricity generation while the remaining 53% is dumped/burnt as a means of waste disposal. The GEA seeks to encourage rice mills to generate electricity based on rice husk gasification technologies to enhance waste management of agricultural by-products, reduce the environmental degradation and GHG emissions, promote energy security, and reduce energy consumption costs among rice mill operators. The pilot demonstration unit seeks to demonstrate the feasibility of the technology, build awareness, and promote adoption by rice mill operators across the country.

Quantitative Goals

- Installation of a pilot 32kW rice husk biogas power plant to promote waste-to-energy generation in Guyana among rice mill operators.

Steps Taken or Envisaged to Achieve Action

In 2014, Guyana completed a comprehensive feasibility study identifying all potential rice husk gasification power plants that can be installed in the country, including a mapping of the location and quantities of biomass available at rice mills across Guyana. In 2018, The Energy and Resources Institute (TERI) provided financial and technical assistance support to successfully install a 32kW gas gasifier serving Regions 5 and 6, which became operational in 2021.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 32kW rice husk biogas power plant successfully installed and operational. • Increased awareness, capacity, and buy-in among rice mill operators to adopt rice husk gasification technologies for enhanced waste management and low-cost/low-emission energy generation.	101 tons CO_2e/yr	The pilot rice husk biomass power plant is purposed to generate 112 MWh/yr. A combined emission factor of approximately 0.9 tons CO_2e/MWh has been assumed to reflect the GHG reductions encompassing both the open-burning of rice husk, as well as the use of grid electricity from Regions 5&6, that has now been replaced from the self-generation of electricity at the rice husk biomass power plant.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Progress in feasibility study completion.	%	0%	100%	100%
Number of pilot rice husk biomass power plants installed.	3	0	1	1
Installed capacity of rice husk biomass energy generation.	kW	0	20-30	32

Name of Action	Leguan 0.6MWp Solar PV Farm					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Planned	2023-2025	Guyana Energy Agency (GEA)	CO_2	Region 3	Power Generation

Description and Objective

This project aims to install a 0.60 MW solar PV farm with a 0.80 MW storage capacity on a land area of 1 hectare (2.48 acres) and a new transmission line on the island of Leguan located in the Essequibo River in Region 3. The project aims to address the island's current deficiencies in terms of energy reliability by expanding the installed capacity of energy generation on the island, while also promoting clean energy use through the diversification of the electricity grid away from fossil fuels. Currently, Leguan tends to have issues related to the unreliability of power supply, whereby electricity is provided on a 24-hour basis by an isolated 1.23 MW grid relying on heavy fuel oil (HFO), owned and operated by the state electricity provider, GPL. In the medium term, GPL plans to link the Leguan grid to those of nearby islands using a subsea cable. At a design life of 20 years, the solar PV farm is expected to save more than 840 tons CO_2e/yr.

Quantitative Goals

- Installation of a 0.6MWp Solar PV farm in the Leguan regional grid, including a transmission distribution system to address current issues with energy reliability while reducing dependence on heavy fuel oil as energy supply.

Steps Taken or Envisaged to Achieve Action

In 2018, Guyana secured a $21 million USD concessional loan from the Inter-American Development Bank (IDB) for the project "Energy Matrix Diversification and Institutional Strengthening of the Department of Energy (EMISDE)", which encompassed the installation of renewable energy generation and enhanced transmission infrastructure, together with institutional strengthening, under which a total of $1.2 million USD was saved under the EMISDE. While the Leguan 0.6MWp Solar PV farm was not initially catered for under the loan, it is being funded through savings accrued under the EMISDE programme, as well as an additional concessional loan requested by the Government of Guyana and approved by the IDB. As of mid-2023, the GEA has initiated the tendering process for the environmental assessment and management plan for the solar PV power plant at Leguan, as well as the engineering, procurement, construction and installation, commissioning and turn-key delivery for the solar PV power plant at Leguan, including the battery energy storage system & transmission line. It is estimated that the solar PV farm will be operational starting 2025.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Increased energy reliability. • Reduced dependence on heavy fuel oil for electricity generation. • Enhanced transmission infrastructure. • Reduced CO_2 emissions.	841 tons CO_2e/yr	The Leguan Solar PV farm is purposed to generate 899 MWh/yr. An emission factor of 0.936 tons CO_2e/MWh has been assumed to reflect the GHG reductions attained by the use of solar energy compared to the consumption of the same amount of energy generated by conventional heavy fuel oil historically used at Leguan to date.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Quantity of GHG emissions reduced at Leguan.	tons CO_2e/yr	0	899	0
Capacity of solar PV infrastructure installed and operational at Leguan.	MW	0	60	0
Number of environmental assessments for plant design and permitting.	#	0	1	1

Name of Action	Amaila Falls Hydroelectric Project Preparation Studies					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Completed	2010-2011	Inter-American Development Bank (IDB)	Not Applicable	Regions 3, 4, 5, 6, 10	Power Generation
Description and Objective						
The enabling activity was conducted in preparation for the Amaila Falls Hydro Project. The studies included an (i) Environmental and Social Impact Assessment, (ii) Hydrology Review and (iii) Off-Taker and Market Assessment. The objective is to assess the feasibility of the hydro project according by analysing the adverse impacts to flora and fauna from the Amaila Falls Hydro Project and provide recommendations regarding monitoring as well as additional data collection or mitigation, if any.						
Quantitative Goals						
• Wet season Environmental Baseline Survey (ESB I) • Dry season Environmental Baseline Survey (ESB II)						
Steps Taken or Envisaged to Achieve Action						
The Amalia Falls Hydro Project was approved by the Guyana Environmental Protection Agency (EPA) based on the Amaila Hydropower Project Environmental Impact Assessment (EIA) completed in 2002. However, additional environmental and social studies have been performed to assist in the final pre-construction planning process and to provide updated information on the environmental and social aspects. The primary objective of ESB I in April/May 2010 was to characterise flora and fauna of the project area during the dry season. However, conditions at the time of ESB I were more characteristic of a wet season than a dry season and therefore a complementary survey (ESB II) was undertaken during the dry season in March/April 2011.						

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Quantitative and qualitative information regarding characteristics of the flora and fauna communities in the area.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Implementation of a flora and fauna study.	#	0	1	2

Name of Action	Wakenaam 0.75MWp Solar Farm					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2019-Ongoing	Guyana Power and Light Inc. (GPL)	CO_2	Region 3	Power Generation

Description and Objective

In line with the Low Carbon Development Strategy (LCDS) 2030, this project will install a 750-kilowatt (0.75 MW) solar-powered system in Wakenaam Island which will benefit over 3,500 residents with access to clean and reliable energy and reduce the dependency of diesel for electricity generation. This development forms part of a macro plan to develop the island with the necessary infrastructure for it to lead in food production, and ultimately, bring economic prosperity to the people.

Quantitative Goals

- Generate approximately 1,044 MWh of solar-powered electricity annually.
- The addition of renewables to the energy mix will reduce approximately 5,919.57 tons CO_2e per year.

Steps Taken or Envisaged to Achieve Action

Once the solar-powered system is fully operational, it will improve the quality of life of the farming community located on Wakenaam Island.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Provision of affordable, stable, and reliable energy to benefit both households and businesses. • Decrease in electricity generation costs. • Avoidance of CO_2 emissions. • Renewable energy solutions are introduced.	940 tons CO_2e /yr	The annual power generation of 1,044 MWh/yr is multiplied by an emission factor of 0.901 tons CO_2/MWh to estimate the annual GHG emission reductions. Grid emission factors for the Wakenaam Isolated system of Guyana (tons CO_2/MWh) from report Standardized baseline: Grid Emission Factors of Guyana Version 01.0, ASB0045-2019

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Emissions per year reduced in Wakenaam Island.	tCO_2e/yr	0	5,919.57	5,919.57
Installation of solar-powered system.	#	0	1	1

Name of Action	Small Hydropower Project for the Cooperative Republic of Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2022-Ongoing	Guyana Energy Agency (GEA)	CO_2	Region 9	Power Generation

Description and Objective

To increase the share of renewable energy sources within Guyana's electrical generation system, in the context of sustainable energy development, the country is actively rehabilitating old hydropower plants and installing new hydropower plants. The objective of the Project is to provide a reliable and affordable supply of electricity to Lethem and nearby villages by construction of two small hydropower plants. The main components of the project include the construction of a new 1.5MW Kumu hydropower plant and the rehabilitation and upgrade of the defunct Moco Moco hydropower plant to 0.7MW capacity. The Moco-Moco 0.5 MW (2 x 0.25 MW) hydropower project, Region 9, was commissioned on November 22, 1999. The Moco-Moco hydropower station is a run-of-the-river, diversion-type with a high water head. The Moco-Moco hydropower plant supplied power to the community of Lethem and its environs. Severe rainstorms and subsequent landslide on July 5, 2003 resulted in a fractured penstock. This project aims to rehabilitate the defunct hydropower plant and increase the installed capacity to 0.7 MW. The project will provide electricity from an indigenous and renewable energy source to serve the demand of Lethem and its environs. This project forms a complementary suite of planned energy initiatives in the town, consisting of a hydropower plant and a solar PV farm. The proposed Kumu hydropower project entails the installation of a 1.5 MW hydropower plant and construction of a transmission line. The Kumu Creek, located in Region 9 (Upper Takutu-Upper Essequibo), is also part of the Amazon River System. The Kumu Hydropower Project will operate as a run-of-the-river type plant and its topographical specifications can accommodate the construction of a small reservoir on the top of the mountain plateau so as to maintain a constant water level for operation of the plant. The project will provide electricity from an indigenous and renewable energy source to serve the demand of Lethem and its environs.

Quantitative Goals

- Rehabilitated Moco-Moco hydropower plant with an installed capacity of 0.7 MW.
- Installed Kumu hydropower plant with a capacity of 1.5 MW.

Steps Taken or Envisaged to Achieve Action

The Kumu hydropower plant and the Moco Moco hydropower station will be a strong, reliable, and redundant power supplier and controller for existing and future demand. The combined operation of the Kumu and Moco Moco hydropower systems, together with the planned solar PV, can result in 100% of renewable energy generation in the power sector of Lethem.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 100% of renewable energy generation in the power sector of Lethem. • Decrease in electricity generation costs. • Avoidance of CO_2 emissions.	12,344 tons CO_2e / yr	The total capacity is 2.2 MW. The annual power generation of 14,454 MWh/yr is multiplied by an emission factor of 0.854 tons CO_2/MWh to estimate the annual GHG emission reductions. Grid emission factors for the Bartica Isolated system of Guyana (tons CO_2/MWh) from report Standardized baseline: Grid Emission Factors of Guyana Version 01.0, ASB0045-2019

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Installed capacity of Moco-Moco hydropower plant.	MW	0.5	0.7	NA
Functional Kumu hydropower plant.	#	0	1	NA

Installed capacity of Kumu hydropower plant.	MW	0	1.5	NA

Name of Action	Hinterland Solar PV Farms					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Planned	2023-2025	Guyana Energy Agency (GEA)	CO_2	Regions 1 and 10	Power Generation

Description and Objective

The Guyana Energy Agency has dedicated funding from the national budget to increase utility-scale penetration of solar PV power in Regions 1 and 10 through the installation and commissioning for the following four solar PV farms: 1.4MWp Solar PV farm in Kwakawani regional grid, 0.9 MWp Solar PV farm in Port Kaituma regional grid, 0.3MWp Solar PV farm in Matthews Ridge regional grid, and 0.3MWp Solar PV farm in Ituni regional grid. The objective is to increase the national grid capacity to supply increasing energy demands through the electrification transition, whilst reducing GHG emissions and electricity costs from the current diesel-dependent regional grids.

Quantitative Goals

- Installation of a combined 2.9 MWp utility-scale solar PV capacity to reduce dependency of diesel for electricity generation at the Kawakami Port Kaituma, Matthews Ridge, and Ituni regional gids.

Steps Taken or Envisaged to Achieve Action

As of early 2023, the Guyana Energy Agency launched request for proposal for consultancy services for the preparation of detailed site investigation reports for the envisioned Kawakami, Port Kaituma, Mathews Ridge, and Ituni sites. The site investigation reports encompass drone imaging, topographic and geotechnical studies, as well as environmental impact assessments as part of the standard process to obtain authorization protocols by Guyana's Environmental Protection Agency. Once the projects have received authorization, work will begin on procurement and installations aiming to have these four solar PV sites fully commissioned and operational by mid-2025.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Provision of affordable, stable, and reliable energy to benefit both households and businesses. • Decrease in electricity generation costs. • Avoidance of CO_2 emissions. • Renewable energy solutions are introduced to decrease dependence on fossil fuels as well as vulnerability to fossil fuel market instabilities	3,046 tons CO_2e / yr	The Kwakawani, Port Kaituma, Mattews Ridge, and Ituni solar PV farms are purposed respectively to generate 1,754 MWh/yr, 1135 MWh/yr, 307 MWh/yr, and 371 MWh/yr for a combined total of 3,567 MWh/yr. An emission factor of 0.854 tons CO_2e /MWh has been adopted to reflect the GHG reductions assuming this PV energy would replace current diesel-run generators.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Installed capacity of utility-scale solar PV systems in Regions 1 and 10.	MWp	0	2.9	0
Number of utility-scale solar PV systems installed in Regions 1 and 10.	#	0	4	0
Annual quantity of renewable energy generated in Regions 1 and 10.	MWh/yr	0	3,567	0

Name of Action	Solar PV Public Buildings Program					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2014-2022	Guyana Energy Agency (GEA)	CO_2	National	Power Generation

Description and Objective

The Solar PV public buildings program is a multi-year programme managed by the GEA with public financing from the national budget seeking to enhance the distributed generation capacity of solar-powered electricity by installing grid-connected solar PV systems across public buildings in Guyana spanning schools, healthcare facilities, convention centres, libraries, radio stations, and government offices, as well as other government and public service buildings. The ultimate goal is to increase the diversification and reliability of the national electric grid while promoting by example the adoption of solar PV technology.

Quantitative Goals

- Develop a self-sustaining and efficient public buildings systems fully run by solar PV to reduce operational costs and associated GHG emissions from energy consumption.

Steps Taken or Envisaged to Achieve Action

Between 2014 and 2022, the Guyana Energy Agency has installed a over 6.3 MWp of rooftop solar PV systems in over 409 public buildings distributed across the country, spanning schools, healthcare facilities, radio stations, libraries, exhibition centres, and government buildings, among others, resulting. A total of 291 public buildings now completely run on solar PV power and result in an estimated $2.3 million USD energy savings each year. The GEA also assisted in upgrading and completing the electrical network infrastructure at some of these public buildings, along with installing outlets and energy-efficient LED lights to improve the lighting system of the buildings. Additionally, the GEA provided training on the operation and basic maintenance of the installed Solar PV Systems, to ensure their adequate operation and to build awareness and encourage uptake by their users.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Reduced operational costs for public buildings related to energy consumption. • Enhanced access reliable, on-site, clean electricity. • Promoting adoption of solar PV technology by leading by example from government operations. • Enhanced awareness and capacities among building users on solar PV technologies. • Reduced dependence on fossil fuels for energy purposes.	5,518 tons CO_2e / yr	It is assumed that the installed capacity of solar PV systems at public buildings would generate a cumulative 8,348 MWh/yr. Assuming an average emission factor for the national grid of Guyana of 0.661 tons CO_2e/MWh, the energy produced by these systems would prevent the generation of 5,518 tons CO_2 each year.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of public buildings with solar PV systems.	#	0	Not Estimated	409
Installed capacity of solar PV systems in public buildings.	MWp	0	Not Estimated	6.35
Annual savings in energy bills at public buildings from onsite solar PV generation.	$ USD / yr	0	Not Estimated	2.3 million
Annual GHG reductions at public buildings from onsite solar PV generation.	tons CO_2e	0	Not Estimated	5,518

Name of Action	Promotion of Private Solar PV Rooftop Systems					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2020-2022	Guyana Power and Light Inc. (GPL) and private actors	CO_2	National	Power Generation

Description and Objective

Promote the adoption of rooftop gird-connected solar PV technology by private consumers across Guyana to reduce operational costs and associated GHG emissions from energy consumption through a combination of policy and fiscal incentives allowing increased distributed generation of solar PV in the country.

Quantitative Goals

- Increased share of private consumers installing grid-connected solar PV systems.

