GUYANA

First Biennial Transparency Report

to the United Nations Framework Convention on Climate Change

February 2024

Publication Title

Biennial Transparency Report of Guyana to the United National Framework Convention on Climate Change.

Publication information

This publication has been prepared by the Government of Guyana.

Date of publication

February 2024

Citation

Government of Guyana, (2024). Biennial Transparency Report of Guyana to the United National Framework Convention on Climate Change. Government of Guyana, Georgetown, Guyana.

Foreword

The Government of Guyana is pleased to present Guyana's First Biennial Transparency Report to the United Nations Framework Convention on Climate Change, including the Technical Annex on REDD+, following the reporting provisions contained within Decision 18/CMA.1: *"Decides that Parties shall submit their first biennial transparency report and national inventory report, if submitted as a stand-alone report, in accordance with the modalities, procedures and guidelines, at the latest by 31 December 2024*; *Also decides that the least developed country Parties and small island developing States may submit the information referred to in Article 13, paragraphs 7, 8, 9 and 10, of the Paris Agreement at their discretion*;"

Gratitude is extended to the individuals and organisations whose substantial contributions played a pivotal role in the successful completion of Guyana's First Biennial Transparency Report (BTR). Special recognition goes to the Global Green Growth Institute (GGGI) and Gauss International Consulting for their support, especially in the production of the Biennial Update Report (BUR) which formed the foundation for this BTR.

Through the submission of this First Biennial Transparency Report and Technical Annex on REDD+ to the United Nations Framework Convention on Climate Change, Guyana provides an update of the national greenhouse gas (GHG) inventory, an articulation of progress on NDC commitments; information about climate adaptation challenges and efforts to address them; and information on mitigation actions, needs and support received. It also presents details on results achieved through the reduction of emissions from deforestation, forest degradation, and enhancements of forest carbon stock. This transparently highlights the continuous endeavours of the country in implementing the Convention.

Acronyms and Abbreviations

ACTO	Amazonian Cooperation Treaty
AD	Activity Data
ADF	Amerindian Development Fund
AFOLU	Agriculture, Forestry and Other Land Use
ALT	Amerindian Land Titling
ANAP	Aligned National Action Plan
ART-TREES	Architecture for REDD+ Transactions Environmental Excellence Standard
AR5	Fifth Assessment Report
BAU	Business-As-Usual
BEMS	Building Energy Management System
BOD	Biochemical Oxygen Demand
BoS	Bureau of Statistics
BUR	Biennial Update Report
C	Confidential
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CDM	Comprehensive Disaster Management
CDOs	Community Development Officers
CDPs	Community Development Plans
CF	Carbon Fraction
CIF	Caribbean Investment Facility
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMRV	Community Monitoring Reporting and Verification
CMTs	Community Management Teams
COP	Conference of Parties
CRSAP	Climate Resilience Strategy and Action Plan
CRT	Common Reporting Table
DAI-SBG	Development Alternatives Incorporated Sustainable Business Group
DBIS	Demerara-Berbice Interconnected System
DC	Direct Current
DE	Department of Energy
DECC	Department of Environment and Climate Change
Dm	Dry matter
DOC	Degradable Organic Carbon
DOCf	Fraction of DOC Dissimilated
DoE	Department of Environment
DRR	Disaster Risk Reduction
DSA	Data Sharing Agreements
ECOSEO	Ecosystemic Services Observatory of the Guiana
EDWC	East Demerara Water Conservancy
EF	Emission Factor

EIA	Environmental Impact Assessment
EIMMS	Environmental Information Management and Monitoring System
EMISDE	Energy Matrix Diversification and Institutional Strengthening of the Department of Energy
ENSO	El Niño-Southern Oscillation
EPA	Environmental Protection Agency
ERR	Emission Reductions and Removals
ESB	Environmental Baseline Survey
ESMF	Environmental and Social Management Framework
ETF	Enhanced Transparency Framework
EU	European Union
EV	Electric Vehicle
EXIM	Export and Import Bank US
FAO	Food and Agriculture Organization
FCF	Fossil Carbon Fraction
FCPF	Forest Carbon Partnership Facility
F-gases	Fluorinated Gases
FLEGT	Forest Law Enforcement, Governance and Trade
FOD	First Order Decay
FOLU	Forestry and Land Use
FPIC	Free Prior and Informed Consent
FPSO	Floating Production Storage and Offloading
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
FSC	Forest Stewardship Council
FSO	Forest Sector Operator
GCCI	Georgetown Chamber of Commerce and Industry
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEA	Guyana Energy Agency
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GFOI	Global Forest Observations Initiative
GGGI	Global Green Growth Institute
GGMC	Guyana Geology and Mines Commission
GHG	Greenhouse Gas
GLDA	Guyana Livestock and Development Authority
GMSA	Guyana Manufacturing & Services Association
GOG	Government of Guyana
GPL	Guyana Power and Light Inc.
GRA	Guyana Revenue Authority
GRDB	Guyana Rice Development Board
GRIF	Guyana REDD+ Investment Fund

GSF	Guyana Shield Facility
GTA	Guyana Tourism Authority
GTI	Guyana Technical Institute
GTLAS	Guyana Timber Legality System
GUYSOL	Guyana Utility Scale Solar Photovoltaic Program
GuySuCo	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
GWP	Global Warming Potential
HDI	Human Development Index
HECI	Hinterland Electrification Company Incorporated
HFLD	High Forest Low Deforestation
HFO	Heavy Fuel Oil
HPRCs	Hinterland, Poor, and Remote Communities
ICT	Information and Communications Technology
IDB	Inter-American Development Bank
IE	Included Elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPED	Institute for Private Enterprise Development
IPLC	Indigenous Peoples and Local Community
IPP	Independent Power Producer
IPPU	Industrial Processes and Product Use
IsDB	Islamic Development Bank
ITCZ	Inter-Tropical Convergence Zone
JICA	Japan International Cooperation Agency
KfW	German Development Bank
KMPA	Kanuku Mountains Protected Area
LAS	Legality Assurance System
LCDS	Low Carbon Development Strategy
LCOE	Levelized Cost of Electricity
LDC	Least Developed Country
LED	Light-Emitting Diode
LIDCO	Livestock Development Company
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land Use Change, and Forestry
MCF	Methane Correction Factor
MMA	Mahaica Mahaicony Abary
MNR	Ministry of Natural Resources
MoA	Ministry of Agriculture
MoAA	Ministry of Amerindian Affairs
MoB	Ministry of Business
MoPW	Ministry of Public Works

MoU	Memorandum of Understanding
MPGs	Modalities, Procedures, and Guidelines
MPs	Members of Parliament
MRV	Monitoring, Reporting, and Verification
MRVS	Guyana REDD+ Monitoring Reporting and Verification System
MSMs	Micro and Small Enterprises
MSMEs	Micro, Small and Medium Enterprises
MSW	Municipal Solid Waste
NA	Not Applicable
NAP	National Adaptation Plan
NAREI	National Agricultural Research and Extension Institute
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategy and Action Plan
NC	National Communication
NCSA	National capacity self-assessment
NCV	Net Calorific Value
NDC	Nationally Determined Contribution
NDMA	National Data Management Authority
NDA	National Designated Authority
NDC	National Determined Contribution
NDIA	National Drainage and Irrigation Authority
NE	Not Estimated
NFP	National Focal Point
NGL	Natural Gas Liquids
NGMC	New Guyana Marketing Corporation
NGO	Non-Governmental Organisation
NIR	National Inventory Report
NLUP	National Land Use Plan
NMVOCs	Non-Methane Volatile Organic Compounds
NO	Not Occurring
NORAD	Norwegian Agency for Development Corporation
NPC	National Parks Commission
NPAS	National Protected Areas System
NRF	Natural Resource Fund
NRAC	Natural Resources Advisory Committee
NRW	Non-Revenue Water
NTC	National Toshaos Council
OCC	Office of Climate Change
OLADE	Latin-American Energy Organization
OPM	Office of the Prime Minister
OPS	Office of the President
O&G	Oil and Gas

PAC	Protected Areas Commissions
PAM	Policy and Measure
PATF	Protected Areas Trust Fund
PCG	Petroleum Commission of Guyana
PMO	Project Management Office
PPP	Public-Private Partnership
PSA	Public Service Announcement
PSSP	Power Sector Support Programme
PUC	Power Utility Commission
PV	Photovoltaic
QA	Quality Assurance
QC	Quality Control
RDC	Regional Democratic Council
REDD+	Reducing Emissions from Deforestation and Degradation
R-PIN	Readiness Plan Idea Note
R-PP	Readiness Preparation Proposal
RRU	REDD+ Results Unit
SBB	Small Business Bureau
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SESA	Social Environmental and Strategic Assessment
SIDS	Small Island Developing State
SNC	Second National Communication
SOP	Standard Operating Procedure
SWDS	Solid Waste Disposal Site(s)
TERI	The Energy and Resources Institute
TNA	Technology Needs Assessment
UAE-CREC	United Arab Emirates Caribbean Energy Development Fund
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAR	Volt-Ampere-Reactive
VAT	Value Added Tax
VCM	Voluntary Carbon Markets
VCS-JNR	Verified Carbon Standard Jurisdictional and Nested REDD+ Framework
VPA	Voluntary Partnership Agreement
VSATs	Very Small Aperture Terminals
VSP	Village Sustainability Plan
WCMC	Wildlife Conservation and Management Commission
WTS	Wood Tracking System
WWF	World Wildlife Fund

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 and Institutional Arrangements

Guyana is part of the Guiana Shield and the Amazon Biome. It is located on the north-eastern coast of South America, and it is bound by Venezuela on the west, Brazil on the south-west and south, Suriname on the east and the Atlantic Ocean to the north.

Due to its geographic location, Guyana features a diverse natural heritage, including coastal artesian basins, a vast river and creek network, and wetlands. Rich in natural resources, it boasts a remarkable 85% forest coverage, and unique biodiversity. The large carbon sequestration that happens within its forest makes the country a significant sink of GHG emissions, and the protection of this resource and marketing of these global ecosystem services are key national priorities. In this context, major efforts are being undertaken to monitor the economic use of the forest and to avoid deforestation. Its natural resources further allow for mining activities of precious and semi-precious metals such as gold and bauxite and its fluvial networks provide great potential for the use of hydropower.

Experiencing fluctuations in population size and growth rate over the past decades, Guyana's population has increased to approximately 808,726 in 2022. Most of the population resides in low-lying coastal areas, where most urban centres, including the capital Georgetown, are situated. With 88% of the population younger than 55 years and an average birth rate of 2.6 children per woman, the population is poised for further growth.

Fuel consumption, transport and electricity generation account for the highest source of emissions, followed to a lesser extent, by agriculture, forestry, and fishing sectors. Efforts are underway to enhance the contribution of renewable energy sources to meet the country’s energy demands.

The expansion of the national oil and gas sector in recent years has spurred remarkable economic growth. In fact, while historically Guyana’s gross domestic product (GDP) per capita ranked among the lowest in South America, economic growth since 2020, has averaged 42.3% over the last three years. According to the International Monetary Fund (IMF), Guyana was one of the fastest growing economies in the world in 2023.

Guyana’s abundant natural resources and remarkable economic development have set the country on a path of growth. Guyana has emphasized that while capitalizing on the expanding economic strength, it is imperative to adopt prudent measures that support ongoing and sustainable growth. As such, Guyana has prioritized the balancing of economic progress with environmental conservation as the key to ensuring a harmonious and resilient future for Guyana.

Institutional, Legal and Policy Frameworks and Regulations

Guyana's commitment to sustainable development is evident through various strategic frameworks and plans. The Low Carbon Development Strategy (LCDS), launched in 2009, positions Guyana on a low carbon, green trajectory. The LCDS, updated in 2013 and subsequently in 2022 (after 7 months of stakeholder engagement), aims to transform the economy while providing a model for addressing climate change. Notably, the strategy addresses climate change mitigation, adaptation, and resilience-building priorities. The National Biodiversity Strategy and Action Plan (NBSAP), aligned with the UNCBD, guides biodiversity conservation efforts until 2020. Additionally, the Aligned National Action Plan (ANAP) works against land degradation, aligning with the UNCCD Strategic Plan [103]. The National Land Use Plan (NLUP) strategically guides land development, promoting multiple land uses. The Climate Resilience Strategy and Action Plan (CRSAP) outlines key objectives and actions to enhance resilience to climate change across various sectors. This Plan informs the development of Guyana's National Adaptation Plan (NAP). Several pre-existing strategies and plans contribute to Guyana's comprehensive approach, including the National Development Strategy (2001), Integrated Coastal Zone Management Action Plan (2000), National Mangrove Management Action Plan (2001), National Agricultural Sector Climate Change Adaptation Policy (2009), Guyana Climate Change Action Plan (2001), and the National Action Plan for Combating Land Degradation (2006). In 2018, the National Forest Policy Statement and National Forest Plan were revised. The overall objective goal of the National Forest Policy Statement and Plan is *"The conservation, protection and utilization of the state's forest, by ensuring its social, economic and environmental attributes and benefits are sustained and enhanced for the benefit of cur-rent and future generations of Guyanese, whilst fulfilling Guyana's commitments under international agreements and conventions"*.

These collectively reflect Guyana's dedication to sustainable development, conservation, and climate resilience.

Policy responsibility for climate change, including engagement with the United Nations Framework Convention on Climate Change (UNFCCC), rests with the Office of the President. Within the Office of the President, the Department of Environment and Climate Change (DECC) supports Guyana's transition to a low carbon state and works closely with agencies such as the Guyana Forestry Commission, Environmental Protection Agency (EPA), Protected Areas Commission (PAC), National Parks Commission (NPC), and the Wildlife Conservation and Management Commission (WCMC). The DECC coordinates all reporting to the UNFCCC.

The Department of Environment and Climate Change actively participates in international and regional efforts to safeguard the Earth's natural resources, with Guyana 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 1.9).

At the regional level, Guyana is committed to CARICOM's 2009 objectives for enhancing climate change resilience.

Chapter 2 – National Inventory Report of Anthropogenic Emissions

In this initial Biennial Transparency Report (BTR), Guyana presents a revised greenhouse gas (GHG) inventory spanning the period 1990-2022. The inventory utilizes the 2006 IPCC Guidelines for National GHG Inventories [referred to as the 2006 Intergovernmental Panel on Climate Change (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 for Guyana's first Biennial Update Report (BUR), and consequently, this BTR, was 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, supported aspects of 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).

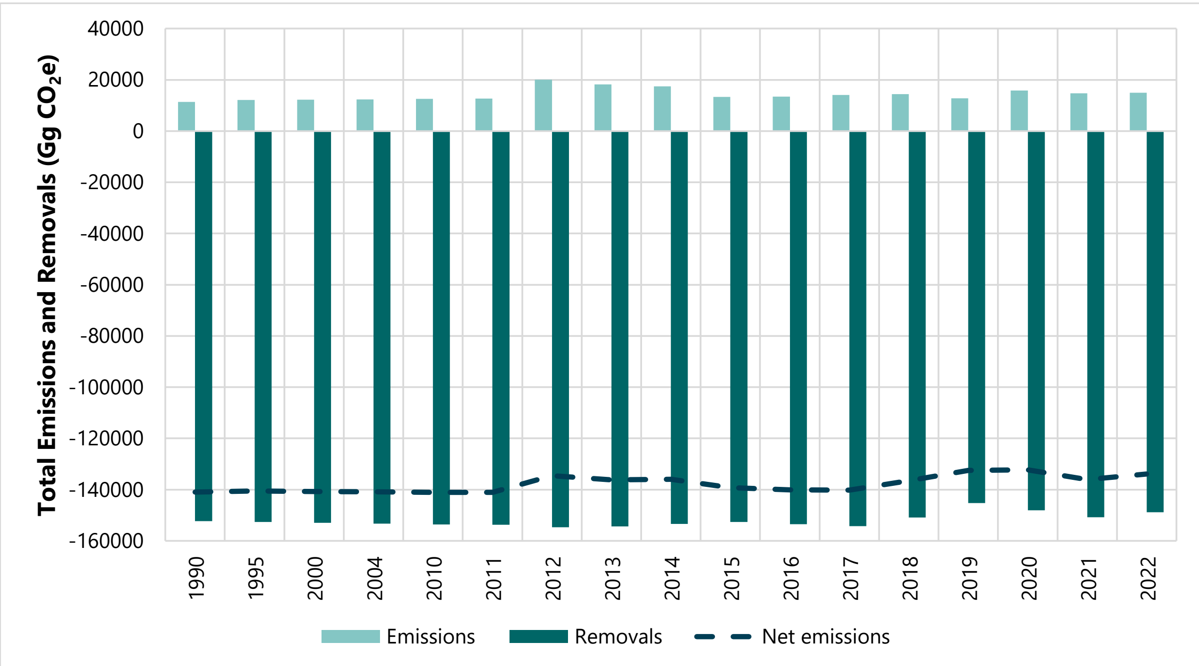
As previously mentioned, the four sectors covered in the national GHG inventory are energy, IPPU, AFOLU, and waste. The inventory is organized by numerical designations, followed by categories (indicated by capital letters), sub-categories (identified by numbers), and emissions sources (denoted by small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



GHG emissions and removals of Guyana – 1990-2022.