Steps Taken or Envisaged to Achieve Action

Along with investments in transformational infrastructure, Government policy is to encourage individual consumers and businesses to invest in, and use, renewable energy through fiscal incentives and policies. The GPL has reported that by 2022, the total registered installed capacity of solar PV systems from private sources sums to 1.4 MWp. These have been made possible thanks to the following policies:

- Self-Generation: Private self-generation is allowed as per Guyana's legislation. Any consumer who wishes to interconnect their solar PV system into the public grids to eliminate the need for battery storage (solar PV on-grid) must submit an interconnection request and comply with the Interim Interconnection Requirements set by GPL.
- Grid Feed-In Mechanism: A grid feed-in mechanism is being advanced by GPL to establish the regulatory framework for consumers to supply excess energy to the grid, from renewable energy sources.
- Fiscal Incentives: Machinery and equipment imported for the purposes of generating and utilising renewable energy are eligible for Customs duty and Value-Added Tax Exemptions under existing laws. This includes solar panels, solar lamps, deep-cycle batteries, solar generators, solar water heaters, solar cookers, direct current (DC) solar refrigerators, DC solar freezers, DC solar air-conditioners, wind turbines, water turbines, and power inverters; and energy-efficient lighting, including compact fluorescent lamps and light-emitting diode (LED) lamps. There is also a one-off tax holiday of two years for corporation tax to importers of items for wind and solar energy investments.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Reduced operational costs for private buildings related to energy consumption. • Enhanced access reliable, on-site, clean electricity. • Promoting adoption of solar PV technology by demonstrating the technical and financial feasibility of solar PV technology adoption. • Enhanced awareness and capacities among building users on solar PV technologies. • Reduced dependence on fossil fuels for energy purposes.	1,431 tons CO_2e / yr	It is assumed that the installed capacity of private solar PV systems at public buildings would generate a cumulative 2,164 MWh/yr. Assuming an average emission factor for the national grid of Guyana of 0.661 tons CO_2e/MWh, the energy produced by these systems would prevent the generation of 1,431 tons CO_2 each year.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Installed capacity of solar PV systems in public buildings.	MWp	0	Not Estimated	1.40
Annual GHG reductions at public buildings from onsite solar PV generation.	tons CO_2e	0	Not Estimated	1,431

Name of Action	Mabaruma 0.4MWp Solar PV Farm					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2017-2020	Hinterland Electrification Company Inc. (HECI)	CO_2	Region 1	Power Generation

Description and Objective

The Mabaruma Solar Farm was described in the 2017 national budget as the first of several such farms which were to be established under the Hinterland Electrification Programme (HEP). At the time, a budgetary allocation of almost $1 billion was announced to implement a series of renewable energy and energy efficiency projects. This would include the installation of the first solar farm on a large scale in Mabaruma. When operational, the 400-kilowatt solar farm would afford an additional 17 hours of electricity to the 3,000 residents of Mabaruma. It will include a 134kWh battery storage and a 500kVA power transformer. A working solar farm in Mabaruma would provide the impetus for similar imminent renewable energy projects ambitiously highlighted in Guyana's First Voluntary National Review of the Sustainable Development Goals. These include planned solar PV farms at Bartica, Lethem, Mahdia, Port Kaituma, Kwakwani and Matthews Ridge.

Quantitative Goals

- The project is expected to generate approximately 560 MWh of electricity annually.
- The addition of renewables to the energy mix will reduce approximately 478 tons CO_2e / yr.

Steps Taken or Envisaged to Achieve Action

The Mabaruma solar farm has been in the works since 2017 under the former Government, as part of the Hinterland Electrification Project. The 400-kilowatt farm was designed and constructed by German company Meeco Group. Work on the project was supposed to have been completed by 2018. But over the years, the project was hampered by vandalism, non-delivery of items and faulty construction, which contributed to the project being damaged by a lightning strike. However, the project was finalised in 2020.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Provision of affordable, stable, and reliable energy to benefit both households and businesses. • Decrease in electricity generation costs. • Avoidance of CO_2 emissions. • Renewable energy solutions are introduced.	478 tons CO_2e / yr	The annual power generation of 560 MWh/yr is multiplied by an emission factor of 0.854 tons CO_2/MWh to estimate the annual GHG emission reductions. Grid emission factors for the Bartica Isolated system of Guyana (ton CO_2/MWh) from report Standardized baseline: Grid Emission Factors of Guyana Version 01.0, ASB0045-2019

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Emissions per year reduced.	tons CO_2e/yr	0	478	478
Installation of solar-powered system.	#	0	1	1
Installed capacity of solar PV farm.	MWp	0	0.4	0.4
Annual quantity of renewable energy generated.	MWh/yr	0	560	560

Name of Action	Gas to Energy Project					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2023-Ongoing	Ministry of Public Works (MoPW)	CO_2	National	Power Generation

Description and Objective

The Gas-to-Energy project is purposed to establish infrastructure so natural gas can be transported from the offshore Stabroek Block's Liza oilfield to an integrated gas processing facility at Wales, on the West Bank of Demerara. The project will deliver natural gas liquids (NGL) and dry gas to the government of Guyana. A subsea pipeline will be installed on the seafloor to transport natural gas from the Liza field to an onshore pipeline at the West Coast of the Demerara river. The onshore pipeline will deliver the gas to an integrated facility at Wales, on the West Bank of Demerara. At this facility, a NGL processing plant will treat the gas to remove NGLs for commercialisation, and a 300 megawatts power plant will use the dry gas to generate electricity for domestic use. The pipeline would transport up to ~50 million standard cubic feet per day of natural gas to the facilities.

Quantitative Goals

- The project will provide the fiscal space to cut the cost of power by 50%.
- Replacing imported heavy fuel oil (HFO) with Guyana's natural gas as the main source of electricity generation will significantly reduce emissions.
- Through the project, cooking gas and fertiliser will be sold to locals at reduced rates, and sell the remaining NGLs to third parties.

Steps Taken or Envisaged to Achieve Action

ExxonMobil Guyana is responsible for the installation of the pipeline. The Guyana government will handle the integrated facility at Wales. Some preparatory work has commenced but the substantive construction will have to wait on a few things. On ExxonMobil's side, the company is waiting on all regulatory approvals. While it has already received environmental authorisation from the EPA, the company is waiting for the Guyana government to approve its proposed revisions to the Liza field development plan and production license. When this is done, Exxon and its partners will make their final investment decisions and continue the substantive work. On the government's side, it is still working on securing the loan from the Export and Import Bank US (EXIM Bank) to meet the rest of the cost. ExxonMobil and the Guyana government plan to deliver the power plant and pipeline by the fourth quarter of 2024, to allow for a reduction in the cost of electricity. The NGL facility is expected to be completed the following year.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• A successful project has the potential to significantly reduce the cost of electricity in Guyana. • Reduce emissions through the shift to natural gas.	703,150 tons CO_2e / yr	The total capacity is 300 MW and 2,450,000 MWh/yr power generation. The power generation is multiplied by an emission factor of 0.287 tons CO_2/MWh to estimate the annual GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Amount of natural gas delivered through the pipeline to the integrated facility at Wales.	ft^3	0	50,000,000	0
Installed capacity of the power plant.	MW	0	300	0
Electricity generation for domestic use.	KWh	0	NA	0
Reduced cost of electricity in Guyana.	$ G	NA	NA	0
Share of natural gas in the national electricity generation.	%	NA	NA	0

Energy Efficiency

Name of Action	EcoMicro Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2018-2022	Institute for Private Enterprise Development (IPED)	CO_2	National	Energy Efficiency

Description and Objective

The EcoMicro project is a technical assistance facility established to pilot green finance for Micro, Small and Medium Enterprises (MSMEs) across the Caribbean. By partnering with financial institutions (banks, credit unions, cooperatives, etc.) to develop new finance instruments to capitalize on opportunities in green financing, while adjusting their risk management models to climate change risk and incorporating climate impact assessment into their internal policies and operations. The project's goal is to facilitate green finance as a means to increase access to renewable energy and energy efficiency products. The project activities are broadly broken down into three key components as follows: (i) capacity development of finance institutions; (ii) access to clean and efficient energy products and services by MSME; and (iii) consolidating the green micro-finance ecosystem. The EcoMicro project for Guyana was funded by the Interamerican Development Bank (IDB) whereby the Development Alternatives Incorporated (DAI) Sustainable Business Group (SBG) worked with the Guyana Institute for Private Enterprise Development (IPED) to help Guyanese MSMEs grow through innovative green finance products. The direct beneficiaries of this project are 350 MSMEs across 8 of IPED's 13 Branches located in Pomeroon-Supenaam (Region 2), Demerara-Mahaica (Region 4), East Berbice-Corentyne (Region 6), and Upper Takutu-Essequibo (Region 9). These 8 branches account for 67% of their overall portfolio value and 62% of their overall client base. The project also aimed at training all 75 IPED staff in areas relating to designing and piloting of green finance, climate vulnerability and risk assessment, and institutional greening. IPED also received specialized technical assistance to design and pilot new green finance products to diversify their product offering, differentiate themselves from other financial institutions and attract new clients. IPED also benefited from institutional capacity building to analyse the vulnerability of its loan portfolio to climate change and incorporate climate risk management into future credit decisions, therefore reducing its portfolio at risk, as well as undertaking in-house renewable energy and energy efficiency measures to reduce their own operational GHG footprint.

Quantitative Goals

- Facilitating access for MSMEs to adopt renewable energy and energy efficiency technologies that complement, reduce the usage of, or substitute unreliable supplies of energy and displace energy from fossil fuels.

Steps Taken or Envisaged to Achieve Action

As part of the project, SBG conducted the following activities:

- Landscape assessment and market analysis across four regions of Guyana, including coastal, river, and rainforest areas to assess demand for renewable energy and energy efficiency products among IPED clients.
- Surveying a range of firms within IPED's portfolio, including agriprocessors, retail shops, hostelry, and catering businesses to better understand financing constraints, average energy usage, and opportunities to incorporate renewable energy and energy efficiency technologies and solutions.
- Designing a digital tool for IPED's loan officers to screen climate risk as part of their loan underwriting process and assist IPED in developing an institutional greening policy.
- Assisting IPED and its regional branch offices to develop green loan products.

– Assist businesses to responsibly finance the purchase of renewable energy generation and energy-efficient technologies, including new or upgraded refrigeration units, solar panels, and optimal insulation materials. – Conducting a Technology Review that assessed the supply of renewable energy and energy efficiency technologies within the local market. – Through a stakeholder-driven analysis included, assessing strategic partnerships that would complement the comparative advantages of IPED and ensure alignment with national programs and objectives.		
Estimated Outcomes	**Estimated GHG Emission Reductions**	**Methodologies and Assumptions**
• Green financial products developed and launched to help MSMEs invest in GHG mitigation technologies. • IPED equipped with a climate risk evaluation tool to analyse and reduce the climate change vulnerability of its loan portfolio. • IPED´s environmental impact reduced. • Enhanced capacities at IPED to promote investments in green technologies while reducing climate change vulnerability.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of MSMEs adopting renewable energy and energy efficiency technologies.	#	0	350	14
Financing mobilized from IPED´s balance sheet for green strategies accessed by MSMEs clients.	$ million USD	0	1,000,000	42,155
Number of green finance products developed and made available to MSMEs.	#	0	2	2
Number of IPED employees training on renewable energy and energy efficiency finance products.	#	0	75	75
Proportion of credit decisions utilizing climate risk tool.	%	0%	100%	75%

<table>
<tr><th>Name of Action</th><th colspan="6">Transitioning to National Energy Security: Bartica as a Model Green Town</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Enabling Activity</td><td>Ongoing</td><td>2017-Ongoing</td><td>Office of Climate Change (OCC)</td><td>Not Applicable</td><td>Region 7</td><td>Energy Efficiency</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">Bartica is a small community situated on the Essequibo River, 80 km inland from the Atlantic Ocean. As part of Guyana's pursuance of Green Economy as a development paradigm, the primary objective of this project is to establish a reliable point of reference for the existing state of energy use in Bartica from which the data generated will be used for future measurements and predictions for evidence-based decision making and pursuance of projects and programs. As such, the project aims to increase the capacity of planning for the Government of Guyana by carrying out energy audits and baseline studies in one model town, Bartica. The secondary objectives are the first tier interventions that are expected to stimulate and expedite a comprehensive and robust renewable energy uptake program in the New Bartica Township. This includes:
• The sensitization and awareness of the Bartica populace.
• Conducting household baseline study of the Bartica community.
• Complete an energy audit of public institutions, facilities and street lighting in Bartica.
• Energy efficiency pilot implemented with government agency.
• Transportation sector energy audit.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Reduced energy demand to reduce emissions and energy cost for consumers.
• Transitioning Bartica from a 100% fossil fuel based economy to more reliance on clean energy generation.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">The main aim is to ensure that Bartica, as a new municipality, follows the green economy development paradigm. In this regard, data capture through various audits, building awareness, and completing demonstration/pilot type activities are critical. In this context, the technical activities as part of the project are split between different work packages:
• Work Package 1: Sensitization and Awareness
• Work Package 2: Conduct Household Baseline Survey of the Bartica Community
• Work Package 3: Complete an Energy Audit of public institutions, facilities and street lighting in Bartica
• Work Package 4: Transportation Sector energy audit
• Work Package 5: Energy Data Management Centre</td></tr>
<tr><th colspan="4">Estimated Outcomes</th><th>Estimated GHG Emission Reductions</th><th colspan="2">Methodologies and Assumptions</th></tr>
</table>

• Information for a competitive bid process for large scale renewable energy supply for Bartica. • Energy conservation and energy efficiency for energy and economic savings. • Enhanced streetlighting for security and safety. • Data of the local baseline energy characteristics and performance. • Reducing pollutants from vehicles and reduce the incidence and severity of respiratory and cardiovascular diseases.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Content manual to effectively communicate details about project including benefits and plans.	#	0	1	1
Stakeholder workshops and community fora.	#	0	2	2
Baseline household data set.	#	0	1	1
Report on the dynamics of household appliances and energy consumption and use.	#	0	1	1
Report on energy audit of public institutions, facilities, and street lighting.	#	0	1	1
Localized study report on energy use in transport sector.	#	0	1	1
Recommendations on reduction of inefficiencies in transport sector in Bartica.	#	0	1	1
Energy data management centre operationalised.	#	0	1	1

<table>
<tr><th>Name of Action</th><th colspan="6">Promotion of Energy Efficiency Measures in the Manufacturing and Service Sectors</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Completed</td><td>2011-2013</td><td>Guyana Manufacturing & Services Association (GMSA)</td><td>CO_2</td><td>National</td><td>Energy Efficiency</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">The GMSA energy efficiency project will pilot and promote the adoption of energy efficiency measures in the manufacturing and service sectors in 5 pilot companies, resulting in reductions in energy use and the cost to industry of energy. Additionally, it is envisaged that the results of the project will be used to influence policy changes at the national level that address the quality of supply and utilization of energy in the manufacturing and service industries. The project is critical to the development of enterprises in Guyana since it directly addresses the often-contentious issue of high energy costs. It sensitises companies especially in the manufacturing and services sectors to the best means of measuring and managing their energy distribution equipment/components and consumption, to make the most efficient use of their energy applications and simultaneously, employ the most effective methods of energy conservation.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Implementation of the energy efficiency programme in 5 pilot companies.
• Increase of the energy savings in the 5 pilot companies.
• Reduce at least 800 tons CO_2e in the 5 pilot companies.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">The five pilot companies selected to represent the manufacturing and service sector were Sterling Products Ltd. representing the agro-processing sub-sector, Caribbean Containers which represents the packaging sub-sector, Demerara Mutual Life Insurance Company representing the services sector, National Milling Co. (NAMILCO), the Edward B. Beharry Group and Brass Aluminium & Cast Iron Foundry (BACIF). These pilot companies were guided across the business spectrum towards effectively managing their energy costs through the application of conservation methodologies, technological adaptations and best practice techniques.</td></tr>
<tr><th colspan="3">Estimated Outcomes</th><th colspan="2">Estimated GHG Emission Reductions</th><th colspan="2">Methodologies and Assumptions</th></tr>
<tr><td colspan="3">• To assess and audit energy consumption trends in pilot companies across five sub-sectors, in order to demonstrate how the adoption and implementation of energy efficiency technologies/measures can result in the reduction of high energy bills as a percentage of operation cost.</td><td colspan="2">291 tons CO_2e / yr</td><td colspan="2">During the implementation years of the project (2012-2013) a total of 582 tons CO_2e was reduced/saved. It is assumed that an equal share of GHG emission reductions occurred during these two years.</td></tr>
<tr><th colspan="7">Progress Indicators</th></tr>
<tr><th colspan="3">Indicator</th><th>Unit</th><th>Baseline</th><th>Target</th><th>Progress</th></tr>
<tr><td colspan="3">5 energy efficiency programs implemented in pilot companies.</td><td>#</td><td>0</td><td>5</td><td>5</td></tr>
<tr><td colspan="3">15 energy efficiency experts trained on energy audits acting as energy efficiency MSMEs.</td><td>#</td><td>0</td><td>15</td><td>33</td></tr>
<tr><td colspan="3">Increased awareness among 100 private sector companies on the demonstrative benefits of adopting energy efficiency measures and promotion at the national level.</td><td>#</td><td>0</td><td>100</td><td>85</td></tr>
<tr><td colspan="3">5 MSMEs benefitting from clean or efficient energy.</td><td>#</td><td>0</td><td>5</td><td>5</td></tr>
<tr><td colspan="3">Energy saved in kwh.</td><td>kWh</td><td>0</td><td>NA</td><td>824,186</td></tr>
<tr><td colspan="3">At least 800 tons CO_2, emissions reduced/saved.</td><td>tons CO_2e</td><td>0</td><td>800</td><td>582</td></tr>
</table>