Examining the breakdown of national GHG emissions reveals an undulating trend from 2019 to 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 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 – Information Relating to Climate Change Impacts and Adaptation Under Article 7 of the Paris Agreement

The adverse and potentially catastrophic impacts of climate change are already being experienced in Guyana. Since the 1960s, the country has observed marked increases in temperature, sea level, and the frequency and intensity of extreme rainfall events.

The first half of 2021 saw catastrophic flooding and impacted large parts of the population. Over 74,000 acres (43,473 acres of cash crops and 30,684 acres of rice) of farmlands and over 20,000 farmers were affected. The 2021 flood is likely to be comparable to the 2005 flood which affected close to 37% of the population and caused economic damage equivalent to 60% of GDP. Some areas experienced 120-150 centimetres of standing water, which remained for several days. A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts on the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica, and Mahaica/West Berbice. Region Four was most severely affected in the 2005 flood (though less affected in the 2021 flood), experiencing close to 55% of the total damage, followed by Regions Two (23%) and Five (19%). Considerable losses were recorded in the sugar, rice, livestock, and other crops (fruits, vegetables, roots and tubers, and herbs and spices) subsectors.

Floods are not the only climate emergencies that Guyana faces. Following an extended period of dry weather in late 2014 and early 2015, the hinterland was facing drought conditions by April 2015. Region Nine (Upper Takutu-Upper Essequibo) and parts of Region One (Barima-Waini) were particularly affected, resulting in a reduction in the agricultural output in the Regions, a reduction in available water supply, and increased dust pollution, among other issues. The lack of rainfall caused decreased water levels in the wells, lakes, ponds, rivers, creeks and other water sources. Frequent bush fires destroyed several farms at Aranaputa, in Region 9. Local communities experienced limited access to potable water for domestic and agriculture use. Residents were forced to go to local rivers, including the Rupununi River, for untreated water for domestic use. There were reports of an increase in the number of people suffering from vomiting, and diarrhoea. The drought conditions were also linked to a resurgence of pests, including acushi ants and caterpillars, which attacked the few remaining crops. Dasheen, cassava, eddo and other cash crops were particularly severely impacted by the drought.

With increases in the number of dry spells, drought conditions and changing rainfall patterns, stress on Guyana's internal water resources, aquifers and rivers is increasing. With resources from the Guyana-Norway Partnership, Guyana developed a Climate Resilience and Adaptation Strategy to set out a comprehensive and overarching framework for adapting and building resilience to climate change impacts.

Chapter 4 – Tracking Progress of Guyana's Nationally Determined Contribution under Article 4 of the Paris Agreement

Guyana was among the countries that submitted its NDC in October 2015 to the UNFCCC under the Paris Agreement. In keeping with Paris Agreement (Article 4, paragraph 2), which requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve, Guyana's NDC outlined domestic conditional and unconditional contributions to the global effort to combat climate change.

Guyana's NDC recognizes the land use and forest sector as a key sector for its unconditional and conditional commitments, together with the energy sector. In this regard, Guyana's contribution to the Paris Agreement draws on the LCDS and early REDD+ efforts in order to continue promoting a combination of conservation and sustainable management practices as key climate change mitigation measures.

At the national level, unconditional and conditional commitments established in the NDC – together with the National Forest Policy, Codes of Practice for Timber Harvesting for Sustainable Forest Management – established the overarching guiding instruments and systems in Guyana to support country efforts on reducing emissions in the forest sector by 2025.

The unconditional and conditional commitments identified in Guyana's NDC covered the forestry, energy, and adaptation sectors.

Guyana's Nationally Determined Contributions for the Forestry Sector

Within the forestry sector, deforestation and forest degradation have been caused by mining and logging. These activities have generated considerable economic and employment opportunities – yet also are responsible for greenhouse gas emissions.

Since 2008, Guyana has advocated for the REDD+ mechanism within the UNFCCC – to provide economic incentives that value the global climate benefits provided by the world's tropical forests, and ultimately to outcompete economic alternatives which lead to greenhouse gas emissions. In time, these valuations may be augmented by mechanisms that also value the biodiversity and water regulation services which benefit the entire Western Hemisphere and the world.

Since 2008, Guyana has pursued a set of actions that advance this vision – and as a result, has maintained one of the (and often, the) lowest deforestation rates in the world.

Guyana's NDC – and the supporting Forest Reference Emissions Level (FREL), which is part of the UNFCCC's REDD+ architecture – set out the combination of domestic and international actions required to achieve the overall global goals of REDD+ in Guyana.

Further detail on the use of the FREL and REDD+ are set out below.

Unconditional Contributions

- Ensure compliance with the various Codes of Practice to realise sustainable forest management (SFM);
- Maintainance of a high level of timber legality, including the finalisation and implementation of the Voluntary Partnership Agreement (VPA) under the EU Forest Law Enforcement Governance and Trade (EU FLEGT);
- Improve added-value activities locally to assist in creating a higher potential for carbon storage in long-term wood products.

Conditional contributions

- Since 2009, with payments from the Government of Norway, Guyana had sustained progress on REDD+ in line with the overall vision set out in 2008. Guyana's NDC outlined how this progress on REDD+ would be continued if payments for climate services like those provided under the Guyana-Norway Agreement could be continued, whether through further bilateral agreements with Norway or other governments, or through a market based mechanism. Regardless of whether post-2015 payments were through a bilateral or a market mechanism, international payments would be based on the FREL as assessed and accepted by the UNFCCC. The FREL was assessed and accepted - using a total carbon stock of forests in aboveground and belowground biomass of 19,197,411,268 tCO_2e, Guyana's Reference Level, as assessed and accepted by the UNFCCC, is therefore 48.7 $MtCO_2e$.
- Use of Reduced Impact Logging (RIL) with the potential to reduce annual emissions by 13.5%
- Completion and maintenance of building the national MRVS, provided that adequate financial resources are available to do so.

Further detail on the REDD+ approach is provided below.

Energy Sector

Unconditional Contributions

Guyana's NDC set out a goal to develop a mix of wind, solar, biomass and hydropower to supply both the demand of the national grid and the energy requirements for towns and villages in Guyana's hinterland.

The Government of Guyana continue to work closely with farmers in agricultural areas across Guyana to encourage the use of bio-digesters to reduce waste, produce biogas and provide affordable, healthy and efficient cooking means at the household level.

Legislation was enacted to remove import duty and tax barriers for the importation of renewable energy equipment, compact fluorescent lamps and LED lamps to incentivize and motivate energy efficient behavior. Guyana continued to conduct energy audits and replace inefficient lighting at public, residential and commercial buildings to reduce energy consumption. Public education and awareness programmes will continue to play a major role in providing consumers with information and tools to reduce energy consumption and expenditure.

Guyana implemented other policies to encourage energy efficiency and the use of renewable energy, including building codes and net-metering of residential renewable power.

Conditional Contribution

Guyana's NDC set out a commitment to eliminating near complete dependence on fossil fuels. Given Guyana's solar, wind and hydropower, the country set out that with adequate and timely financial support, Guyana could develop a rapid move towards renewable power supply by 2025.

Adaptation

Unconditional contributions

Guyana's NDC set out an intention to continue basic work on integrated water management infrastructure, which includes the construction, rehabilitation and maintenance of conservancies and canals, and sea defences, water supply and sanitation, as well as the introduction of new agricultural techniques such as hydroponics and fertigation. Climate change considerations were to be mainstreamed in all sectors of national development.

The NDC set out an intention to prepare a Climate Resilience Strategy and Action Plan (CRSAP) which was expected to provide a comprehensive framework for adaptation and resilience building in Guyana, but it would require significant resources to implement it.

Conditional contributions

Given the requisite support, Guyana's NDC set out commitments to undertake actions in the following areas:

- Implementation of the CRSAP.
- 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 flood resilient varieties which are:
    - Drought tolerant,
    - Disease resistant.
        - Develop environmental and climate change awareness programmes at all levels.
        - Developing innovative financial risk management and insurance measures.