Baseline survey conducted for at least 5 pilot companies and energy efficiency consuming appliances/components for the respective companies.	#	0	5	6
Guidelines for live-in plant monitoring and variance analysis developed for at least 5 pilot companies.	#	0	5	6
Development of sector benchmarks and action plans for implementation of energy efficiency program for at least 5 companies.	#	0	5	6
At least 15 technical staff from 5 pilot companies trained to effectively implement company action plans and monitor program.	#	0	15	30
Pilot assessment and audit study prepared and disseminated.	#	0	1	1
Host at least 2 national workshops to share the results of the pilots.	#	0	2	5

Name of Action	Project for the Introduction of Renewable Energy and Improvement of Power System in Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2018-2022	Guyana Energy Agency (GEA)	CO_2	Region 4	Energy Efficiency

Description and Objective

The objective of the project is to improve the efficiency of the power systems by enhancing the quality of the substation equipment and distribution lines within the City of Georgetown and the surrounding areas. As well as, by installing and demonstrating a solar photovoltaic system and energy management system at the Caribbean Community (CARICOM) Secretariat, thereby contributing to economic development within Guyana. It has two components, namely the:

- Procurement of electric power distribution materials (293km of Cosmos Wire, 48 pole-mounted transformers and 2x1500kVA power factor compensators) and 2x5MVAr reactive power compensators for the Guyana Power & Light Inc. (GPL).
- Procurement of a 400kWp solar PV power generation system with battery storage and a Building Energy Management System (BEMS) for the CARICOM Secretariat.

The project will directly solve the problems of power loss and power supply reliability that GPL has, by installing reactive power compensators and procuring distribution equipment and materials. These components will greatly help to improve GPL's profitability and reduce CO_2 emissions emitted from thermal power plants. In addition, this project will materialise the renewable energy and energy conservation policy of CARICOM by installing a PV system and BEMS. Also, it is highly expected that the PV system and BEMS installed in the CARICOM secretariat building will showcase the technologies to CARICOM member countries and regions.

Quantitative Goals

- Enhancing power supply reliability and reducing technical loss by introducing reactive power compensator in the project target areas.
- Enhancing power supply reliability and reducing technical loss by improving distribution network in the project target areas.
- Renewable energy is supplied to CARICOM Secretariat main building by introducing PV system with battery.
- Promote energy saving by introducing BEMS with functions which visualize electricity usage and control air conditioner.

Steps Taken or Envisaged to Achieve Action

The GPL component was completed on September 29, 2021 and the one year defect notification period for the reactive power compensators expired on September 28, 2022. Regarding the CARICOM component, the 400kWp solar PV power generation system with battery was completed on January 11, 2022 but had to be taken out of operation on March 28, 2022 due to defective equipment (PV panels and battery modules). Following the completion of an investigation by the contractor and equipment manufacturers into the possible cause of the equipment failure, partial (200kWp) operation of the system was restored on August 6, 2022 pending receipt of the replacement equipment from Japan in January 2023. Meanwhile, the BEMS was completed on November 23, 2022 and additional O&M training for staff completed from November 21-22, 2022

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Enhance the efficiency of electricity sector in Republic of Guyana through the installation of renewable energy and energy saving facilities.	429.65 tons CO_2e / yr	The total estimated annual energy is 650 MWh. The power generation is multiplied by an emission factor of 0.661 tons CO_2/MWh to estimate the annual GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Introduction of reactive power compensator.	#	0	2	2
Improving distribution network.	km	0	293	293
Introduction of PV system.	#	0	1	1

Introduction of BEMS.	#	0	1	1

Transportation

Name of Action	Electric Vehicle Supporting Infrastructure					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2019-2023	Guyana Energy Agency (GEA) and Guyana Power and Light Inc. (GPL)	CO_2	Regions 4 and 6	Transportation

Description and Objective

By 2030, Guyana aims to have made significant progress on the transition from a transportation system largely built around petroleum and diesel vehicles, to one which introduces other affordable and competitive transportation options including electric public and private ground transportation. To achieve such an ambitious target, Guyana has launched a pilot project to provide the necessary supporting infrastructure to enable electric vehicle (EV) adoption in the country by addressing enabling factors for adequate EV supporting infrastructure provision through a 3-prong approach: (i) providing access to cheaper and cleaner electricity to power EVs via comprehensive renewable energy diversification and electrification initiatives; (ii) providing access to EV charging stations; and (iii) reducing EV acquisition costs. This particular project focuses on components (ii) and (iii), whereby component (i) is achieved through the above-mentioned efforts under the energy sector.

Quantitative Goals

- Reduce supporting infrastructure barriers for EV adoption in Guyana through the construction of 6 public EV charging stations and the introduction of financial incentives to encourage private investment in charging station construction.

Steps Taken or Envisaged to Achieve Action

With 2022 budget support, GEA and GPL have partnered to install 6 public electric vehicle charging stations in Regions 4 and 6 as part of a pilot project to support the nascent electric-mobility sector. The 6 public electric vehicle charging stations were installed at: S & R Parking Lot, Guyana Energy Agency, Movie Towne, Giftland Mall, Massy at Providence, Little Rock Suites. The government of Guyana is also encouraging private providers who wish to establish charging to do so, through the removal of customs duty for the set-up of electric vehicle charging stations. Guyana's Ministry of Finance published the Budget Speech 2023, which was delivered on 16 January 2023 and included the following two measures to promote EV uptake, effective as of 1 January 2023: (1) EVs are exempt from customs duty, excise tax, and value-added tax (VAT); and (2) A 50% per year writing down allowance is provided for all businesses that invest in switching to EVs. To prepare locals for the automotive transition, the government has also been facilitating training for Guyanese auto-technicians in EV maintenance and repairs. Furthermore, the government has approved a policy to promote the procurement of electric vehicles for Government Ministries and Agencies, where appropriate,

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Increased EV adoption throughout Regions 4 and 6 through enhanced access to EV charging infrastructure, coupled with favourable policy and financial incentives for public procurement and private purchase of EVs. • 6 public EV charging stations installed in Regions 4 and 6.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress

Number of public EV charging stations installed.	#	0	6	6
Number of financial incentives provided for EV purchases.	#	0	5	5

Rural Electrification

<table>
<tr><th>Name of Action</th><th colspan="6">Sustainable Business Models for Rural Electrification and Energy Access in Guyana</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Enabling Activity</td><td>Completed</td><td>2015-2019</td><td>Hinterland Electrification company Inc. (HECI)</td><td>Not Applicable</td><td>Regions 1, 2, 7, 8, 9</td><td>Rural Electrification</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">The Sustainable Business Models for Rural Electrification and Energy Access project aims to increase sustainable, affordable, and reliable access to renewable energy technologies to rural communities in regions 1, 2, 7, 8, and 9 of Guyana while ultimately improving the quality of lives for those living in the hinterland regions. This will allow for at least 6,000 homes across 25 hinterland communities to receive solar home systems. In this context, the general objective is to improve institutional capacities including training of sector staff and promote the use of renewable energy technologies in the urban areas and the Hinterlands, with the aim to: (i) implement sustainable business models for operation and maintenance; (ii) increase quality energy access in the country; (iii) reduce long-term operational costs of on-grid and off-grid electricity service; and (iv) contribute to sector sustainability and reduction of GHG emissions. Additionally, community members and other energy sector agencies will be trained in technical, operational, social and environmental aspects of the project.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Facilitation for the implementation of 6,000 solar home systems across 25 hinterland communities with a total capacity of 0.36MW.
• Electrification of the 80% of rural areas in Guyana that have no electricity.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">The project, which is being spearheaded by the Ministry of Public Infrastructure’s Hinterland Electrification Unit (HEU), is a collaboration with the not-for-profit company, CARIBSAVE, and the Multilateral Investment Fund (MIF), a member of the Inter-American Development Bank (IDB) Group.</td></tr>
<tr><th colspan="3">Estimated Outcomes</th><th colspan="2">Estimated GHG Emission Reductions</th><th colspan="2">Methodologies and Assumptions</th></tr>
<tr><td colspan="3">• Development of business models for solar for solar photovoltaic systems which will be installed in community buildings in the 25 communities.
• Expansion of renewable energy sources leading to an overall positive impact on the environment and improvements to people’s lives.
• Increase of sustainable, affordable, and reliable access to renewable energy technologies to rural communities.</td><td colspan="2">Not Applicable</td><td colspan="2">Regarding the total capacity of the 6,000 solar home systems, it is assumed that each solar home system has a size of 60W as can be observed in several Hinterland villages.</td></tr>
<tr><th colspan="7">Progress Indicators</th></tr>
<tr><th colspan="3">Indicator</th><th>Unit</th><th>Baseline</th><th>Target</th><th>Progress</th></tr>
</table>

Number of implemented sustainable business models.	#	0	NA	NA
Share of rural areas in the Hinterland regions electrified.	%	20%	100%	NA
Number of implemented solar home systems in the Hinterland communities.	#	0	6,000	NA

Name of Action	Sustainable Energy Program for Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2013-2023	The Hinterland Electrification Company Inc. (HECI) and Guyana Energy Agency (GEA)	CO_2	National	Rural Electrification

Description and Objective
The general objective of the program is to promote and support sustainable energy projects in Guyana, in order to contribute to Guyana's energy security, energy access, reduction of fossil-fuel dependence and provide additional opportunities to reduce GHG emissions. The specific objectives are: (i) to support the use of solar, small-hydro and wind energy resources; and (ii) create social awareness of sustainable energy. To promote and support sustainable energy programs in rural areas of Guyana. The specific objective of the first component is to foster the transition to alternative renewable energy and improve energy access in un-served and/or isolated communities with the following sub-components: (i) support to the design/installation/completion of renewable pilot projects; (ii) revision of the legal, institutional and regulatory framework of the electricity sector affecting the deployment of non-conventional renewable initiatives; and (iii) support the development of on-grid renewable projects to reduce fossil-fuel dependency. On the other hand, the second component focuses on supporting the ongoing creation of adequate knowhow, in order to guarantee the long-term sustainability of the implemented renewable energy projects.
Quantitative Goals
• Increased access to electricity throughout Guyana, targeting 90% of the population, while enhancing the penetration of solar, wind, and small-hydro energy sources.
Steps Taken or Envisaged to Achieve Action
Concerning the promotion of solar energy sources, a total of 154kW of off-grid solar PV systems were installed in 9 rural communities across Guyana estimated to benefit 7,000 residents directly and indirectly, all of which have been commissioned and are now operational. As well, a total of 180kW of grid-tied solar PV systems on 7 public buildings in the capital city of Georgetown, including secondary schools, tertiary institutions, and Ministries. Concerning the promotion of small-hydro energy sources, the program provided support to Kato village in Region 8, through the construction of a 150 kW run-of-the river power plant at the Kato waterfall site located on the Chiung River, a 13.8 kV primary distribution network from the power plant to the Kato Secondary School and thence to the Kato village, and a 120/220 V secondary distribution network in the Kato village. Construction progress has been slowed due to the effects of Covid-s9 pandemic compared to original program schedule, but are continued and improved. These small-hydro efforts from the Sustainable Energy Program would enable Regions 8 to transition to 100% renewable energy. Concerning the promotion of wind energy sources, in-depth data was collected at the Onverwagt Wind Measurement Station, with analysis indicating that there is sufficient wind resource for a utility-scale wind project in that area.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 7,000 residents across 9 rural communities given access to electricity generated from solar PV sources. • Increased awareness and capacity for renewable energy project implementation and use.	842 tons CO_2e / yr	It is assumed that the KATO hydropower lant would produce 968 MWh/yr, replacing a grid emission factor for Region 8 of 0.854 tons CO_2e/MWh. For electrification of urban and rural areas through PV systems, it is assumed 0 emissions are saved, as in the majority of cases these PV systems provide new electricity access. Even in some cases, diesel generators for shops and houses are being replaced by the PV systems, there is insufficient information to estimate the value of associated GHG reductions. Further feasibility studies and

• Diversification of local economies and employment creation in renewable energies.		preliminary design would need to be conducted for the wind sites for estimating their renewable energy and GHG reduction contribution.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Proportion of population with energy access.	%	85	90	86
Installed capacity of solar PV systems for rural electrification.	kW	0	154	154
Installed capacity of solar PV systems in urban areas.	kW	0	180	180
Installed capacity of hydroelectric systems for rural electrification.	kW	0	150	150
Number of wind measurement stations analysed.	#	0	2	1
Number of trainings conducted.	#	2	7	6

<table>
<tr><th>Name of Action</th><th colspan="6">Solar Home Systems</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Ongoing</td><td>2021-Ongoing</td><td>Guyana Energy Agency (GEA)</td><td>CO_2</td><td>National</td><td>Rural Electrification</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">The project, known as the ‘30,000 solar home systems’ project, was designed to balance the energy gap between urban and rural areas, simultaneously propelling the nation towards sustainable, eco-friendly power sources. Under the project, a total of 30,000 homes across various regions of the country will receive 150-watt solar PV systems. The project’s completion is anticipated in 2024, with successful implementation promising a significant leap forward in the country’s renewable energy landscape.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Installation of thirty thousand (30,000) 150-watt solar home systems.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">In 2020, 2021, 2022, and 2023, solar PV systems were installed at a number of public buildings across the hinterland regions. These included health centres, community centres, food processing, and educational facilities. For instance, in 2020, a 0.4 MW solar PV farm, the first in Guyana, was commissioned in Mabaruma, Region One (Barima-Waini). Following its operationalisation, solar PV farms were also commissioned at Lethem, Region Nine (Upper Takutu-Upper Essequibo) in 2022, and Bartica, Region Seven (Cuyuni-Mazaruni) in 2023. Furthermore, in 2023, a 0.5 MW solar PV farm is eyed for completion at Wakenaam, Region Three (Essequibo Islands-West Demerara), and a 0.65 MW solar farm is envisaged for completion in Mahdia, Region Eight (Potaro-Siparuni).</td></tr>
<tr><th colspan="2">Estimated Outcomes</th><th colspan="2">Estimated GHG Emission Reductions</th><th colspan="3">Methodologies and Assumptions</th></tr>
<tr><td colspan="2">• Provide electricity to off-grid households and micro enterprises, through individual Solar Home Systems.</td><td colspan="2">5,003.71 tons CO_2e / yr</td><td colspan="3">These 30,000 households total 4.8MW installed capacity. The figure represents energy produced by the solar panels, without which would have required fossil-based energy sources. The annual energy (MWh) is estimated through the following equation:

4800*4.8*365*0.85)/1000

The total estimated annual energy is estimated at 7,148.16 MWh. The power generation is multiplied by an emission factor of 0.7 tons CO_2/MWh to estimate the annual GHG emission reductions.</td></tr>
<tr><th colspan="7">Progress Indicators</th></tr>
<tr><th colspan="3">Indicator</th><th>Unit</th><th>Baseline</th><th>Target</th><th>Progress</th></tr>
<tr><td colspan="3">Installation of solar home systems</td><td>#</td><td>0</td><td>30,000</td><td>NA</td></tr>
</table>

Name of Action	Solar PV Mini-grids					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2021-Ongoing	Guyana Energy Agency (GEA)	CO_2	Region 1, 2, 7, 8, 9, 10	Rural Electrification

Description and Objective

The project includes the installation of 31 solar PV mini-grids with a total capacity of 919kW for public and community buildings. This includes solar PV mini-grids at Sebai, Karaburi, Kwebanna, Haimacabra, Baramita and Canal Bank of Region 1; Wakapao, Capoey Mission, St. Monica and Tapakuma, of Region 2; Waramadong, Paruima and Jawalla of Region 7; Kurukubaru of Region 8; Annai, Karasabai, Aishalton and Kraudarnau of Region 9; and Riversview of Region 10. Through this project, electricity will be provided to these communities with solar PV and battery storage. The mini-grid is an aggregation of several energy generators, powered by one main grid to disperse electricity to a small, local group of beneficiaries.

Quantitative Goals

- The project is expected to generate approximately 1,369.32 MWh of electricity annually.
- The addition of renewables to the energy mix will reduce GHG emissions.

Steps Taken or Envisaged to Achieve Action

Nine of these mini-grids have already been completed, with 28 communities set to benefit so far from this project.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Provide affordable, stable, and reliable energy to benefit both households and businesses. • Avoidance of CO_2 emissions. • Renewable energy solutions are introduced.	958.52 tons CO_2e / yr	31 solar PV mini-grids with a total installed capacity of 919kW. Figure represents energy produced by the solar panels, without which would have required fossil-based energy sources. The annual energy (MWh) is estimated through the following equation: $919.5*4.8*365*0.85/1000$ The total estimated annual energy is estimated at 1,369.32 MWh. The power generation is multiplied by an emission factor of 0.7 tons CO_2/MWh to estimate the annual GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Solar PV mini-grids installed	#	0	31	9
Communities gaining access to renewable energy	#	0	NA	28

Name of Action	Moraikobai Micro-grid PV System					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2018-2020	Guyana Energy Agency (GEA)	CO_2	Region 5	Rural Electrification

Description and Objective

The project included the installation of a 72kWp (0.072 MWp) solar micro-grid in Moraikobai which will provide electricity from a renewable energy source to supply approximately 270 households (approximately 1,000 persons). The project will allow an increase in the duration of daily electricity supply from 4 hours to 12 hours, avoid annual CO_2 Emissions of 70,199.57 kg (70.20 tons CO_2) and will generate about 97.36 MWh of energy annually.

Quantitative Goals

- The project is expected to generate approximately 97.36 MWh of electricity annually.
- The addition of renewables to the energy mix will reduce approximately 70.20 tons CO_2e / yr.

Steps Taken or Envisaged to Achieve Action

The system was completed and operational by the second quarter of 2020.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Provide affordable, stable and reliable energy to benefit both households and businesses. • Provide electricity to an off-grid community. • Avoidance of CO_2 emissions. • Renewable energy solutions are introduced.	70.20 tons CO_2e / yr	According to the 2019 annual report of the Guyana Energy Agency (GEA), the project will avoid annual CO_2 Emissions of 70,199.57 kg and will generate about 97.36 MWh of energy annually.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Emissions per year reduced	tons CO_2e / yr	0	70.20	70.20
Installation of micro-grid PV system	#	0	1	1
Installed capacity of micro-grid PV system	MWp	0	0.072	0.072
Annual quantity of renewable energy generated	MWh/yr	0	97.36	97.36

Training and Development

Name of Action	Power Utility Upgrade Program					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2014-2021	Guyana Power and Light Inc. (GPL)	CO_2	Regions 2, 3, 4, 5, 6, 9, 10	Training and Development
Description and Objective						
The program aims to improve the efficiency and reliability of Guyana's power system through electricity loss reduction measures, improvements in the operational capabilities, and strengthening the management and corporate performance of the country's utility, GPL. As Guyana's energy demand increases, the distribution infrastructure will experience greater stresses, and in turn, this will challenge GPL's management and its ability to manage electricity supply. The Power Utility Upgrade Program is designed as a holistic, integrated approach to support GPL with financing for critical infrastructure investments and technical support for GPL's key business areas. This support should increase GPL's overall performance, reinforce GPL's operational capabilities, and the achievement of a sustained trend in overall loss reduction. As such, the programme aims to improve the safety and reliability of the GPL electricity distribution system by financing infrastructure specifically focused on the reduction of electricity losses, deploying a strong Corporate Development Program to manage GPL's operations and implement solutions to GPL's longstanding problems, while improving quality of service through: (a) the rehabilitation of the existing distribution network and associated equipment as part of a strategic loss reduction programme; and (b) the strengthening of GPL, in order to contribute to the enhancement of its corporate capacities, which will help to achieve a set of performance targets for GPL.						
Quantitative Goals						
• The program will rehabilitate approximately 830 kilometres or 40% of GPL's distribution network. • Installation of 43,838 smart meters throughout the regions.						
Steps Taken or Envisaged to Achieve Action						
The Power Utility Upgrade Program engaged almost 4900 stakeholders in 176 communities across the regions of Guyana to make them aware of the activities as part of the programme, which included planting new poles, stringing of new conductors, upgrading the distribution network and installing new meters to reduce voltage fluctuations, reduce the frequency of power outages, eliminate all faulty network connections, sustain the life expectancy of the electrical appliances, and eliminate low voltage supply. This has allowed GPL to expand and equip the power system to take off and manage the forecasted electricity demand, and provide services, and operate at the required reliability levels of a modern power utility company.						

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Sustained trend in overall loss reduction. • Improved and accountable management performance within minimum international standards. • Modern, efficient, and reliable operational systems in GPL.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Rehabilitation of distribution network.	Km	0	830	830
Rehabilitation of distribution network.	%	0	40	40

Installation of smart meters.	#	0	43,838	43,838
Reduction of electricity losses.	%	31.4	25.86	25.86

Name of Action	Sustainable Operation of the Electricity Sector and Improved Quality of Service					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2011-2017	Guyana Power and Light Inc. (GPL)	CO_2	National	Training and Development

Description and Objective

As part of the overall objective of the GPL to reduce losses in the Demerara Berbice Interconnected System (DBIS), the project aimed at improving the overall efficiency of GPL's electricity power system. In this context, the general objective of the program is to improve the overall efficiency of the system by: (i) achieving a lower level of electricity losses; (ii) improving operation and maintenance of the distribution network; (iii) improving understanding of the main technical, financial, social, environmental and operational issues; (iv) reducing the incidence of theft of electricity; and (v) gaining commitment to the sustainability of the power sector. The program has financed three major components: (i) capacity building and energy conservation; (ii) rehabilitation of the low voltage distribution network; (iii) commercial loss reduction actions.

Quantitative Goals

- The program's interventions addressed the issue of technical losses by replacing 122.33 km of network, including conductors, transformers and the installation of new meters.
- Actions to reduce commercial losses included preparing consumer indexes and mapping, increasing the number of legal customers in the rehabilitated Low Voltage network and informing 15,000 customers on the rational use of energy and culture of payment

Steps Taken or Envisaged to Achieve Action

In order to achieve the objective of the project, the operation financed (i) capacity building and energy conservation; (ii) rehabilitation of the distribution network; and (iii) commercial loss reduction actions.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Achieving a lower level of electricity losses. • Improving the operation and maintenance of the distribution network. • Improving understanding of main technical, financial, social, environmental, and operational issues. • Reducing the incidence of theft of electricity. • Gaining commitment to the sustainability of the power sector.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Sustained decreasing overall losses trend achieved.	%	31.3	24.7	29.65
Level of losses in the low voltage network reduced.	%	6.0	4.98	5.53
Implementation of the ITRON Meters and prepaid meter program.	%	0	100	100
Number of customers informed on efficient energy usage and culture of payment in targeted areas for rehabilitation.	#	0	15,000	15,000
Increased number of legal customers in the low voltage rehabilitated and reconfigured network.	#	53,460	66,000	2,468

Name of Action	Power Sector Support Program					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2007-2012	Guyana Power and Light Inc. (GPL)	CO_2	National	Training and Development

Description and Objective

The Power Sector Support Programme (PSSP) was established to support the efforts of the Government of Guyana to promote a more sustainable and efficient energy sector. As such, the project included support activities in the electricity sector that will help promote the sustainable development of the energy sector and institutionalize policies and programs to (i) establish planning and priority setting in the sector; (ii) improve the enabling environment to encourage sustainable energy loss reduction and efficiency; (iii) provide institutional strengthening in order to assure regulatory capacity of the sector; (iv) strengthen the power utility provider (GPL) in order to address loss reduction on a sustainable basis, efficiency and quality of service; and (v) promote social awareness to curb loss reduction. Achieving these objectives will help to improve the financial stability of the company and the sector itself by bringing back "lost" customers, improving long term planning for the sector, and reducing losses that increase costs to all consumers. One of the desired effects of a successful program would also be an improved environment for new investment, thereby contributing to Guyana's competitiveness and growth.

Quantitative Goals

- Reduction of electricity losses to 25.5%.

Steps Taken or Envisaged to Achieve Action

The Program provided financing to execute the three components. Component 1 - Promote institutional, legal, and regulatory reforms. Component 1's objectives included a) strengthen the regulatory and legal framework to contribute to a more effective power sector with increased efficiency, transparency and accountability and b) contributing to more efficient and effective development of the power sector with a long-term strategy. Component 2 - Strengthen the Power Utility Company Capabilities. Component 2 sought to strengthen the utility's capabilities to manage a loss reduction program by contributing to improvements in corporate governance, transparency and accountability. Component 3 - Promote Sustainable Electric Loss Reductions. Component 3 objectives included a) coordinate consistent efforts to allow for effective overall electricity loss reduction and b) build consensus on the benefits of a sustainable power service.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Strengthened regulatory and legal framework to contribute to a more effective power sector with increased efficiency, transparency and accountability. • More efficient and effective development of the power sector with a long-term strategy. • Strengthened utility's capabilities to manage loss reduction program by contributing to improvements in corporate governance, transparency and accountability. • Coordination and consistency of efforts allow for effective overall loss reduction. • Building consensus on the benefits of a sustainable power service.	Not Applicable	Not Applicable. Emission reductions largely linked to energy efficiency measures captured under the Power Utility Upgrade Program: this includes capacity building, network rehabilitation or reconfiguration, upgrade and optimal relocation of distribution transformers at load centres, addition of new distribution transformers, interventions to pursue the reduction of commercial losses.

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Updated legal and regulatory framework (PUCA/other related legislation) is fully enacted with operating regulations, where necessary, implemented for at least six consecutive months.	#	0	1	1
Development of a sector strategy.	#	0	1	1
Minutes of the board reflect procedures derived from new corporate administrative tools.	#	0	1	1
Electric losses are under 20.4% 5 years after program execution.	%	34.5	25.5	20.4
Customer survey results indicate increase of in willingness to pay and social awareness of full cost of electric losses.	#	0	2	2

Name of Action	Strengthening Capacity in Energy Planning and Supervision					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Completed	2012-2016	Inter-American Development Bank (IDB)	Not Applicable	National	Training and Development

Description and Objective

In comparison with similar utility organizations, Guyana Power and Light Inc. (GPL) has a limited number of experienced staff and information resources, particularly within system planning and design, network operations, maintenance and system control and engineering services. The objective of this project is to strengthen capacity in the energy sector in Guyana through targeted support on training, technical and strategic planning, coordination, and supervision activities in government agencies. Specifically, the it provides for: (i) strengthening GPL's technical coordination unit with respect to energy projects; (ii) support to government agencies involved in the planning, data collection and analysis of energy data for the use of other energy sources in Guyana; (iii) strengthening of commercial demand-side management in GPL.

Quantitative Goals

- Establishing efficiently coordinated provision of energy services.

Steps Taken or Envisaged to Achieve Action

During the project, training will be provided to existing and new staff in: (i) operational management systems including Supervisory Control and Data Acquisition (SCADA) systems; (ii) power grid center systems; (iii) recording of data and management information related to interconnected system operation; (iv) analytical tools for operational management information and project management; and (v) procurement and financial support. Furthermore, technical advice and training will be delivered to promote improvements in data collection and analysis in order to facilitate coordination of energy demand and supply-side data between key governments agencies involved in monitoring the expansion of the energy sector in Guyana. Finally, it will assist in the design, execution, and monitoring of demand-side management, strengthening GPL's capabilities to adequately manage transparency and accountability of commercial operations, improved collection rate and reduced commercial losses.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Strengthen operational performance, enabling agencies such as GPL, Office of the President (OPS), Office of the Prime Minister (OPM), Power Utility Commission (PUC) and the Guyana Energy Agency (GEA), among others, to optimise and function to their required capacity.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Information management training for new and existing staff in GPL.	#	0	1	1
Technical assessment of coordination capacity.	#	0	1	1
Training for staff in government agencies.	#	0	2	2
Commercial expert contracted in GPL.	#	0	1	1

2. Forestry

Name of Action	Institutional Strengthening for the Implementation of the LCDS 2030 under REDD+ Partnerships					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Completed	2011-2017	Guyana Forestry Commission (GFC) and Office of Climate Change (OCC)	CO_2	National	Forestry

Description and Objective

In July 2022, Guyana adopted the Low Carbon Development Strategy 2030 (LCDS 2030), an update from the original strategy set out in 2009. The LCDS 2030 aims at avoiding deforestation and maintaining forests, while growing the economy five-fold over 10 years and keeping energy emissions flat; investing in urban, rural and Amerindian development; protecting the coast and hinterland from climate change; creating jobs in a suite of low carbon sectors; aligning the education and health sectors with low carbon development; and integrating Guyana's economy with its neighbours. The LCDS sets out the following four inter-linked objectives: (i) value ecosystem services; (ii) invest in clean energy and stimulate low carbon growth; (iii) protect against climate change and biodiversity loss; and (iv) align with global climate and biodiversity goals. Under the first objective, Guyana sets out goals towards enhancing Reducing Emissions from Deforestation, Degradation and sustainable forest management (REDD+) partnerships. This project aimed to enhance the national institutional capacity in Guyana to address the impacts of climate change through the effective implementation of the LCDS 2030, and to assist Guyana in meeting its commitments under interim REDD+ partnerships. These commitments include the reduction of deforestation which translates into the avoidance of CO_2 emissions. The project was funded by result-based payments under Guyana-Norway partnership channelled through two ways: (i) the Guyana REDD+ Investment Fund (GRIF) and the Inter-American Development Bank (IDB) and (ii) direct engagement between Norad and Conservation International. The specific objective of the project was to strengthen the technical and administrative capacity of the three principal institutions responsible for implementing and monitoring, reporting, and verifying Guyana's LCDS 2030, namely the Office of Climate Change (OCC), the Project Management Office (PMO) and the GFC, through supporting the recruitment of specialized personnel with expertise in strategic fields, training and capacity building of permanent staff, and ensuring sufficient equipment and technical resources to ensure smooth running of the project. Additionally, the project aimed to conduct a diagnostic for future institutional strengthening which was to assess the institutional capacities of other Government agencies whose responsibilities are related to the LCDS and REDD+ activities.

Quantitative Goals

- Enhance national institutional capacity in Guyana to address the impacts of climate change via reduction of deforestation and while demonstrating its ability to earn the maximum portion of funds available via the GRIF.

Steps Taken or Envisaged to Achieve Action

On 9 November, 2009, Guyana and Norway signed a Memorandum of Understanding (MoU), agreeing that Norway would start to provide Guyana with result-based payments for forest climate services, whereby Norway intended to make performance-based contributions of up to $250 million USD by 2015 for results achieved by Guyana in generating the capacity to reduce emissions from deforestation and forest degradation, whilst creating a replicable model for REDD+. Guyana was set to be paid by Norway for performance on reducing GHG emissions from deforestation and forest degradation, and for progress made against enabling conditions including those relating to indigenous rights, consultation, and establishing a MRV system. In 2010, the IDB, the World Bank, Norway and Guyana developed the Guyana REDD+ Investment Fund (GRIF) in accordance with the LCDS, constituting the financial mechanism that allows results-based payments associated with the interim REDD+ program. Among the activities undertaken, the capacities of the GFC, OCC, and PMO were strengthened by recruiting and training specialized technical and administrative personnel; investor negotiations with OCC and PMO were facilitated; junior staff in the PMO were trained on project management; and a diagnostic was conducted on future institutional strengthening needs of government agencies whose responsibilities are related to the LCDS and REDD+ activities such as the EPA and the GGMC. Through these activities, the PMO reported that, as of 2017, the Government of Guyana has received four results-based payments totalling $190 million USD of the $220 million USD potentially available through the GRIF under the bilateral agreement with Norway for the 2009-2015 period, which have been allocated to fund future LCDS related projects. Over 156 communications and outreach activities on LCDS and REDD+ were conducted. Methodologies for determining the extent and scale of forest degradation were developed and a digital database of archived satellite data and national spatial data sets were established. Historical and current drivers and processes affecting forest carbon levels were assessed and implementation plans for long term measurements and monitoring of national forest carbon stocks were developed. Within the GFC, eight technical staff were trained in the area of forest carbon stocks and change assessments; fourteen field staff were trained in forest carbon monitoring systems; and six staff were trained in GIS and Remote Sensing. Multiple reports and areas of research were advanced by the GFC, including: Assessment Report in Current Drivers and Processes Affecting Forest Carbon; Report on Independent Forest Monitoring; Report on Identification of Non-Carbon Ecosystem Services for Integration into Guyana's National MRVS Assessment; Report on Shifting Agriculture; and Report on Assessment of Requirements of a Monitoring System for Carbon as well as Non-Carbon Variables. Technical capacities of forest based indigenous communities were also built to engage in community-based monitoring for forest resources (Community MRV).