REDD+ in Guyana

Guyana is committed to safeguarding its forests, recognising their vital role in mitigating climate change by absorbing substantial amounts of 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) [1]. 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) and containing an estimated 5.96 Gt of carbon in aboveground biomass which is equivalent to 21.8 Gt of CO_2 with the inclusion of soil carbon.

However, in addition to being one of Guyana's most valuable natural assets, these forests are suitable for logging and agriculture, and have significant mineral deposits. Mining is the primary driver of deforestation in Guyana1, 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.

To achieve a balance between preserving Guyana's forests as a global asset in the fight against climate change and at the same time meeting addressing poverty and other developmental challenges, Guyana has pursued a Low Carbon Development Strategy (LCDS).

The latest revision of the LCDS sets out plans up to 2030 to maintain Guyana's low deforestation and high HFLD score [2] including through the use of economic incentives. These economic incentives are grounded in united Nations Framework for Climate Change (UNFCCC) modalities, including Reducing Emissions from Deforestation and Degradation (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.

REDD+

'REDD' stands for 'Reducing emissions from deforestation and forest degradation in developing countries. The '+' stands for additional forest-related activities that protect the climate, namely sustainable management of forests and the conservation and enhancement of forest carbon stocks [3].

[1] Decision 4, CP.15 paragraph 1(a) requests developing country Parties to identify drivers of deforestation and forest degradation resulting in emissions.

The primary objective of REDD+ is to encourage developing countries like Guyana to shift economic incentives so that they can actively contribute to climate change mitigation. This is achieved through economic incentives that value the globally-significant forest climate services provided, and in so doing to help with curbing, stopping, and reversing forest loss and degradation, while simultaneously enhancing the removal of greenhouse gases (GHGs) from the atmosphere through the conservation, management, and expansion of forests. There are five globally agreed-upon REDD+ activities that play a crucial role in mitigating climate change in the forest sector:

1. Reducing emissions from deforestation.
2. Reducing emissions from forest degradation.
3. Conservation of forest-carbon stocks.
4. Enhancement of forest-carbon stocks.
5. Sustainable management of forests.

Within the framework of these REDD+ activities, Guyana has been receiving results-based payments for REDD+ activities. The outcomes of REDD+ efforts are quantified in metric tonnes of CO_2e or GHG emissions reductions, leading to the creation of REDD+ Results Units (RRUs).

Guyana has long been a leader in working out how REDD+ can be evolved and strengthened. In 2008, Guyana set out to start building a mechanism for REDD+, through a three-phase process:

- Phase I – a bilateral agreement with a partner which shared Guyana's vision.
- Phase II – available market-based mechanisms.
- Phase III – a fully-fledged UNFCCC REDD+ mechanism.

In Phase I, the forest reference emission level (FREL) was assessed and accepted by the UNFCCC. Within the REDD+ framework and utilising the FREL, the Governments of Guyana and Norway established a REDD+ agreement in 2009, known as the Guyana – Norway Partnership. In the agreement, Norway committed to providing Guyana up to $250 million USD by 2015 for REDD+ results.

In Phase II, the FREL serves as a benchmark for voluntary carbon market engagement, and in Phase III, the mechanism will be seamlessly integrated once a UNFCCC REDD+ mechanism is fully operational [4].

In this context, Guyana has submitted its first REDD+ Technical Annex alongside its first Biennial Update Report (BUR), and is now submitting its first Biennial Transparency Report (BTR). The REDD+ Technical Annex outlines the country's endeavours in preserving environmental integrity and promoting the sustainable use of its forest resources. These efforts align with the promotion of sustainable development along a low-carbon pathway, in accordance with national priorities and international obligations [5]. The Technical Annex includes an overview of the FREL, GHG emission reduction results, consistency in methodology between REDD+ results calculation and FREL construction, details about the national forest monitoring system and the responsibilities of relevant authorities, as well as the necessary information for the reconstruction of the results.

The initial REDD+ Technical Annex details Guyana's achievements from 2013 to 2022

Phase II Transition to a Market-Based Mechanism: ART-TREES

For Phase II of Guyana's approach to forest climate services, Guyana has adopted the Architecture for REDD+ Transactions (ART) as the accreditation standard for integration with voluntary and carbon markets. The overall approach was set out in Guyana's LCDS 2030 – Appendices 1 and 2.

ART's "The REDD+ Environmental Excellence Standard", known as TREES, is ART's market-based approach to crediting REDD+ performance. TREES outlines the criteria for crediting emission reductions from REDD+ on both national and subnational scales. It encompasses rigorous standards for accounting and crediting, monitoring, reporting, and independent third-party verification, as well as measures for mitigating leakage and reversal risks, preventing double counting, ensuring robust environmental and social safeguards, and ensuring the transparent issuance of serialised TREES Credits on a public registry [6].

Guyana is in the process of revising the FREL. This updated FREL will be effective from 2023 and was part of a nation-wide national consultation on the LCDS 2030. It will serve as a refinement of the 2015 FREL, incorporating stepwise improvements and additional data. Noteworthy revisions include:

- Inclusion of additional data collected, ensuring nationwide coverage and eliminating stratification based on the convergence of biomass values and updated emission factors.
- Adjustment of the reference period.
- Incorporation of all national drivers contributing to both deforestation and forest degradation.

Chapter 5 – Financial. Technology Development and Transfer and Capacity Building Provided, Mobilised, Needed and Received under Articles 9-11 of the Paris Agreement

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 decade in a wide range of actions to continually strengthen and build-out existing systems. Substantial resources are mobilised to finance targeted activities in energy and forestry representing the priority sectors outlined in Guyana's NDC and LCDS. Additionally, operational support for fulfilling reporting obligations under the UNFCCC and to enhance decision-making for climate change action is provided.

In this context, numerous projects are supported across these sectors. The majority of these projects involve capacity-building, seeking to address prevalent capacity gaps identified. Moreover, in line with the technology needs of Guyana in particular in the energy sector, the majority of projects implemented in that sector seek to strengthen the transfer of technology to improve the renewable capacity and energy efficiency in the country.

To support these actions, Guyana depended in the past strongly on the disbursement of grants and concessional loans from bilateral partners and from multilateral development banks. However, in recent years, mobilisation of market instruments and private sector investments as major sources of climate finance has increased substantially. In fact, nearly all the support anticipated stems from private investments in the power generation sector and from an innovative carbon credit mechanism, providing financial resources in return for the forest protection services provided by Guyana.

Summary of total support received and anticipated by sector (updated to 2022).

Sector	Support received (USD)	Support anticipated (USD)
Energy	**127,253,732.00**	**1,702,650,452.00**
Power Generation	34,401,492.00	1,696,895,452.00
Energy Efficiency	2,975,000.00	3,045,000.00
Rural Electrification	13,603,240.00	2,710,000.00
Training and Development	76,274,000.00	0.00
Forestry	**351,175,362.00**	**575,283,409.00**
Cross-cutting	**61,410,457.00**	**103,804,349.00**
Grand Total	**539,839,551.00**	**2,381,738,210.00**

This includes those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement)

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 focuses on the forest and energy sectors as this is where most of Guyana’s current and historical emissions are produced, and the objective of the LCDS, which aims to enhance clean energy and create incentives for a low-carbon economy through primarily the forestry sector. Furthermore, Guyana has actively participated in REDD+ and the latest developments in market-based mechanisms supported by the Paris Agreement. Further details regarding these activities are presented in Chapter 5 of this Biennial Transparency Report (BTR).

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.

Forestry Sector

In addressing climate change within the forestry sector, Guyana is employing a combination of conservation and sustainable forest management strategies.

Within this 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.

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 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.

In Guyana, substantial resources are mobilised to finance activities in the priority sectors, namely energy and forestry and, to a lesser extent, transport, as outlined in Guyana's Nationally Determined Contribution (NDC) [3] and Low Carbon Development Strategy (LCDS) [4]. Additionally, operational support for fulfilling reporting obligations under the UNFCCC is provided. The funding is obtained from various sources, including the country's budgetary investments, investment loans and grants from bilateral and multilateral entities, as well as through private sector investment.

Overall, the funding received by Guyana underscores a significant dependence in the past on bilateral support often disbursed as grants and on concessional loans from multilateral development institutions in the past. Moreover, the Global Environment Facility (GEF) [5] and the Green Climate Fund (GCF) [6] provided support in the form of project grants to fund projects aimed at enhancing the country´s operational capacity for climate action.