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Maintenance of forest cover by 85%. • Progressively decreased total level of deforestation across the five-year project implementation period from 0.056%, 0.054%, 0.079%, 0.068% to 0.065% respectively. • Full access to results-based payments potentially available through the GRIF to finance LCDS 2030 implementation. • Attainment of all LCDS 2030 goals.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
LCDS execution capacity of the OCC score.	%	55%	72%	90%
LCDS execution capacity of the GFC score.	%	76%	85%	90%
Stakeholder awareness of LCDS.	%	60%	90%	72%

Name of Action	Guyana-EU Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Ongoing	2012-2025	Guyana Forestry Commission (GFC)	CO_2	National	Forestry

Description and Objective

The Guyana-European Union (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement (VPA) supports sustainable forest management, governance, and law enforcement in the trade of sustainable and legal timber products. The VPA aims to support governance reform and strengthen enforcement activities within Guyana´s forest sector, with commitments to improve transparency, accountability, legislative clarity, and other aspects of governance. Under the VPA, Guyana may issue FLEGT licenses on their timber exports under a national FLEGT Licensing Schemes based on a Legality Assurance System (LAS), ensuring that only legally produced timber produced in a sustainable manner are exported to the EU. The FLEGT VPA aims to foster business growth by shipping Guyana´s timber products to the EU and other global markets that are moving towards forest sustainability and new forest policies and laws.

Quantitative Goals

- Guyana-EU Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement finalized, in place, and fully operational.
- Empower Guyana´s forests to forge a green economy based on low levels of deforestation, reduced carbon emissions, and climate resilience.

Steps Taken or Envisaged to Achieve Action

In 2012, a policy decision was taken by the Government of Guyana to enter into formal negotiations with the EU on a FLEGT VPA. Guyana and the EU negotiated the terms of the VPA through a collaborative process with both Parties that shared the goal of fostering good forest governance and addressing illegality. Negotiations began through a multi-stakeholder process aimed at fostering national ownership, stakeholder engagement, wide participation, and a broad consensus to promote effective VPA implementation. Negotiations between the EU and Guyana began in December 2012, lasted for nearly six years, and were successfully concluded with the initialling of the agreement on 23 November 2018. The European Council adopted the Decision on the signing of the VPA with Guyana in October 2022. The final signing of the agreement took place at the UN Biodiversity Conference (COP 15) in Montreal on 15 December 2022, whereby the Minister for Natural Resources signed the agreement on behalf of Guyana and the EU was represented by the European Commissioner for Environment, Oceans and Fisheries and the Czech Deputy Minister of the Environment. It is intended that a period of preparedness will follow for 3-5 years to enable Guyana to effectively implement the VPA under EU-FLEGT by the issuance of FLEGT licences. Guyana has already begun taking significant steps to begin implementing the VPA under the period of preparedness, whereby Guyana enacted New Forest Regulations and gazetted the Code of Practice for Forests Operations in 2018, in addition to developing a national VPA Communication Strategy and held a virtual learning event for Forest Sector Operators (FSO) in 2020. To begin issuing FLEGT Licences, Guyana is upgrading existing the national Wood Tracking System (WTS) to develop a robust timber legality assurance also known as the Guyana Timber Legality System (GTLAS). The FLEGT Licensing Scheme will take effect when the GTLAS is successfully evaluated, and Guyana and the EU are satisfied that it functions as described in the VPA. Guyana also has a series of VPA Annexes which describe the practical components for implementing the core commitments in the VPA in detail. Further legal works are being conducted by Guyana including identifying and addressing possible gaps in the forest allocation process and the legal framework; stakeholder capacity-building; improving procedures for verifying legal compliance; developing approaches that ensure the traditional rights of Amerindian peoples are not impeded; and establishing independent audits, a complaints mechanism, and systems and procedures for information on the forest sector to be publicly available. Additional resources are required to build institutional and private sector capacity to meet other trade and supply conditions such as the Lacey Act, Forest Stewardship Council (FSC) certification, and other procurement requirements.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Reduced deforestation from illegal logging and its associated socioeconomic problems.	Not Estimated	Insufficient information available to estimate the

• Strengthened forest sector governance and improved regulatory frameworks with formalized multi-actor and multi-sector structures, including reinforced capacities of the GFC. • Modernized Wood Tracking System and Timber Legality System. • Increased transparency, reputation, and accountability. • Strengthened capacities among forestry sector stakeholders for sustainable forest management. • Sustainable economic growth and expansion securing Guyana's access to EU and other international Markets for sustainable timber products. • Enhanced community benefits through a sustainable livelihoods approach, including local communities, Forest Sector Operators, and Indigenous peoples.		GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Level of transparency in the forestry sector.	%	53.0%	100%	71.3%
Level of implementation of sustainable forest management plans.	%	51.4%	100%	70.6%
Level of timber harvesting qualified as legal.	%	53.7%	100%	57.8%
Level of legal timber traded on the export market.	%	62.5%	100%	78.5%
Level of legal timber traded on the domestic market.	%	54.2%	100%	68.1%
Tax collection efficiency of the forestry sector.	%	41.7%	100%	52.4%

Name of Action	Guyana REDD+ Monitoring Reporting & Verification System (MRVS)					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Ongoing	2010-2025	Guyana Forestry Commission (GFC)	CO_2	National	Forestry

Description and Objective

This activity has designed, implemented, and is currently improving the Monitoring, Reporting and Verification System (MRVS) for the forestry sector in Guyana as a key element to enable the performance-based payments of Guyana's REDD+, and support Guyana´s carbon markets through mechanisms such as ART-TREES. The design of the MRVS comprised three phases, each with a progressively ambitious objective as follows: Phase 1 had the goal to establish the MRVS, Phase 2 had the goal of consolidate and expand capacities for national REDD+ monitoring, and Phase 3 has the goal to maintain an efficiently functioning MRVS that meets international and national requirements and supports natural resources management in Guyana. The MRVS aims to establish a comprehensive, national system to monitor, report, and verify forest carbon emissions by tracking forest change due to both deforestation and degradation, by tracking change drivers and the interpretation of national coverage high-resolution satellite imagery.

Quantitative Goals

- A fully operational MRVS system is in place in line with REDD+, UNFCCC, and IPCC standards, with enhanced capacities for inter-institutional multi-dimensional use of its benefits, including access to international carbon markets as a source of sustainable income to fund domestic climate action, as well as to enhance monitoring and enforcement of forest-based activities in the country.

Steps Taken or Envisaged to Achieve Action

A climate and forest partnership between the Government of Guyana and the Government of Norway was established in 2009, which included the progressive development of the Guyana Monitoring Reporting and Verification System (MRVS). In 2009 Guyana brought forth a framework for a national MRVS and a roadmap for its phased development, improvement, and implementation. Under Phase 1 (2010 to 2015) Guyana´s MRVS was established for implementing REDD+ policies and to receive results-based compensation for such activities, while building capacity in the GFC to carry out forest cover and change monitoring and forest carbon monitoring, as well as fostering stakeholder awareness and participation in MRVS design and implementation. Under Phase 1, reference measures and interim indicators were developed and applied while aspects of the MRVS were under development and were to eventually be phased out and replaced by a complete forest carbon accounting system as methodologies are further developed. The continued development and implementation of Guyana's MRVS under Phase 2 (2016 to 2021) maintained its focus on the implementation and further development of the key technical areas of forest area change assessment and monitoring and forest carbon measurement and monitoring. Emphasis was placed on improvements in the emissions and removals reporting, and application of the system to improve forest management, achieving in 2018 the total forest carbon and removals accounting for the first time. Over the years, Guyana's MRVS has become an internationally acclaimed model and an enabler to enter voluntary international carbon markets. On 18 December, 2020, Guyana submitted an application to the Architecture for REDD+ Transactions (ART) Secretariat, and as of December 2022, ART has issued the world´s first TREES credits to Guyana, whereby each credit represents 1 ton CO_2e. A total of 33.47 million TREES credits for the five-year period from 2016 to 2020 were issued to Guyana. It is anticipated that an additional 7.5 million credits per year will be issued on average from 2021 to 2030 under the ART-TREES initiative. The country is allocating 85% of revenues from their sale to multi-community and national programs, and 15% to village-led sustainability plans for indigenous communities. Under Phase 3 (2022-2025), Guyana will further improve the MRVS to attain further participation in the ART-TREES initiative and fully adhere to emerging TREES standard. Hess Corporation has committed to purchase 37.5 million ART-TREES credits consisting of 12.5 million of the 33.47 million carbon credits issued for the period 2016-2020, and an additional 2.5 million per annum from the credits to be issued each year from 2021 to 2030, at a minimum unitary cost of $15, $20, and $25 USD per credit issued in 2016-2020, 2021-2025, and 2026-2030, respectively. In this Phase 3, the GFC and other land management agencies see a compelling need to monitor land cover change more frequently to extend the inter-sectoral benefits of the system beyond current use. MRVS Phase 3 will support the improvement of the necessary human and physical capabilities sustained by local institutions and create the platform for monitoring, reporting, and compliance verification under a market-based mechanism. This phase will continue to see routine annual reporting on forest carbon emissions and removals in compliance

with UNFCCC and IPCC requirements. Simultaneously, this phase will create complementary systems for reporting on REDD+ governance compliance requirements, such as supporting REDD+ forest sector safeguards, Guyana's Nationally Determined Contributions, and the UN Sustainable Development Goals 13 and 15. To date, eleven national assessments (2010 to 2021) have been conducted and issued by the GFC.		
Estimated Outcomes	**Estimated GHG Emission Reductions**	**Methodologies and Assumptions**
• Maintenance of low rates of deforestation and degradation leading to 33.47 million carbon credits issued over the 2016-2020 period and an additional 7.5 million credits issued per year over the 2021-2030 period. • Sustainable income generated to support 242 village-led sustainable development plans among indigenous communities. • Sustainable income generated to support LCDS 2030 implementation unlocking transformative investments in renewable and low-carbon energy generation; climate change adaptation and biodiversity loss; green job creation; health and education; and expanded protected areas.	108.47 million tons CO_2e	Guyana has been issued 33.47 million ART-TREES credits for the period 2016-2020, with an estimated additional 75 million credits to be issued for the period 2021-2030. Each credit being equivalent to 1 ton CO_2e, the total reduction over the 2016-2030 period is estimated at 108.47 million tons CO_2e.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of ART-TREES credits issued.	#	0	108.47	33.47
Number of ART-TREES credits sold (actual and anticipated to 2030).	#	0	37.5 million	12.5 million
Value of ART-TREES credits sold (actual and anticipated to 2030).	$ USD	0	750 million	150 million

<table>
<tr><th>Name of Action</th><th colspan="6">Forest Carbon Partnership Facility Project in Guyana</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Enabling activity</td><td>Completed</td><td>2014-2020</td><td>Guyana Forestry Commission (GFC)</td><td>CO_2</td><td>National</td><td>Forestry</td></tr>
<tr><th colspan="7">Description and Objective</th></tr>
<tr><td colspan="7">The objective of the technical cooperation assisted Guyana in its efforts to establish an enabling framework and build its capacity for REDD+ by providing financial and technical assistance aiming to (i) improve the organization of the country for REDD+ Readiness, including stakeholder consultations; and (ii) develop the Guyana REDD+ Strategy to facilitate Guyana's access to additional funding under performance-based incentives. In Guyana's case, REDD+ goals include mitigating climate change; conserving water resources and prevent flooding; reducing run-off and control soil erosion; reducing river siltation; protecting inland and coastal fisheries; investing in hydropower facilities; preserving biodiversity; and preserving cultures and traditions. The FCPF project had three components as follows: (i) Component 1 - institutional arrangements and consultations for REDD+ readiness; (ii) Component 2 - REDD+ strategy development and implementation framework; and (iii) Component 3 - monitoring and evaluation of readiness activities. The objective of Component 1 was to strengthen the efficacy, accountability, and transparency of the national readiness management and institutional arrangements and increase stakeholder consultation and participation in REDD+ strategy development and implementation. The objective of Component 2 was to build capacities for REDD+ Strategy implementation including capacities to (i) verify and characterize the key drivers of deforestation and forest degradation; (ii) design conservation and sustainable forest management activities that reduce emissions; (iii) identify how current land use, and forest law, policy and governance structures impact on the drivers of deforestation and forest degradation; and (iv) propose alternatives for mitigating the identified drivers and responding to impacts. The objective of Component 3 was to monitor and evaluate the FCPF project implementation.</td></tr>
<tr><th colspan="7">Quantitative Goals</th></tr>
<tr><td colspan="7">• Full REDD+ readiness status attained in Guyana through extensive stakeholder consultation and participation.
• REDD+ Strategy and Implementation Framework established together with its Environmental and Social Management Framework.
• All REDD+ activities in Guyana are monitored and reported effectively.</td></tr>
<tr><th colspan="7">Steps Taken or Envisaged to Achieve Action</th></tr>
<tr><td colspan="7">Guyana joined the World Bank's Forest Carbon Partnership Facility, and submitted its Readiness Plan Idea Note (R-PIN) in 2008 to initiate the REDD+ readiness preparation. In 2011, Guyana became a United Nations REDD Partner Country. In 2012 the government of Guyana prepared and approved its Readiness Preparation Proposal (R-PP) which was submitted to the FCPF that same year. Thanks to parallel activities concerning the development of the national MRVS, Guyana developed and submitted to the UNFCCC its National Forest Reference Level (FRL) for REDD+ in 2014 and a revised Reference Levelin 2015. The activities addressed by the FRL are deforestation from conversion to agriculture, mining, and infrastructure expansion, and forest degradation from timber harvest. The FRL was developed using a Combined Reference Level Approach, in which the average rate of global tropical forest carbon emissions (0.435% / yr) is combined with the rate of annual emissions from forests in Guyana (2001-2012, 0.049% / yr) to obtain a reference level of 0.242%, that results in emissions of 46,301,251 ton CO_2/yr. In 2016, Guyana begun the implementation of the R-PP through the development of REDD+ strategy options, and the reinforcement of its institutional capacity to manage REDD+, including social and environmental safeguards. In 2019, Guyana produced its national REDD+ Strategy, Social Environmental and Strategic Assessment (SESA) and an Environmental and Social Management Framework (ESMF) which underwent extensive stakeholder consultation. With the final readiness Package (R-Package) being developed in August 2020, revised in March 2021, and endorsed in May 2021, Guyana culminated the FCRF REDD+ readiness process.</td></tr>
<tr><th colspan="5">Estimated Outcomes</th><th>Estimated GHG Emission Reductions</th><th>Methodologies and Assumptions</th></tr>
<tr><td colspan="5">• Institutional capabilities were built and mobilized to ensure successful execution of the R-PP.</td><td>Not Applicable</td><td>Not Applicable</td></tr>
</table>

- Enhanced information sharing and accessibility of information as well as implementation of public disclosure of consultation.
- Guyana proposed a REDD+ Strategy in line with its NDC seeking to avoid 48.7 $MtCO_2e$ annually, while maintaining an annual rate of deforestation below 0.1% focusing on the major drivers of mineral mining, forestry, and agriculture, while adopting a principle of promoting biodiversity conservation and enhancement.
- The REDD+ strategy was developed in an inclusive, participatory and transparent manner, ensuring multiple opportunities for learning about and influencing the REDD+ strategy design for all affected or interested stakeholder groups.
- A Social Environmental and Strategic Assessment (SESA) and an Environmental and Social Management Framework is in place to ensure compliance with the Cancun REDD+ social and environmental safeguards.
- Through parallel efforts, Guyana has developed a world-class forest monitoring system (MRVS) that has been independently verified for accuracy by reputable institutions, having produced eleven national assessments (2010 to 2021) to date. Further, Guyana has developed and submitted to the UNFCCC its National FRL for REDD+ in December 2014 and a revised FRL in September 2015.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Extent of consultation, participation, and outreach.	FCPF scale (0-5, whereby 5 is completed)	2	5	4
Extent of development of REDD+ Strategy.		0	5	5
Extent of development of REDD+ Implementation Framework.		0	5	4
Extent of assessment of environmental and social safeguards.		0	5	4
Extent of development of Environmental and Social Management Framework.		0	5	4
Stage of REDD+ Readiness.	Qualitative	R-PIN	R-Package	R-Package

Name of Action	Securing a Living Amazon through Landscape Connectivity in Southern Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2022-2027	Environmental Protection Agency (EPA) / Protected Areas Commission (PAC)	CO_2	Region 9	Forestry

Description and Objective

Under the Amazon Sustainable Landscape Impact Program, this project aims to strengthen and improve landscape connectivity through the establishment of conservation areas (800,000 ha) and the management of productive areas (400,000 ha) within southern Guyana as a method to combat degradation, fragmentation, and unsustainable exploitation of forest resources due to unplanned land-use expansion and unsustainable land/water use from logging and mining sectors, new infrastructure (e.g. roads and trails), and wildlife harvesting. Key project components are four-fold. First, to fortify integrated protected landscape management, whereby focus is placed on the Kanuku Mountains Protected Area (KMPA) to strengthen its management together with the Indigenous communities who utilize resources of the protected area. Second, fortify integrated productive landscapes, whereby focus is placed on strengthening the management of the North Rupununi Wetland (NRW). Third, strengthen policies and incentives for protected and productive landscapes, including the revision of the Protected Areas Act in consultation with all key stakeholders. Fourth, capacity building and cooperation including monitoring and evaluation, communications, and cooperation with the wider Amazon Sustainable Landscapes Impact Program.