However, since 2022, this situation has changed with the vast amount of the funding yet to be received being formed of increasing mobilisation of market instruments and private sector investments as major sources of climate finance.

Chapter 6 – Information on Flexibility

Guyana has applied the following areas of flexibility in its reporting under this first submission of its Biennial Transparency Report:

GhG Inventory Reporting

- Reporting on Greenhouse Gas Inventory utilizes the template 2006 IPCC Guidelines, with common reporting tables (CRT) for the electronic reporting of the information in the national inventory reports to be submitted separately in 2024.

Timeframe: October 2024

NDC Reporting

- NDC reporting tables reflect status of progress for each area outline in Guyana's NDC. **Projections** coMoPWled will be submitted using the required templates as part of Guyana Third National Communication scheduled for submission in August 2024.

Timeframe: August/September 2024

National Adaptation Planning

- Guyana has in place a national strategy for low carbon development that addresses adaptation. There is also a framework document for climate adaptation and resilience in the form of Guyana's Climate Resilience Strategy and Action Plan. Guyana is currently in the process of updating its plans on adaptation towards a National Adaptation Plan (NAP). Adaptation areas outlined in the BTR includes many aspects already laid out in the National Strategy (Guyana's Low Carbon Development Strategy 2030), and the National Plan (Climate Resilient Strategy and Action Plan). The NAP will be advanced in 2024 and submit upon completion.

Timeframe: first half 2025

Chapter 7 – Improvements in Reporting Over Time

Guyana intends to develop a sector led data management system as part of its national integrated MRV framework. The country will work to create a structure to feed information from the sector level into a reporting system for the UNFCCC. The envisioned data management system will collate data at the sector level and support the organisation, storage, and archiving of Guyana's information utilised within its national MRV framework. This, in turn, will play a crucial role in shaping national policies and plans while ensuring the fulfilment of the country's reporting obligations to international agreements.

By creating this networking structure, the national MRV, with implementation at the sector level generating inputs for a dedicated data management system, Guyana aims to integrate all MRV subsystems. This approach is designed to facilitate the fulfilment of commitments under both the UNFCCC and the Paris Agreement, providing an effective solution for comprehensive and streamlined reporting processes.

Improvements will be addressed by implementing the main actions listed below:

1. **Agreement on consistent and comparable definitions:** Adopting consistent and comparable definitions, abbreviations, and acronyms will support alignment of datasets, which allows for more detailed comparisons and, ultimately, better informs policy discussions.

2. **Stakeholder engagement and consultation during design and development:** Identifying and engaging stakeholders is crucial for the design of the data management system. This process offers various benefits, such as aligning the system with national priorities, securing early buy-in from key user groups, and building capacity to reduce data entry errors. Stakeholder engagement also aids in maintaining public support and refining the system by gathering feedback on specific needs and functional components during requirements gathering and testing.
3. **Gradual implementation and continuous improvement framework for long-term sustainability:** Regular enhancements to the data management system will be anticipated to align with evolving policy landscapes and enhance overall system functionality. This will ensure the adaptability to policy changes and the ability to harmonise data from various reporting elements.
4. **Build sense checking into systems to ensure robust data systems:** Input errors are likely to occur when large volumes of data are submitted to the system, undermining users' confidence in the data quality. To mitigate these errors, checks will be incorporated into the data submission process including safeguards to ensure data integrity. This will ensure user confidence in the robustness of the data, which will ensure that the data is used for decision-making.
5. **Create data security and integrity controls:** Security measures will be incorporated for authenticating access to ensure that the data on the system is protected.
6. **Training and support to ensure that the system is used effectively and reduces user error:** Enhanced user understanding of the data management system improves the accuracy of data submissions. Post-system development, supporting and building the capacity of climate data management users will be ensured for smooth operations.

Chapter 1 - National Circumstances and Institutional Arrangements

Introduction

Guyana, nestled in the Guianas Shield and the Amazon Biome, is located on the north-eastern coast of South America. It operates as a parliamentary democracy with ten regions that span over 214,970 km^2, showcasing diverse topography and ecological richness.

Named for its abundant hydrological resources, Guyana features a diverse natural heritage, including coastal artesian basins, a vast river and creek network, and wetlands. Rich in natural resources like gold and offshore oil, it boasts 85% forest coverage, arable land, and unique flora and fauna. The fisheries sector and agriculture are crucial for protein supply and employment. The coastal areas, the most densely populated, experience diverse climate and weather patterns, including two distinct rainy seasons. These areas face vulnerability to climate-related events, recurrent flooding, and the threats of tidal floods and storms, plus the rise in mean annual air temperature, poses risks to economic stability, emphasizing the need for robust sea defences and drainage systems.

Guyana, with a population of 808,726 [1], exhibits a balanced gender distribution and diverse demographics, including six ethnic groups and nine Indigenous groups. Employment and education are critical, with an average unemployment rate of 12.4% and a 10% national illiteracy rate in 2022.

In 2022, Guyana's gross domestic product (GDP) was G$3,068,784 million ($14.66 billion USD approximately)], with the agricultural sector contributing over 25% to the non-oil GDP and employing 17% of the workforce [3].

Guyana's energy sector so far relies on petroleum-based fuel imports, particularly diesel, fuel oil, and motor gasoline. Changes in economic activities, such as reduced energy-intensive agriculture and the growth of the service sector, have influenced Guyana's energy consumption patterns.

Guyana has responded to significant climate changes by establishing a climate change policy and institutional framework aligned with international and regional environmental agreements. Key institutions, such as the Department of Environment and Climate Change (DECC), and legislation like the Environmental Protection Act, have been developed based on these agreements. Initiatives in Protected Areas and wildlife conservation and management are also integral. Guyana's strategic policies, including the Low Carbon Development Strategy (LCDS) 2030, focus on sectors like Agriculture, Forest, and Energy, aligning with comprehensive sector-wide considerations such as the Nationally Determined Contributions (NDC). The LCDS 2030 serves as a comprehensive plan to shift away from petroleum dependency for national power generation, emphasizing sustainable and low-carbon alternatives in the energy sector. It includes targeted measures to mitigate and adapt to climate change impacts, aiming to enhance the country's ability to cope with environmental challenges and protect vulnerable communities. The LCDS 2030 aligns with Guyana's commitments under the NDC framework, emphasizing dedication to international climate goals.

In this chapter of the first Biennial Transparency Report (BTR), Guyana explores its national context, delving into crucial aspects across ten distinct sections to depict the country's current circumstances and pertinent considerations. The report offers detailed insights, incorporating relevant subsections as needed.

Administrative Structure

Guyana operates as a parliamentary democracy with a representative system of government. It is divided into 10 regions and the capital is Georgetown (Figure 1.1). The administrative structure of Guyana includes the following key components:

Executive Branch:

President: The President is the head of state and government. The President is elected by the people and is responsible for the overall administration of the country.

Cabinet: The President is supported by a Cabinet, which consists of ministers responsible for various government departments and functions. Ministers are appointed by the President.

Legislative Branch:

National Assembly: Guyana's unicameral legislature is called the National Assembly. Members of the National Assembly, known as Members of Parliament (MPs), are elected by the public. The Parliament is responsible for making laws and overseeing the executive branch.

Judicial Branch:

Judiciary: The judicial branch is independent and includes the Supreme Court. The Chief Justice heads the judiciary, and there are other justices and judges responsible for interpreting and upholding the law.

Local Government:

Regional Democratic Councils: Guyana is divided into regions, each with its own Regional Democratic Council (RDC) responsible for local governance within the region.

Municipalities: There are also municipalities that have their own local government structures.

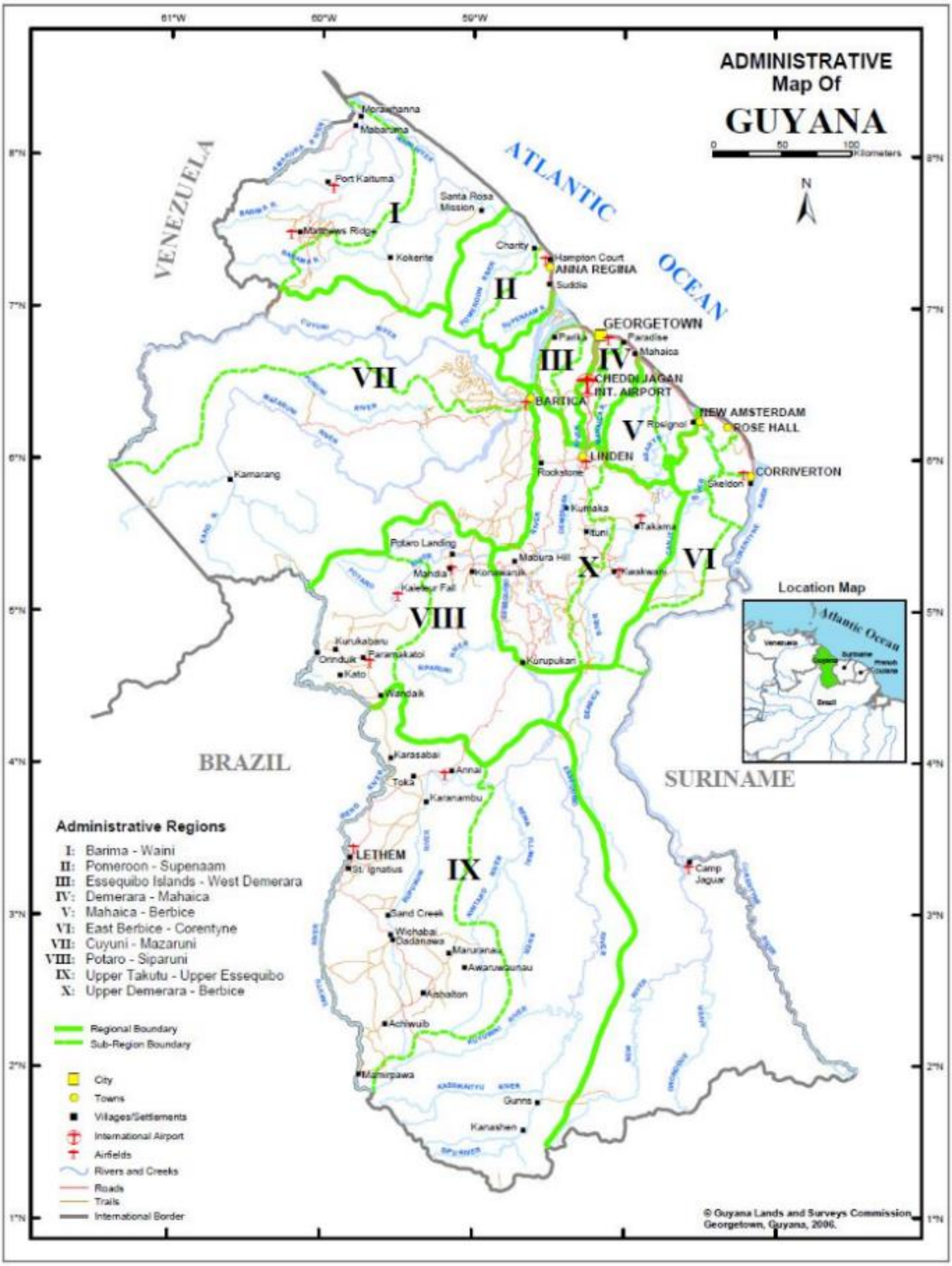


Figure 1.1. Guyana’s Administrative Regions [9].

Geography and Topography

Guyana is an integral part of the expansive Guianas Shield and the Amazon Biome. It is bordered by Venezuela to the west, Brazil to the southwest and south, and Suriname to the east, with the Atlantic Ocean stretching along its northern border.

Encompassing 214,970 km^2, Guyana's territory comprises 196,850 km^2 of land and 18,120 km^2 of water, making it the third smallest independent state on the South American mainland. With 430-kilometre Atlantic coastline on the northeast, and a continental extent of about 724 km, the country has a coast that is 0.5 m to 1 m below mean high tide level of the Atlantic Ocean.

Despite its modest size, Guyana's diverse topography and ecological richness are remarkable. Geographically situated in South America, the nation shares deep cultural and historical ties with the Caribbean, underscored by its role as a founding member of the Caribbean Community (CARICOM) [10].

The country’s landscape is marked by four Biophysical Regions (Figure 1.2) as follows:

- Low Coastal Plain;
- Hilly Sand and Clay;
- Forested Highland; and
- Interior Savannahs.

The Coastal Plain, vital for its population concentration, sits between 0.5 meters to 1 meter below the mean high tide level of the Atlantic Ocean. It extends from Waini Point to the Corentyne River, with an area of approximately 9,120 km^2 and it is geologically divided into the Demerara (sandy old beach ridges forming higher deltaic terrain) and Coropina (fluvio-marine clays and silts) Formations. The coastal region features sandy old beach ridges and fluvio-marine clays and silts.

Further inland, the Hilly Sand and Clay Region extends approximately 160 km southward to the Coastal Plain, the Crystalline Basement Rock Outcrops with an area of approximately 28,920 km^2. The Forested Highlands showcase plateaus and tepuis (table-topped mountains) with steep escarpments, waterfalls, and rapids permeate the Region. It makes up about 73% of the country’s land mass with an area of approximately 156,450 km^2. The interior (Rupununi) Savannahs are bordered by the Pakaraima Mountains in the north, a low-forested plateau in the east, the Marudi Mountain in the south-east, and the headwaters of the Kuyuwini River in the south-west. The forested Kanuku Mountains divide the area into two – the North and South Savannahs. The vegetation consists of mostly grassland, scrub and low trees with hills [11].

The nation's soils vary, from coastal and riverine clay, sand, and alluvial soils to laterites and gley soils in fluctuating water table areas. Clay, sand, and alluvial soils are found on unconsolidated sediments of the coast and riverine areas. In depressions, where the water table fluctuates, groundwater laterites are formed in lower layers of the soil profile while in water-logged areas the lower layers have gley soils. However, in poorly drained low-lying areas, deep peat soils are formed. On steep sloping areas with rock outcrops, such as the Pakaraima Mountains, lithosols (thin soils) are common. Deep reddish-brown soils with visible horizons (latosols) develop in most of the country, especially on old erosion surfaces.

Key to Guyana's natural wealth that endows the country with fertile agricultural lands, are valuable mineral deposits, including bauxite, gold, and diamonds. Additional to the extensive forest that covers about 85% of the country and the recently discovered large offshore oil and gas reserves, Guyana has hydrological resources such as the major rivers Demerara, Essequibo, and Berbice flowing through the landscape [12]. The highest rainfall volume occurs in the Upper Mazaruni Mountains with more than 4,000 mm annually.