Quantitative Goals

- Strengthened protected area management effectiveness.
- Increased areas of forests and watersheds brought under sustainable land and water management practices.
- Strengthened regulatory frameworks for natural resource conservation/sustainable use.
- Strengthened monitoring, evaluation, and cooperation.

Steps Taken or Envisaged to Achieve Action

Approximately 169 persons from the communities of Fair View, Crashwater, Rewa and Apoteri, Iwokrama River Lodge, the North Rupununi District Development Board and the Kanaku Mountain Community Resource Group participated in consultations during November 2019 on barriers, threats, and potential opportunities that may arise as a result of the project. In June 2019, the Global Environment Facility (GEF) Council approved the project concept and the EPA in partnership with WWF-Guyana prepared the project document through extensive project stakeholder consultation so as to secure their maximum input in project design. As of May 2022, the GEF approved project for implementation, whereby Guyana secured a total $5.1 million for implementation.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Kanuku Mountains Protected Area (KMPA) under enhanced management. • North Rupununi Wetland (NRW) implementing and integrated wetland management strategy.	847,406 tons CO_2e	The EX-ACT tool was used to calculate CO_2e reductions. The project is expected to improve practices in 1,800 ha of the KMPA during the lifetime of the project, contributing to 72,489 tons of CO_2e mitigated. It is expected that the project will move at least 1% of the NRW (or 15,128 ha) from very low degradation to no degradation over 5 years, which contributes to an additional 774,917 tons of CO_2e mitigated.

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Area of protected landscapes created or under improved management for conservation and sustainable use.	ha	0	611,000	0
Area of productive landscapes under improved management practices.	ha	0	901,800	0
Number of community members with built capacities, training, exchanges, and participation in planning processes.	#	0	700	0

3. Cross-cutting

Name of Action	Amerindian Development Fund					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2012-2016	Ministry of Amerindian Affairs (MoAA)	Not Estimated	National	Hinterland Development
Description and Objective						
The Amerindian Development Fund (ADF) was established to provide funding to support the low-carbon socio-economic development of Amerindian communities and villages, through the implementation of their Community Development Plans (CDPs) across agriculture, village infrastructure, tourism, manufacturing, village business enterprise, and transportation. The project aimed to strengthen the entrepreneurial and institutional capabilities of the village economies of Amerindian communities; improve linkages with the private sector to further develop value chains; and strengthen institutional frameworks to support local economies in low-carbon socio-economic development.						
Quantitative Goals						
• Strengthened entrepreneurial and Institutional capabilities of the village economy of Amerindian communities. • Improved linkages with the private sector to further develop value chains. • Strengthened institutional framework to support local economies.						
Steps Taken or Envisaged to Achieve Action						
Phase 1 (2012) of the ADF provided funding to 26 communities and villages in the amount of $753,877 USD for the implementation of their CDPs and capacity development of the Ministry of Indigenous Peoples' Affairs was conducted. Under Phase 2 (2014) of the ADF approximately $3,658,663 USD was disbursed to154 communities and villages for the implementation of their CDPs. In all 154 communities, Community Development Officers (CDOs) were trained in monitoring and financial accounting techniques and Community Management Teams (CMTs) were trained to prepare budgets, financial reports and provided with business management, marketing, and leadership techniques training. Furthermore, Cluster Training Sessions were held for entrepreneurs on cattle management, fish culture, wood working, and business operations, among others. Work was completed to improve linkages with the private sector to further develop value chains and to strengthen the institutional framework to support local communities. As a result, beneficial connections with several agencies and institutions, including the Small Business Bureau (SBB); Guyana Livestock and Development Agency (GLDA); Guyana Tourism Authority (GTA); National Agricultural Research and Extension Institute (NAREI); Regional Democratic Councils (RDCs); New Guyana Marketing Corporation (NGMC); Guyana Technical Institute (GTI); Global Seafood Distributors; Georgetown Chamber of Commerce and Industry (GCCI); and the Guyana Energy Agency (GEA) were made. A CDP database was also elaborated over the life of the project and shared with various agencies and institutions, enlisting all grant recipients, types of CDPs, typologies, villages, tranches disbursed, dates, population, and other particulars. Phase 2 of the ADF project ensured to incorporate key lessons learned from Phase 1 for greater efficiency, impact and sustainability of CDPs, including: (i) community ownership and participation is fundamental to the preservation and respect for Amerindian rights, traditional knowledge and practices, and the implementation of this project; (ii) development of the village economy is critically linked to clustering, marketing, availability of economic opportunities, and other industry linkages, inter alia; (iii) modalities for the disbursement of funds should be mindful of risks, costs and delays in situations where communities cannot use bank accounts; (iv) it is fundamental to ensure access to, and account for the cost of, energy; and (v) logistical costs, risks, weather, and mitigation measures should be fully considered in the planning and delivery of activities.						

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 180 Community Development Plans Supported. • 1,253 villagers trained for CDP management teams. • 1,662 low-carbon jobs sustained and/or created. • $4,412,540 USD in value of CDPs funded.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Proportion of community ventures financed operational after 1st year.	%	0%	95%	15%
Proportion of CMTs regarded as effective in managing community business.	%	0%	70%	90%
Proportion of CDPs that are financially break-even.	%	0%	40%	13%
Number of partnerships developed in pursuit of community business development.	#	Limited	Several	Several
Number of CMTs trained to develop, manage, and execute business ventures.	#	27	187	154
Proportion of communities that have developed formal linkages between community-level enterprises and larger firms.	%	0%	50%	8%
Extent to which local government agencies are convening and brokering partnerships to support local economic development.	Qualitative	Somewhat involved in project implementation	Fully covering and brokering partnerships	Village leaders fully engaged in discussions

Name of Action	Support for Micro and Small Enterprise and Vulnerable Groups' Low-Carbon Livelihoods					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2012-2018	Ministry of Business (MoB)	Not Estimated	National	Economic Development

Description and Objective

The project addressed two of the major bottlenecks that constrained the development of micro and small enterprises (MSEs) and the ability of vulnerable groups to build alternative low-carbon livelihoods in Guyana, namely (i) limited access to finance and (ii) limited technical and business skills. Access to finance was addressed through (i) a credit guarantee facility covering 40% up to 70% of the collateral requirements for low-carbon venture loans at participating financial institutions; (ii) an interest payment support facility which lowered interests from a range 0f 14-26% down to 6% for entrepreneurs approved for loans for low-carbon ventures; and (iii) a low carbon grant scheme to assist vulnerable persons with viable business propositions in low carbon sectors. A training voucher scheme enabled MSEs to obtain the skills they require at existing training institutions free of cost to them. The project targeted MSEs working in, or transitioning to, 17 low carbon sectors such as: low carbon agriculture and agro-processing; aquaculture; eco-tourism; sustainable business process outsourcing; bio-ethanol; energy efficient transportation and logistics; low carbon manufacturing activities; apiculture; low carbon energy production and/or distribution; sustainable professional and business services; sustainable internet and computer based services; sustainable culture; and sustainable publishing and printing.

Quantitative Goals

- Support carbon emission reductions by re-orienting the economy onto a low carbon path, through the creation of the necessary incentives and creation of jobs in MSEs under key sectors of Guyana´s Low Carbon Development Strategy 2030.

Steps Taken or Envisaged to Achieve Action

A total of 224 loans were approved for beneficiaries (61% males and 39% females) in low carbon sectors at a total approximate value of $4,399,138 USD and 591 grants were approved for entrepreneurs (38% males and 62% females) in low carbon sectors at an approximate value of $891,055 USD. Additionally, 4,482 persons were trained free of cost in several areas, including: basic business management skills, record keeping, packaging and labelling, a special course aimed at female entrepreneurs, climate smart agriculture, sustainable forestry, sustainable mining, videography, photography, cosmetology, cookery, and craft.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 24 low-carbon loans provided. • 591 low-carbon grants provided. • 2,101 low-carbon jobs sustained and/or created. • 4,482 persons trained in low-carbon sectors. • 17 low-carbon sectors supported. • $4,399,138 USD in value of low-carbon loans provided. • $891,055 USD in value of low-carbon grants provided.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of jobs created in low-carbon sectors	#	0	811	2,101
Number of loans approved to eligible MSEs	#	0	542	224
Number of grants approved to eligible MSEs	#	0	212	591
Number of MSE and vulnerable groups who have accessed technical and business skills	#	0	1,231	4,482

Name of Action	Amerindian Land Titling					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2013-Ongoing	Ministry of Amerindian Affairs (MoAA)	Not Estimated	National	Hinterland Development

Description and Objective

Amerindians total approximately 14% of Guyana's population and currently own more than 15.65% of Guyana's territory, up from about 6% in the early 1990s. The Amerindian Land Titling (ALT) project seeks to enable Amerindians to secure their lands and natural resources with an overall goal towards sustainable self-driven socioeconomic development. The ownership of land empowers and allows Guyana's first peoples the liberty to engage in and promote investments towards their own social and economic advancement in a sustainable low-carbon manner. It is envisaged that titling of communities will strengthen land tenure security and expand the asset base of Amerindians, enabling improved long-term planning for their future sustainable development. The objective of ALT project is to facilitate and fast track the Amerindian Land Titling process. The project seeks to (i) have land titles issued and demarcation process completed for all Amerindian villages that submit requests, including those that request extensions; (ii) strengthen existing mechanisms to deal with unresolved land issues; and (iii) improve the communication and outreach efforts of the Ministry of Amerindian Affairs.

Quantitative Goals

- Land titles issued and demarcation process completed for all Amerindian villages that submit requests.
- Increased access to existing and alternative mechanisms for resolving land titling disputes.

Steps Taken or Envisaged to Achieve Action

The principle of Free Prior and Informed Consent (FPIC) is a fundamental and respected principle that is applied to ensure Amerindians are provided with enough information well in advance of planned or proposed activities to allow communities and villages to agree or consent to the execution land titling. To date, over 210 persons were trained in FPIC to ensure that not only do Amerindians understand their rights but importantly, for other stakeholders to recognise and understand those rights and practically apply the principle of FPIC during project implementation. A communication strategy was formulated under the project and associated activities involved the distribution of communication materials (including brochures and flyers, radio and television broadcasts), documentaries on titling activities, and workshops throughout communities and villages in the various regions. Many of the communication materials were translated into the different Amerindian languages. A grievance redress mechanism was established as an alternative for helping to resolve land titling disputes. A total of 23 persons have been trained as GRM liaisons, 254 community members have been trained in mediation and 378 persons were part of cluster awareness exercises on the core function of the GRM. To date, a total of 15 villages have issued with absolute grants, bringing the total number of Amerindian villages titled with absolute grants to 111. A total of 26 villages have been demarcated and 24 were issued with certificates of title, which has brought the total number of villages in Guyana demarcated and issued with Certificates of Titling to 101.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 111 villages with absolute grants. • 101 villages demarcated and issued certificates of title.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Number of villages issued absolute grants.	#	96	All	111
Number of villages issued certificates of titling.	#	77	All	101
Number of persons trained in mediation under FPIC.	#	0	210	210

Name of Action	ICT Access and E-services for Hinterland, Remote, and Poor Communities					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2017-Ongoing	Office of the Prime Minister (OPM)	Not Estimated	National	Hinterland Development
Description and Objective						
The objective of the project is to provide the necessary infrastructure, equipment, hardware, and software necessary to enable access to high-quality Information and Communications Technology (ICT) connectivity and accompanying electronic services to 200 Hinterland, Poor, and Remote Communities (HPRCs) across Guyana, as well as to provide capacity building for communities in the use of newly developed e-services. It is envisaged that the project will provide the supporting capacity to create linkages to generate inter-sectoral benefits in education, health, and business while fostering low-carbon technologies. The goals of the project include the development of a digital knowledge-based society, enhancement of national efficiency and competitiveness and the promotion of inclusive and sustainable growth and development.						
Quantitative Goals						
• Strengthened e-government policy environment and legislation. • Increased broad access to ICT among hinterland, poor, and remote communities. • Public e-services and information readily available to HPRCs. • Enhanced capacity of HPRCs to use ICT and access e-services.						
Steps Taken or Envisaged to Achieve Action						
From 2021, ICT hubs are being established to benefit 200 communities and villages across Guyana, each equipped with printers, televisions, laptops, and software. To achieve this target, 90 Very Small Aperture Terminals (VSATs) were procured and installed in communities and villages to provide internet access to remote locations. Additionally, 180 solar systems were procured to provide the necessary energy to power the ICT equipment at the hubs and any additional equipment/appliances using the extra capacity, based on 100% renewable energy. Also, under the project, consultancies were commenced to conduct a comprehensive capacity assessment of the National Data Management Authority (NDMA); map current ICT deployment and capacities in the public sector; and to undertake a multidimensional capacity assessment of public institutions that will offer e-services, identifying gaps and bottlenecks in the process. The following reports were completed: i) Baseline Report focused on market research looking at Guyana's profile, education, health, business, and as-is analysis of technical infrastructure and regulation; ii) Technical Report looking at technology assessment, design options for Guyana, commercial assessment of solutions, proposed Guyana solution, rollout phases, stakeholder analysis, business models, implication for legislation and policy development, and an implementation plan, and iii) E-Services Readiness Assessment Report on important service needs, status quo of e-services readiness today, vision of e-services offered by government agencies, and description of selected e-services. Several communities have already benefited from the rollout of this project, specifically regions 9 and 7. A photovoltaic technician training programme was also completed as to build technical capacity within these HPRCs. A massive ICT training rollout will soon commence within these communities where a basic to advanced curriculum will be employed. These specific interventions will enhance the communication deficit within these communities, improve remote health and education management (including the Guyana Online Academy of Learning 20,000 scholarship programme) and access to government eservices.						