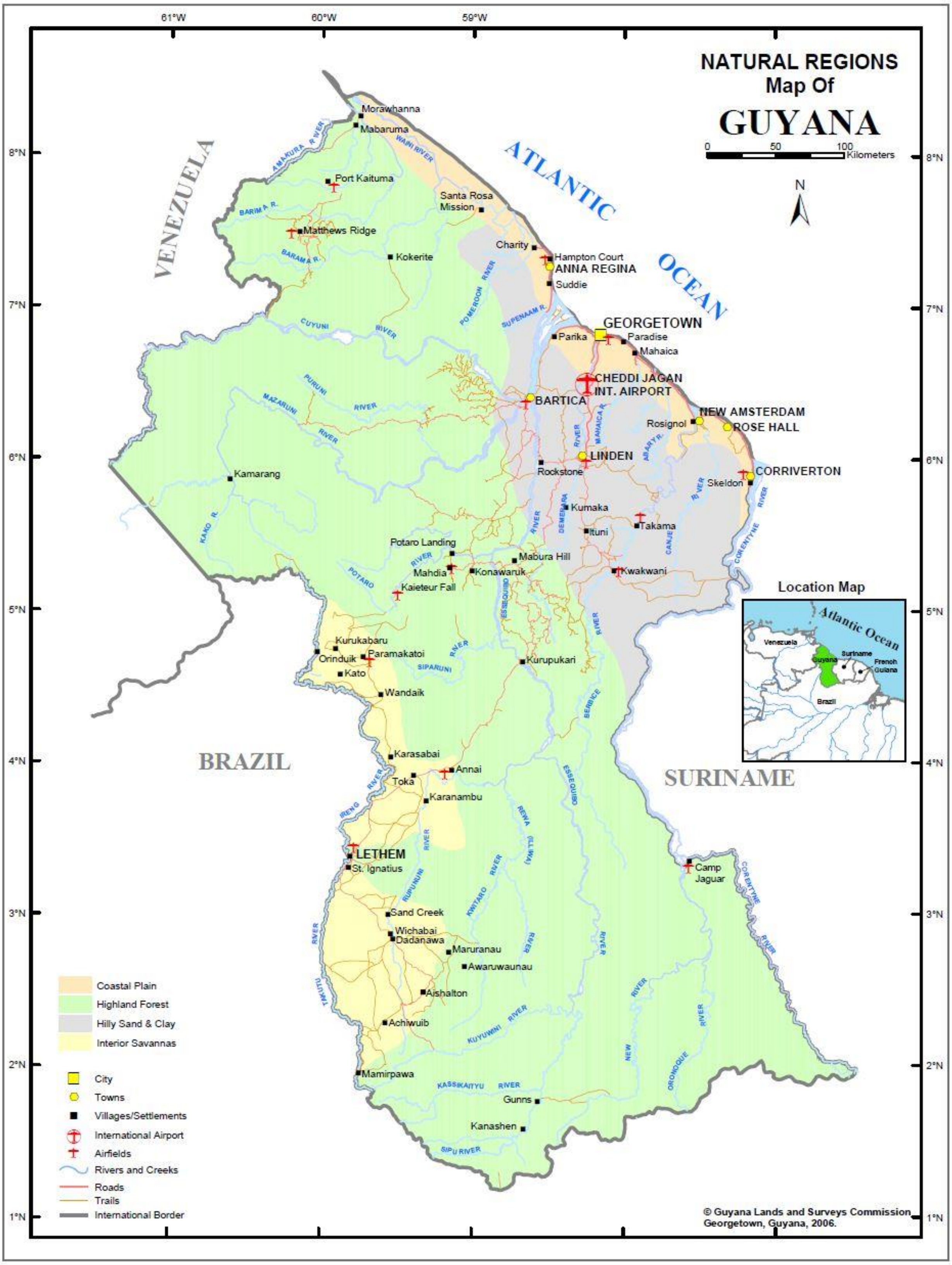


Figure 1.2. Guyana's Natural Regions [9].

Hydrological Resources

With the looming threats of climate change, Guyana's water resources face substantial challenges, primarily due to the anticipated rise in sea levels, leading to saltwater intrusion into rivers and potential adverse effects on aquifers, among others.

Coastal Artesian Basin and Aquifers

The coastal artesian basin, covering 20,000 km^2, houses three main aquifers: Upper Sands, "A" Sands, and "B" Sands. The Upper Sands, the shallowest, ranges from 30 to 60 m in depth. The "A" Sands, the primary source of domestic water supply, varies from 20 to 60 m in thickness. The "B" Sands, the deepest aquifer, extends eastwards from the Demerara River [13].

Rivers

Guyana boasts an extensive network of rivers and creeks, primarily flowing into three major rivers: Essequibo, Demerara, and Berbice. The Essequibo River Basin, the largest among them, includes major rivers such as Essequibo, Cuyuni, Mazaruni, and Potaro, draining an estimated area of 66,563 km^2. Along its course, smaller rivers like Mazaruni, Potaro, Cuyuni, Kuyuwini, Rupununi, and Rewa contribute to its flow.

The Berbice River, the second largest, flows for 595 km from its source in the Rupununi highlands to the Atlantic Ocean, draining an estimated area of 5,102 km^2. Several smaller rivers discharge into the Berbice River. These include Canje, Wikki, and Wairuni Rivers [14].

The Demerara River, the smallest of the main rivers, covers approximately 346 km from its source in the Marakari Mountains and drains over 4,000 km^2.

Besides the major rivers, smaller rivers along the Coastal Plain play a crucial role in drainage, forming essential drainage basins. Apart from the Essequibo, Demerara, and Berbice Rivers, other smaller rivers also empty into the Atlantic Ocean. These form very important drainage basins along the Coastal Plain (Table 1.1).

Guyana features fourteen drainage basins, each characterized by varied river flows throughout the year, contributing to the country's diverse hydrological landscape [15].

Table 1.1. Secondary coastal rivers [14].

Names of Rivers	Location
Barima River **Waini River** **Kaituma River**	Region 1 - Barima Waini
Pomeroon River **Supenaam River** **Moruca River**	Region 2 - Pomeroon-Supenaam
Mahaica River	Region 4 - Demerara- Mahaica Region 5 - Mahaica-Berbice
Mahaicony River	Region 5 - Mahaica-Berbice
Abary River	Region 5 - Mahaica-Berbice
Canje River	Region 6 – East Berbice-Corentyne

Tidal influence within the Essequibo, Demerara, and Berbice Rivers can extend up to 80 km upstream, particularly during the dry season, and over 20 km upstream for smaller rivers.

Watersheds

The eight watersheds are Essequibo, Mazaruni, Berbice, New River, Demerara, Barama, Cuyuni, and Barima [15]. Some of the watersheds are considered transnational or shared watersheds which originate or flow across national borders contiguous with Guyana. The main river in the Cuyuni watershed, the Cuyuni River, originates in the Guiana Highlands of Venezuela and flows 560 km into Guyana where it empties into the Essequibo River.

Lakes and Conservancies

Guyana has an extensive system of lakes and conservancies. There are 37 natural lakes scattered throughout the country. Seven water conservancies were constructed along the Coastal Plain to provide water for agricultural and domestic purposes as well as drainage for flood control through a network of canals. The conservancies are shallow reservoirs of varying sizes and receive freshwater supplies from upland creeks and streams, mainly from the Hilly and Sandy physiographic region [16]. The conservancies are located along the Essequibo Coast (Region 2), East Bank Essequibo, West and East Demerara (Regions 3 and 4), and West Coast Berbice (Region 5). Collectively, these structures provide irrigation water and flood control to over 10,100 hectares of rice lands, 150 hectares of cash crops and the populated centres of the Region.

The major conservancies in Guyana include:

- The Abary Conservancy on the Abary River, also called Mahaica Mahaicony Abary (MMA) Conservancy, has a capacity of 609 million m^3 and irrigates 17,500 ha of land. It is located in Region 5, which plays an important role in the agricultural landscape of Guyana, contributing between 35 to 50% of the gross national rice production [9].

- The East Demerara Water Conservancy (EDWC), which dams the Maduni River and Lama Creek, has a capacity of 16 million m^3 and irrigates 350 km^2 (34,500 ha) of land. It provides one of the primary sources of drinking water of Georgetown (60%), as well as the irrigation of the Guyana Sugar Corporation as a whole [17].

- The Boerasirie Conservancy collects the flow from the Boerasirie River, Warimia Creek, Jumbi Creek, and finally the South Durabana Creek. It has a total capacity of 166 million m^3 and has been designed to provide irrigation to about 360 km^2 (36,000 ha) of land. It is one of Guyana's major flood control facilities [18].

- The Tapakuma Conservancy dams the water from three inland lakes on the Essequibo coast and releases it as needed for irrigation. It has a total capacity of 18 million m^3 and has been designed to provide irrigation to about 120 km2 (12,000 ha) of land.

Wetlands

There is an intricate system of wetlands that exists in Guyana, at least 22 naturally occurring wetlands are recognised. These wetlands are a unique and highly diverse ecosystem that is extremely important for biodiversity and ecosystem services [19]. 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 [20]. The largest wetlands in the country are the North Rupununi wetlands which cover an area of 220 km^2 (22,000 hectares). 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. They supply water from the Rupununi, Rewa, and Essequibo Rivers, along with its lakes, and water inlets [21].

Groundwater Resources

The groundwater system comprises three coastal aquifers that cover an area of 20,000 km^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 30 m to 60 m and thickness from 15 m to 120 m. However, it is not utilized as a water source due to its elevated iron content (>5 mg/l) and salinity (up to 1,200 mg/l) [22]. The latter two aquifers are the primary sources of potable water [16]. The A Sand is usually found at depths between 200 m and 300 m, with a thickness ranging from 15 m to 60 m. Water from the "A" aquifer needs treatment to eliminate iron. The B Sand is situated at approximately 300 m to 400 m and has a thickness ranging from 350 m to 800 m. Water from this aquifer contains minimal iron, a high temperature, and a trace of hydrogen sulphide, which can be addressed through aeration [22]. Others found in the Hinterlands are the White Sands Plateau (Linden, Region 10), the Takutu Sandstone Formation (northern Rupununi Savannah, Region 9), Barima Mazaruni Supergroup (underlays the Kanuku Mountains), and the Merume Mountains in the western parts of the country between 10 m to 30 m depth. There is also a brackish aquifer system along the Waini River at 3 m to 30 m depth [16].