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 200 HPRCs with ICT Hubs. • 4,000laptops installed. • 200 e-services provided.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Proportion of residents in HPRCs with access to ICT.	%	20%	90%	98,000 residents
Number of ICT hubs deployed in HPRCs.	#	14	200	200
Proportion of people in HPRCs using e-services.	%	0%	90%	98,000 residents
Number of online services offered by public institutions to HPRCs.	#	Limited	200	NE
Proportion of residents in HPRCs trained in ICT.	%	Limited	85%	NE

Name of Action	Village Sustainability Plans					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Ongoing	2021-2025	Ministry of Amerindian Affairs (MoAA) / National Toshaos Council (NTC)	Not Estimated	National	Hinterland Development

Description and Objective

Under the Low Carbon Development Strategy 2030 (LCDS 2030), Guyana aims to lead sustainable development at village level with clear strategy in a continuous, predictable, and sustained manner. A dedicated 15% of carbon market revenues in Guyana (under the ART-TREES mechanism) are made available for bottom-up investments in the implementation of community-led low-carbon development programmes for indigenous peoples and local communities (IPLCs) set out in Village Sustainability Plans (VSPs), put together by communities themselves focused on sustainable income generation and socioeconomic upliftment to deliver on climate, energy security, and food security priorities. The VSPs are developed by the villages themselves under the principles of free, prior, and informed consent (FPIC) and should cover the period up to 2025 (or longer if the village choses), whereby the Government of Guyana and non-governmental organizations may aid villages in VSP preparation if this is requested. Because VSPs are led by villages, their specific format and content vary, but typically include a decision statement for the community and priority areas to deliver the vision including community infrastructure and communications (clean energy and ICT), livelihood opportunities (ecotourism and climate-smart agriculture), natural and environmental management, education, and health.

Quantitative Goals

- Operational benefit-sharing mechanism to direct 15% of carbon market revenues in support of bottom-up investments in the implementation of community-led low-carbon development programmes for indigenous peoples and local communities set out in Village Sustainability Plans.

Steps Taken or Envisaged to Achieve Action

The National Toshaos Council (NTC) is established by law under the Amerindian Act of 2006 and comprises all elected Toshaos of Guyana across its ten regions. In July 2022, the NTC adopted a resolution in support of Guyana´s LCDS 2030. The NTC's participation was crucial in developing/proposing the benefit-sharing mechanism for dedicating 15% of carbon market funds such that all IPLCs could benefit equitably. A seven-month-long nation-wide consultation was done with over 200 Indigenous communities on the LCDS carbon credits benefit-sharing mechanism, conducted between November 2021 and June 2022. The NTC spearheaded the process of developing the outline Village Sustainable Plan (VSP) templates and guides by which communities were able to develop their VSPs for participating in the benefit-sharing programme. The NTC was also fully involved, in collaboration with the Ministry of Amerindian Affairs and LCDS Secretariat, in determining the key documents that needed to be submitted by the communities along with their plans, response letters to villages, development of Terms of reference for Finance and Planning Committee, and Finance Officer job descriptions. For the previous and current ART-TREES commitment periods, the village leadership have been invited to consult with members of the community to agree whether to participate in the benefit-sharing mechanism, and if so, to produce an Outline VSP by the end of 2022, and finalize and submit the completed Village Sustainability Plan by the end of June 2023, following the local decision-making processes of each village. In this process, the NTC supported and trained several villagers in the preparation of their outline VSPs across Regions 1, 2, 3, 4, 7, and 9. As of August 2023, 241 villages have produced their village plans, out of a total of 242 IPLCs in the country. In 2023, a total of $22.5 million USD was disbursed to designated Village Bank Accounts from Guyana's first commercial sale of carbon credits to Hess Corporation. Further work is ongoing for the continuity of the programme.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• 242 IPLCs with Village Sustainability Plans. • 15% of carbon market benefits invested in community led low-carbon sustainable development initiatives.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators				
Indicator	**unit**	**Baseline**	**Target**	**Progress**
Number of IPLCs with VSPs.	#	0	242	241
Proportion of revenues from Guyana´s carbon market invested in VSPs.	%	0	15%	15%
Cumulative disbursements to VSPs from Guyana´s carbon market.	$ USD	0	To be determined	22.5 million

<table>
<tr><th>Name of Action</th><th colspan="6">Strengthened Monitoring, Enforcement and Uptake of Environmental Regulations in Guyana's Gold Mining Sector</th></tr>
<tr><th>Type of Action</th><th>Status</th><th>Duration</th><th>Implementing Entity</th><th>GHG Coverage</th><th>Geographic Scope</th><th>Sectoral Scope</th></tr>
<tr><td>Project</td><td>Completed</td><td>2014-2017</td><td>Environmental Protection Agency (EPA) / Guyana Geology and Mines Commission (GGMC)</td><td>Not Estimated</td><td>National</td><td>Economic Development</td></tr>
</table>

Description and Objective

The main driver of deforestation and forest degradation in Guyana is mining, which leads to increased carbon emissions, as the impacts of uncontrolled mining on carbon stocks are believed to be comparable to the degradation of high forest to scrub/savannah, that is, approximately 200 tonnes of carbon per hectare. The objective of the project to reduce ecosystem loss and ecosystem functionality in priority small- and medium-scale gold mining operations through a two-prong approach tackling the sector´s main barriers encompassing noncompliance with mining-related environmental regulations and illegal mining; insufficient personnel and institutional capacity to enforce the environmental regulatory framework; and insufficient capacity to implement environmental codes of practice among miners. The first approach was to strengthen monitoring and enforcement of mining-related environmental regulations and codes of practices, by increasing capacity of EPA and GGMC staff and fortifying inter-institutional coordination mechanisms for enhanced monitoring and enforcement of priority areas, including the improvement of regulations and codes of practice and satellite tracking mechanisms. The second approach was to build capacities and promote uptake of conservation practices by miners.

Quantitative Goals

- Strengthened enabling environment for monitoring and enforcement of mining-related environmental regulations and codes of practice.
- Enhanced capacities for uptake of mining practices that promote conservation.

Steps Taken or Envisaged to Achieve Action

A joint compliance unit for small- and medium-scale mining and a functioning Natural Resources Advisory Committee (NRAC) was established, which has proven useful for its influence on a cabinet decision and initiating bridges for joint work on compliance with non-state actors. Key tools were developed including simplified codes of practice for GGMC staff and practitioners and environmental monitoring check lists for both EPA and GGMC. The project revised and simplified the mining codes of practice; produced learning materials; created Standard Operating Procedures (SOPs), and checklists for joint monitoring; implemented a legal review with EPA; undertook a mining school institutional review, produced a proposed curriculum and developed and disseminated simplified learning materials and public awareness tools. Furthermore, close work was conducted with the Guyana MRVS to access satellite imagery for GGMC and EPA officers to support tracking of environmental infractions or illegal mining.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Increased monitoring and enforcement capacities leading coupled with enhanced awareness to decreased number of environmental infractions and/or illegal mining contributing to lower deforestation and lad degradation rates among small and medium gold mining operations.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Level of capacity of GGMC and EPA to enforce mining-related environmental regulations and codes of practice for small and medium scale gold mining.	UNDP capacity score	0	1	2

Area monitored for compliance with EPA mining-related environmental regulations.	ha	0	50% over baseline	629,304
Area monitored for compliance with GGMC mining-related environmental regulations.	ha	0	50% over baseline	755,693
Proportion of total high priority areas monitored using satellite tracking.	%	0	75	75
Number of courses or seminars implemented through Mining School that integrate environmental considerations.	#	1	5	5
Proportion of miners observed by field officers who are complying with the environmental regulations and codes of practice.	%	0	30	36
Proportion of small and medium scale gold miners participating in project seminars who report an increased awareness of mining related environmental regulations.	%	0	75	100

Name of Action	Caribbean Renewable Energy Development Programme					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2004-2015	Caribbean Community (CARICOM)	CO_2	Regional	Power Generation

Description and Objective

This project aims at removing barriers to renewable energy utilisation in the Caribbean. Through specific actions to overcome policy, finance, capacity, and awareness barriers it is estimated that the contribution of renewable energy sources to the region's energy balance will be significantly increased. At the time, renewable energy provided less than 2% of the region's commercial electricity. It is estimated that due to the planned barrier removal activities the share of renewable energy could reach 5% by 2015. This would imply annual reductions of CO_2 emissions by some 680,000 tons. The project activities concentrate on: (1) strengthening of regional energy sector institutions; (2) government advisory with regards to Renewable Energy (RE) and Energy Efficiency (EE) policies; (3) preparation of RE and EE projects for investment decisions; (4) capacity building activities and public awareness campaigns. Participating countries: Antigua and Barbuda, the Bahamas, Barbados, Belize, British Virgin Islands, Cuba, Dominica, Grenada, Guyana, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, Trinidad and Tobago and Turks and Caicos. Apart from reducing GHG emissions, the project has the following development objectives:

- Establish the foundation for a sustainable renewable energy industry; and
- Create a framework under which regional and national renewable energy projects are mutually supportive.

Quantitative Goals

- Mitigate GHG emissions from the use of fossil fuels in the Caribbean by removing barriers to the utilisation of renewable energy.

Steps Taken or Envisaged to Achieve Action

To achieve the project objectives, several project activities are designed and divided into four groups as follows:

- Supporting the implementation of policies, legislation and regulations that create an enabling environment for renewable energy development;
- Demonstrating innovative financing mechanisms for renewable energy products and projects and building the capacity of financial institutions and renewable energy firms in their application;
- Building the capacity of selected players in the renewable energy field; and
- Putting in place an improved regional renewable energy information network.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
• Remove the barriers to increased use of renewable energy in the Caribbean thus reducing the Region's dependence on fossil fuels.	Not Applicable	Not Applicable

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
Percentage of renewable energy in commercial energy use.	%	NA	NA	NA
National targets for renewable energy defined RE integrated into utility planning.	#	NA	NA	NA
Establishment of power purchase agreements for RE projects.	#	0	NA	NA
Investment resources leveraged directly by the project.	USD	0	NA	NA
Total amount invested in RE projects in the region.	USD	NA	NA	NA
Number of participants in different capacity building initiatives related to RE.	#	0	NA	NA

Supply of RE related training in the region.	#	0	NA	NA
Number of users accessing the information system.	#	0	NA	NA
Availability of updated RE information in the region.	#	0	NA	NA

Annex IV Support received and anticipated by sector

1. Mitigation

1.1. Energy

Project	Energy Matrix Diversification and Institutional Strengthening of the Department of Energy (EMISDE) – Components 1&2										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
Component 1											
2019-2024	Ongoing	Guyana Energy Agency (GEA)	Inter-American Development Bank (IDB)	Concessional loan	8.449.578	547.262	yes	yes	yes	National	Power Generation
Component 2											
2019-2026	Ongoing	Guyana Power and Light Inc. (GPL)	Inter-American Development Bank (IDB)	Concessional loan	2.700.422	9.462.738	yes	yes	yes	Region 2. 3	Power Generation

Project	Expanding Bioenergy Opportunities in Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2008-2010	Completed	Government of Guyana (GOG)	Japan	Grant	675.000		yes	yes	yes	National	Power Generation
			Inter-American Development Bank (IDB)	Grant	250.000		yes	yes	yes		

Project	Enhancing Guyana's Access to GCF to Transition to Renewable Energy										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2019-2020	Completed	Global Green Growth Institute (GGGI)	Green Climate Fund (GCF)	Grant	300.000		yes	yes		National	Power Generation

Project	Guyana Utility Scale Solar Photovoltaic Program (GUYSOL)										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2022-2027	Ongoing	Guyana Power and Light Inc. (GPL)	GRIF (NORAD)	Results-based payment (Grant)		83.300.000	yes	yes	yes	Region 2. 5. 6. 10	Power Generation
			GRIF (NORAD)	Results-based payment (Grant)		1.500.000	yes				

Project	Pilot Rice Husk Biogas Power Plant										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2018-2021	Completed	Guyana Energy Agency (GEA)	Government of India	Grant	62.126		yes		yes	Region 5. 6	Power Generation

Project	Leguan 0.6MWp Solar PV Farm										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2023-2025	Planned	Guyana Energy Agency (GEA)	Inter-American Development Bank (IDB)	Concessional loan	1.200.000	585.452	yes		yes	Region 3	Power Generation

Project	Amaila Falls Hydroelectric Project Preparation Studies										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2010-2021	Ongoing	Government of Guyana (GOG)	GRIF (NORAD)	Grant	1.210.000		yes		yes	Region 3. 4. 5. 6. 10	Power Generation
Project	Wakenaam 0.75MWp Solar Farm										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2019-ongoing	Ongoing	Guyana Power and Light Inc. (GPL)	United Arab Emirates Caribbean Energy Development Fund (UAE-CREC)	Grant	2.300.000		yes		yes	Region 3	Power Generation
Project	Small Hydropower Project for the Cooperative Republic of Guyana										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2022-ongoing	Ongoing	Guyana Energy Agency (GEA)	Islamic Development Bank (IsDB)	Concessional loan	14.630.000		yes		yes	Regional Regions 3. 4. 5. 6. 10	Power Generation
Project	Promotion of Private Solar PV Rooftop Systems										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2020-2022	Completed	Guyana Power and Light Inc. (GPL) and private actors	Private Sector	Equity	2.100.000		yes			National	Power Generation
Project	Gas to Energy Project										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2023-ongoing	Ongoing	Ministry of Public Works	Export and Import Bank US (EXIM)	Loan		646.000.000	yes		yes	National	Power Generation
			Private Sector (ExxonMobil)	Equity		955.500.000	yes		yes		
Project	Caribbean Renewable Energy Development Programme										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2004-2015	Completed	Caribbean Community (CARICOM) and UNDP	Global Environmental Facility (GEF)	Grant	524.366		yes	yes	yes	Regional	Power Generation
Project	Amaila Falls 165 MW Hydropower Project										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2029-	Planned	Amaila Falls Hydro	Public-private Partnership (to be determined)	Equity		700.000.000	yes		yes	Regional	Power Generation
Project	EcoMicro Guyana										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**

2018-2022	Completed	Institute for Private Enterprise Development (IPED)	Government of Canada	Grant	350.000		yes	yes	yes	National	Energy Efficiency
Project	Transitioning to National Energy Security: Bartica as a Model Green Town										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-ongoing	Ongoing	Office of Climate Change (OCC)	Government of Italy	Grant	1.275.000	3.045.000	yes	yes	yes	Region 7	Energy Efficiency
Project	Promotion of Energy Efficiency Measures in the Manufacturing and Service Sectors										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2011-2013	Completed	Guyana Manufacturing & Services Association (GMSA)	Inter-American Development Bank (IDB)	Grant	150.000		yes	yes	yes	National	Energy Efficiency
Project	Project for the Introduction of Renewable Energy and Improvement of Power System in Guyana										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2018-2022	Completed	Guyana Energy Agency (GEA)	Japan International Cooperation Agency (JICA)	Grant	1.200.000		yes		yes	Regional (Region 4)	Energy Efficiency
Project	Sustainable Business Models for Rural Electrification and Energy Access in Guyana										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2015-2019	Completed	Hinterland Electrification Company Inc. (HECI)	Inter-American Development Bank (IDB)	Grant	1.333.240		yes	yes	yes	Region 1. 2. 7. 8. 9	Rural Electrification
Project	Sustainable Energy Program for Guyana										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2013-2023	Ongoing	Guyana Energy Agency (GEA)	Global Environment Facility (GEF)	Grant	2.200.000		yes	yes	yes	Region 8	Rural Electrification
		The Hinterland Electrification Company Inc. (HECI)	Global Environment Facility (GEF)	Grant	2.780.000		yes	yes	yes		
Project	Solar Home Systems										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2021-ongoing	Ongoing	Guyana Energy Agency (GEA)	Government of India	Concessional loan	7.290.000	2.710.000	yes	yes	yes	National	Rural Electrification
Project	Power Utility Upgrade Program										
			Funding				**Type of Funding**				
Duration	**Status**	**Implementing Entity**	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2014-2021	Completed	Guyana Power and Light Inc. (GPL)	Inter-American Development Bank (IDB)	Concessional loan	36.568.750		yes	yes	yes	Region. 3. 4. 5. 6. 9	Training and Development

Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
			European Union Caribbean Investment Facility (CIF)	Investment grant	21.965.250		yes	yes	yes		
Project	Sustainable Operation of the Electricity Sector and Improved Quality of Service										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2011-2017	Completed	Guyana Power and Light Inc. (GPL)	Inter-American Development Bank (IDB)	Concessional loan	5.000.000		yes	yes	yes	National	Training and Development
Project	Power Sector Support Program										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2007-2012	Completed	Guyana Power and Light Inc. (GPL)	Inter-American Development Bank (IDB)	Concessional loan	12.000.000		yes	yes	yes	National	Training and Development
Project	Strengthening Capacity in Energy Planning and Supervision										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2016	Completed	Guyana Power and Light (GPL)	Inter-American Development Bank (IDB)	Grant	740.000		yes	yes		National	Training and Development

1.2. Forestry

Project	Institutional Strengthening for the Implementation of the LCDS 2030 under REDD+ Partnerships									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2011-2017	Completed	Guyana Forestry Commission	GRIF (NORAD)	Grant	7.467.412		yes	yes		National	Forestry

Project	Guyana-EU Forest Law Enforcement. Governance and Trade Voluntary Partnership Agreement										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2025	Ongoing	Guyana Forestry Commission	GRIF (NORAD)	Grant	1.700.000		yes	yes		National	Forestry

Project	Guyana REDD+ Monitoring Reporting & Verification System (MRVS)										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2010-2025	Ongoing	Guyana Forestry Commission	GRIF (NORAD)	Grant	19.387.073		yes	yes		National	Forestry
			GRIF (NORAD)	Results-based Payments (Grant)	190.000.000	60.000.000	yes				
			Hess Corporation	ART-TREE/Carbon Credits	127.500.000	510.000.000	yes				

Project	Forest Carbon Partnership Facility Project in Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2014-2020	Completed	Guyana Forestry Commission	World Bank	Grant	3.800.000		yes	yes		National	Forestry

2. Adaptation

2.1. Agriculture and food security

Project	Entity Support and Strategic Frameworks support for Guyana through FAO										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-2019	Completed	FAO and Office of Climate Change (OCC)	Green Climate Fund (GCF)	Grant	697.183		yes	yes		National	Agriculture and food security

Project	Sustainable Agricultural Development Program										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-2019	Completed	FAO and Office of Climate Change (OCC)	Inter-American Development Bank (IDB)	Concessional loan	8.281.131	6.718.869	yes	yes	yes	Regional	Agriculture and food security

Project	Hinterland Environmentally Sustainable Agricultural Development Project										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

Project	Entity Support and Strategic Frameworks support for Guyana through FAO										
2016-2024	Ongoing	Ministry of Agriculture	International Fund for Agricultural Development (IFAD)	Concessional loan	5.133.040	2.826.960	yes	yes	yes	Regional Regional	Agriculture and food security
			International Fund for Agricultural Development (IFAD)	Grant	275.960	224.040	yes	yes	yes		
Project	Sustainable Livelihoods and Community Economic growth										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2020	Completed	Ministry of Agriculture	Japanese International Cooperation Agency (JICA)	Grant	1.161.000		yes	yes		National	Agriculture and food security
Project	RE-ACT (Resilient Action Guyana): Increasing climate resilience of vulnerable ecosystems and rural communities in Guyana's coastal areas										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2020-	Planned	Ministry of Agriculture	Green Climate Fund (GCF)	Grant		27.500.000	yes	yes	yes	Regional	Agriculture and food security
Project	Caribbean Small Island Developing States (SIDS) Multicounty Soil Management Initiative for Integrated Landscape Restoration and Climate-Resilient Food Systems										

Project	Entity Support and Strategic Frameworks support for Guyana through FAO									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2021-	Ongoing	Guyana Lands and Surveys Commission (GLSC)	Green Climate Fund (GCF)	Grant		900.457	yes	yes	yes	Regional	Agriculture and food security

2.2. Water resources

Project	CC - Cunha Canal Rehabilitation Project									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2017	Completed	Ministry of Agriculture	GRIF (NORAD)	Results-based payment	2.999.862		yes		yes	Regional	Water resources

Project	Guyana Coastal Adaptation and Resilience (CARe) Project										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2024-	Planned	Ministry of Agriculture	GRIF (NORAD)	Results-based payment		45.000.000	yes	yes	yes	Regional	Water resources

Project	Conservancy Adaptation Project										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2007-2014	Completed	Ministry of Agriculture	Global Environment Facility (GEF)	Grant	3.800.000		yes	yes	yes	Regional	Water resources
Project	EWDC Drainage Pump Installation										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2019-2021	Completed	National Drainage and Irrigation Authority (NDIA)	EXIM Bank of India	Concessional loan	4.000.000		yes		yes	Regional	Water resources
Project	GY Flood Risk Management										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2014-2024	Completed	Agriculture Sector Development Unit (Ministry of Agriculture)	World Bank	Concessional loan	37.890.000		yes	yes	yes	Regional	Water resources
2019-2024	Ongoing	Agriculture Sector Development Unit (Ministry of Agriculture)	Government of Canada	Grant	163.817	193.752	yes	yes	yes	National	
Project	Rehabilitation of the EDWC Dam										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2012-2016	Completed	Ministry of Agriculture (MoA) / National Drainage and Irrigation Authority (NDIA)	Japanese International Cooperation Agency (JICA)	Grant	3.800.000		yes	yes	yes	Regional	Water resources

Project	Resilient. Green and Inclusive Flood Investment Baseline for Georgetown										
			Funding				Type of Funding				
Duration	Status	Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2020-2023	Ongoing	Ministry of Agriculture (MoA) / National Drainage and Irrigation Authority (NDIA)	Caribbean Regional Resilience Building Facility	Grant	503.409		yes	yes		Regional	Water resources

Project	Water Resource Management in Hinterland Communities to Protect Aquifer Recharge Zones in the Upper Takatu Region										
			Funding				Type of Funding				
Duration	Status	Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2020-2024	Ongoing	Hydrometeorological Service (Hydromet)	Global Environment Facility (GEF)	Grant		72.000	yes	yes		Regional	Water resources

2.3. Coastal zones

Project	Sea and River Defence Resilience Project										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2014-2020	Completed	Ministry of Public Works	Caribbean Development Bank (CBD)	Concessional loan	12.500.000	12.500.000	yes	yes	yes	Regional	Coastal zones
Project	Conservation of Coastal Mangrove Forest Resource to Support Brackish Water Aquaculture for Enhancement of Community Socio-economic Benefit and Food Security										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2021-2024	Ongoing	Ministry of Agriculture (MoA)	Global Environment Facility (GEF)	Grant	31.234		yes	yes		Regional	Coastal zones
Project	Community led Mangrove Restoration: Towards Sustainable Management of Guyana´s Mangrove Forest										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
2014-2021	Completed	Guyanese Women in Development	Global Environment Facility (GEF)	Grant	43.541		yes	yes		Regional	Coastal zones
Project	Securing the Future of the Barima Mora Passage Mangrove Ecosystems and its Peoples										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2022-2027	Ongoing	Guyana Marine Conservation Society (GMCS)	Inter-American Development Bank (IDB)	Grant	466.000	934.000	yes	yes		Regional	Coastal zones
Project	Unlocking the Potential of Guyana's Mangrove Forests to Build Resilience to Climate Change										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
TBD	Planned	Guyana Forestry Commission (GFC)	Green Climate Fund (GCF)	Grant		35.000.000	yes	yes	yes	Regional	Coastal zones
Project	Guyana Mangrove Restoration Project										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2010-2014	Completed	Guyana's National Agricultural Research and Extension Institute (NAREI)	Global Climate Change Alliance Plus (GGCA+)	Grant	5.537.113		yes	yes		Regional	Coastal zones

2.4. Health

Project	SMART Health Care Facilities Caribbean Project										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2015-2022	Completed	Ministry of Health	UK - Foreign. Commonwealth Development Office (FCDO)	Grant	4.667.974		yes		yes	National	Health

2.5. Ecosystems and biodiversity

Project	Sustainable Gold Mining and Mercury Reduction to Enhance Biodiversity and Maintain Ecosystem Functionality									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2014-2017	Completed	Ministry of Natural Resources and the Environment and UNDP	Global Environment Facility (GEF)	Grant	200.000		yes	yes		National	Ecosystems and biodiversity
2014-2018	Completed	Environmental Protection Agency and UNDP	Global Environment Facility (GEF)	Grant	803.653		yes	yes	yes	National	
			WWF Guianas	Grant	150.000		yes	yes	yes		
2018-2023	Completed	Conservation International Guyana and Guyana Minamata Working Group	Conservation International Guyana	Grant	2.254.829		yes	yes	yes	National	
			Global Environment Facility (GEF)	Grant	2.652.294		yes	yes	yes		
			WWF Guianas	Grant	522.383		yes	yes	yes		
2019-	Ongoing	Basel Convention Regional Centre	Global Environment Facility (GEF)	Grant	500.000		yes	yes	yes	National	

		for Training and Technology Transfer for the Caribbean (BCRC-Caribbean) and UNEP									
2020-	Ongoing	Environmental Protection Agency	Global Environment Facility (GEF)	Grant	3.028.901	1.514.451	yes	yes	yes	National	

Project	Developing a Sustainable Tourism Circuit in South Rupununi										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2020-2025	Ongoing	Guyana Tourism Authority (GTA)	Inter-American Development Bank (IDB)	Grant	250.965		yes	yes		Regional	Ecosystems and biodiversity

Project	Leveraging Natural Capital in Guyana's Rupununi										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2018	Completed	Department of Environment and Climate Change (DECC)	Inter-American Development Bank (IDB)	Grant	1.102.868		yes	yes		Regional	Ecosystems and biodiversity

Project	Measurement of Climate Change Impacts and Ecosystem Services in Iwokrama

Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2009-2013	Completed	Iwokrama International Centre (IIC)	Inter-American Development Bank (IDB)	Grant	229.500		yes			Regional	Ecosystems and biodiversity

2.6. Disaster risk management

Project	Preparation of the National Integrated Disaster Risk Management Plan (NIDRMP)										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2009-2013	Completed	Civil Defence Commission (CDC)	Inter-American Development Bank (IDB)	Grant	1.000.000		yes	yes		National	Disaster Risk Management
Project	Strengthening Disaster Management Capacity of Women in the Cooperative Republic of Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

Project	Preparation of the National Integrated Disaster Risk Management Plan (NIDRMP)										
2018-2023	Completed	Hydrometeorological Service (Hydromet)	Japanese International Cooperation Agency (JICA)	Grant	2.587.575		yes	yes		Regional	Disaster Risk Management

2.7. Land use

Project	LDC/SIDS Portfolio Project: Capacity Development and Mainstreaming for Sustainable Land Management in Guyana										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2004-2012	Completed	Guyana Lands and Surveys Commission	Global Environment Facility (GEF)	Grant	520.700		yes	yes		National	Land-use

Project	SLDM - Sustainable Land Development and Management										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-	Ongoing	Guyana Lands and Surveys Commision	GRIF (NORAD)	Results-based payment	10.535.414	4.556.863	yes	yes	yes	National	Land-use

2.8. Settlements and services

Project	Climate-Resilient Adequate Housing and Urban Accessibility in Georgetown									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-2022	Completed	Ministry of Public Works	Inter-American Development Bank (IDB)	Grant	500.000		yes		yes	Regional	Settlements and services

2.9. Infrastructure

Project	Support for Climate Resilient Road Infrastructure										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2023-2026	Ongoing	Ministry of Public Works	Inter-American Development Bank (IDB)	Grant	110.000	360.000	yes	yes	yes	National	Infrastructure

Project	Program to Support Climate Resilient Road Infrastructure Development									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2022-2026	Ongoing	Ministry of Public Works	Inter-American Development Bank (IDB)	Concessional loan		100.000.000	yes	yes	yes	Regional	Infrastructure

Project	Paris Agreement Alignment Studies for the Guyana-Brazil Integration Corridor for Sustainable Development										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2023-2026	Ongoing	Ministry of Public Works	Inter-American Development Bank (IDB)	Grant		500.000	yes			National	Infrastructure

Project	Integrated Transport Corridors Project										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2025-	Planned	Ministry of Public Works	World Bank	Concessional loan		173.000.000	yes		yes	Regional	Infrastructure

2.10. Cross-sectoral

Project	Support the Alignment of the National Action Plan (NAP) for Land Degradation with the UNCCD's 10- Year Strategy in Guyana									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2013-2017	Completed	Guyana Lands and Surveys Commission	Global Environment Facility (GEF)	Grant	150.000		yes	yes	yes	National	Cross-sectoral

Project	Strengthening Technical Capacities to Mainstream and Monitor Rio Convention Implementation through Policy Coordination										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2016-2020	Completed	Ministry of Natural Resources and Environment (MNRE)	Global Environment Facility (GEF)	Grant	1.050.000		yes	yes		National	Cross-sectoral

Project	CRSAP - Climate Resilience Strategy and Action Plan - CI										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2014-2015	Completed	Department of Environment and Climate Change (DECC)	GRIF (NORAD)	Results-based payment	343.297		yes	yes		National	Cross-sectoral	

3. Cross-cutting

3.1. General cross-cutting

Project	Amerindian Development Fund									
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2016	Completed	Ministry of Amerindian Affairs (MoAA)	GRIF - NORAD	Grant	8.143.042		yes	yes		National	General cross-cutting

Project	Support for Micro and Small Enterprise and Vulnerable Groups' Low-Carbon Livelihoods										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2012-2018	Completed	Ministry of Business (MoB)	GRIF - NORAD	Grant	5.127.476		yes	yes		National	General cross-cutting

Project	Amerindian Land Titling										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2013-ongoing	Ongoing	Ministry of Amerindian Affairs (MoAA)	GRIF - NORAD	Grant	4.340.746	6.415.244	yes	yes	yes	National	General cross-cutting
Project	Information and Communications Technology (ICT) Access and E-services for Hinterland. Remote. and Poor Communities										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-ongoing	Ongoing	Office of the Prime Minister (OPM)	GRIF - NORAD	Grant	17.030.752	3.755.320	yes	yes	yes	National	General cross-cutting
Project	Village Sustainability Plans										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2021-2025	Planned	Ministry of Amerindian Affairs (MoAA) / National Toshaos Council (NTC)	GRIF - NORAD	Grant		3.400.000	yes	yes		National	General cross-cutting
	Ongoing	Ministry of Amerindian Affairs (MoAA)	Hess Corporation	ART-TREE/Carbon Credits	22.500.000	90.000.000	yes				
Project	Guyana-Norway Partnership Operational Support – GGGI										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2021-2024	Ongoing	Green Global Growth Institute (GGGI)	GRIF - NORAD	Grant	935.138	233.785	yes	yes		National	General cross-cutting
Project	GRIF operational Support – Trustee										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2011-ongoing	Ongoing	World Bank	GRIF - NORAD	Grant	1.340.000		yes			National	General cross-cutting
Project	GSDS - Green State Development Strategy: Vision 2040										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2017-2019	Completed	Government of Guyana (GOG)	GRIF (NORAD)	Grant	1.500.000		yes	yes		National	General cross-cutting
Project	Securing a Living Amazon through Landscape Connectivity in Southern Guyana										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2022-2027	Ongoing	Environmental Protection Agency	Global Environment Facility (GEF)	Grant		5.152.753	yes	yes	yes	Regional	General cross-cutting
			WWF Guianas	Grant		720.886	yes	yes	yes	Regional	
			Protected Areas Commission	Grant		710.850	yes	yes	yes	Regional	

3.2. Readiness and reporting

Project	Enabling Guyana to Prepare its First National Communication in Response to its Commitments to UNFCCC										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
1997	Completed	Government and Guyana with support of the United Nations Development Programme (UNDP)	Global Environment Facility (GEF)	Grant	196.700		yes	yes		National	Readiness and reporting

Project	Development of Guyana's National Climate Finance Strategy. MRV Framework and Project Pipeline to Support NDC Implementation										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2020-2023	Completed	Department of Environment and Climate Change / Green Global Growth Institute (GGGI)	Green Climate Fund (GCF)	Grant	692.950		yes	yes		National	Readiness and reporting
Project	National Designated Authority (NDA) Strengthening and Country Programming support for Guyana through CCCCC										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2015-2016	Completed	Caribbean Community Climate Change Centre (CCCCC)	Green Climate Fund (GCF)	Grant	300.000		yes	yes		National	Readiness and reporting
Project	Technical Support towards the Preparation of Guyana's Second Nationally Determined Contribution to the Paris Agreement										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2020-2021	Completed	Department of Environment and Climate Change (DECC)	United Nations Development program (UNDP)	Grant	100.000		yes			National	Readiness and reporting
Project	Technology Needs Assessment (TNA)										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		

2015-2018	Completed	Department of Environment and Climate Change (DECC)	Global Environment Facility (GEF)	Grant	134.800		yes	yes	yes	National	Readiness and reporting
Project	Preparation of the First Biennial Update Report to the United Nations Framework Convention on Climate Change (BUR)										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2016-2018	Completed	Department of Environment and Climate Change (DECC)	Global Environment Facility (GEF)	Grant	352.000		yes			National	Readiness and reporting
Project	Preparation of the Third National Communication under the UN Framework Convention on Climate Change (TNC)										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Mechanism	Received	Anticipated	Financial Support	Capacity-building	Technology Transfer		
2013-2021	Completed	Department of Environment and Climate Change (DECC)	Global Environment Facility (GEF)	Grant	648.000		yes			National	Readiness and reporting

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