Due to the coastal region of Guyana being at or near sea level, there is an ongoing risk of salinization. This phenomenon occurs in dry periods due to elevated salt levels in irrigation water and the intrusion of saltwater into groundwater resources [23]. Estimated values of water withdrawal in Guyana in 2010 were 1444.7 million m3, where agricultural use accounted for 94%, followed by municipal, and industrial uses which accounted for 4% and 2%, respectively. The total volume of water produced by the Guyana Water Incorporated (GWI) decreased from 2012 (126,776,564 m^3/yr.) through 2014 (120,457,196 m3/yr.) and rose in 2015 (122,743,829 m3/yr.) but to a level lower than the previous three years. In 2015, the total water production of GWI was over 122 million m^3/yr. with a customer base of 183,000, a decrease of 3% or 4,032,735 m^3/yr. compared to production volume in 2012 (Table 1.2) [25].

Table 1.2. Water production in m^3/year [26].

Year	Water Production
2012	126,776,564
2013	125,387,658
2014	120,457,196
2015	122,743,829
2019	160,000,000

According to the GWI strategic plan 2021-2025, the Public Corporation charged with the responsibility for water production throughout Guyana and sewerage services in Central Georgetown produced 160 million m^3 of water in 2019.

Natural Resources

Minerals

In Guyana, mineral mining is generally allowed in six designated districts [27]. About 90% of the mining leases issued by the Guyana Geology and Mines Commission (GGMC) are within the state forest boundary, while approximately 61% of prospecting licenses issued for mining overlap with the state forest [28].

There are also 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. The sector contributed 12% to Guyana's non-oil GDP in 2021 [29] and the extractive industries accounted for approximately 52 % of Guyana's total exports in 2016. According to the World Bank, the mining industry contributed to employment with 17,363 in direct employment and 21,626 in indirect employment in 2013, making up a combined 14% of the total labour force [10]. Mining output expanded by 14.8% (2012) and 8.0% (2013) then contracted by 11.5% (2014) as a result of relatively less favourable gold and bauxite prices. It grew by 9.0% and 45.5% in 2015 and 2016 respectively.

Based on Guyana's national statistics, the gold production in Guyana was documented at 15,129 kg in December 2022, indicating a slight decline from the earlier figure of 15,522 kg in December 2021 [30]. Guyana produced 14,024 kg of gold in 2015 contributing 13% to 16% to Guyana's GDP. Diamond production increased to 118,451 carats in 2015. Data for bauxite indicate that production decreased by about 6.4% compared with that of 2014 to about 1.5 million Mt. Crushed stone production decreased by 56% owing to a decrease in construction activity. Bauxite is also another mineral in Guyana's mining sector, though production has decreased from 2012 to 2016 with the highest production growth being recorded in 2012 (21.8%).

In 2015, offshore petroleum was discovered in commercial quantities (more than 5 billion barrels), adding to Guyana's many resources. There are currently additional exploration activities being carried out [32]. Figure 1.3 illustrates the extent of petroleum exploration offshore Guyana.

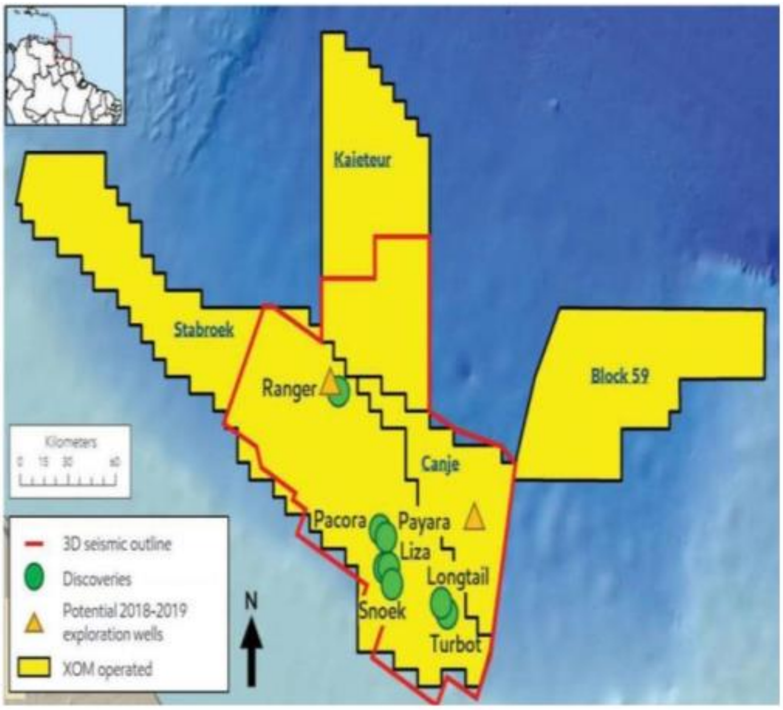


Figure 1.3. Guyana's coastal offshore petroleum exploration area [26].

During the oil extraction significant amounts of associated gas are extracted. All FPSOs have been designed as non-routine flaring to minimize the number of emissions. The gas is compressed and re-injected in the well, increasing production of oil and reducing the amount of flaring. From the first two FPSOs commissioned a 50 million cube feet per day, which represent 8.6% of the gas production in the first two FPSO [35] will be diverted for onshore electricity production.

The environmental permit for the FPSO has been issued with a carbon tax on flaring in amounts exceeding the non-routine flaring. The latest permit includes a carbon tax of $50 USD/ton$CO_2$ emitted.

Forests

Guyana has around 85% forest cover. Guyana's forested region is approximated at 17.84 million hectares, housing around 19.5 billion tons (or Gt) of carbon dioxide (CO_2) within live and deceased biomass reservoirs2. There are different types of forest areas in the country, grouped in four under tenure classifications (Figure 1.5).

There are approximately 120 species being logged in various forms, with between 12 and fifteen 15 of these logged on a commercial scale through a system of concessions. These follow sustainable forest management practices as prescribed by Codes of Practice for Timber Harvesting set again international standards.

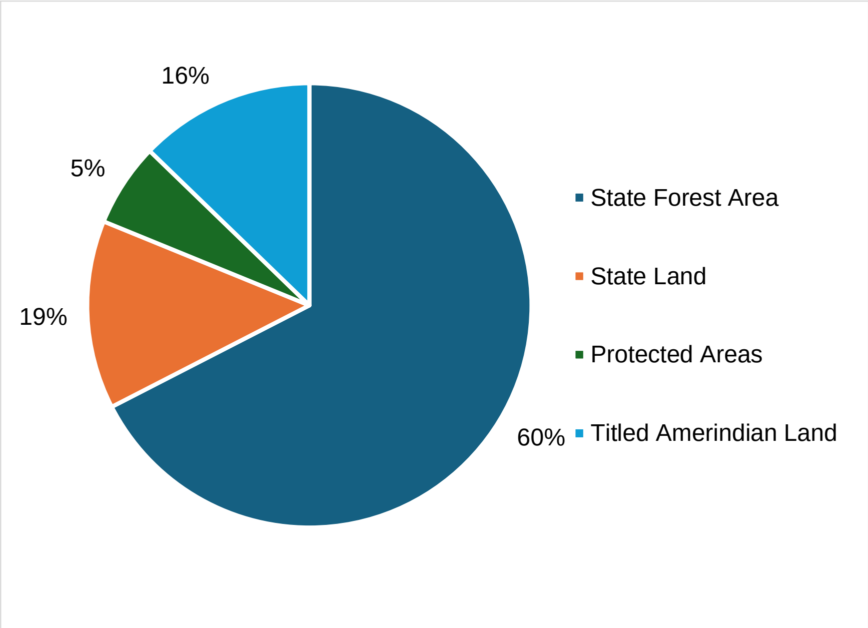


Figure 1.5. Type of Forest areas in Guyana [36].

Furthermore, the average forestland from 2011 to 2022 is 18.6 million hectares, fluctuating over the years but averaging 85% of the total land area of Guyana, which is 21.5 million hectares. The annual average deforestation from 2011 to 2022 is 10.16 thousand hectares, signifying the yearly loss due to deforestation. This translates to a forest loss rate of 0.056% per year during that period – one of the lowest in the world

2 CO_2 removals from forests have been calculated in the GHG emissions inventory of Guyana for the period 1990-2022, presented in this BTR.

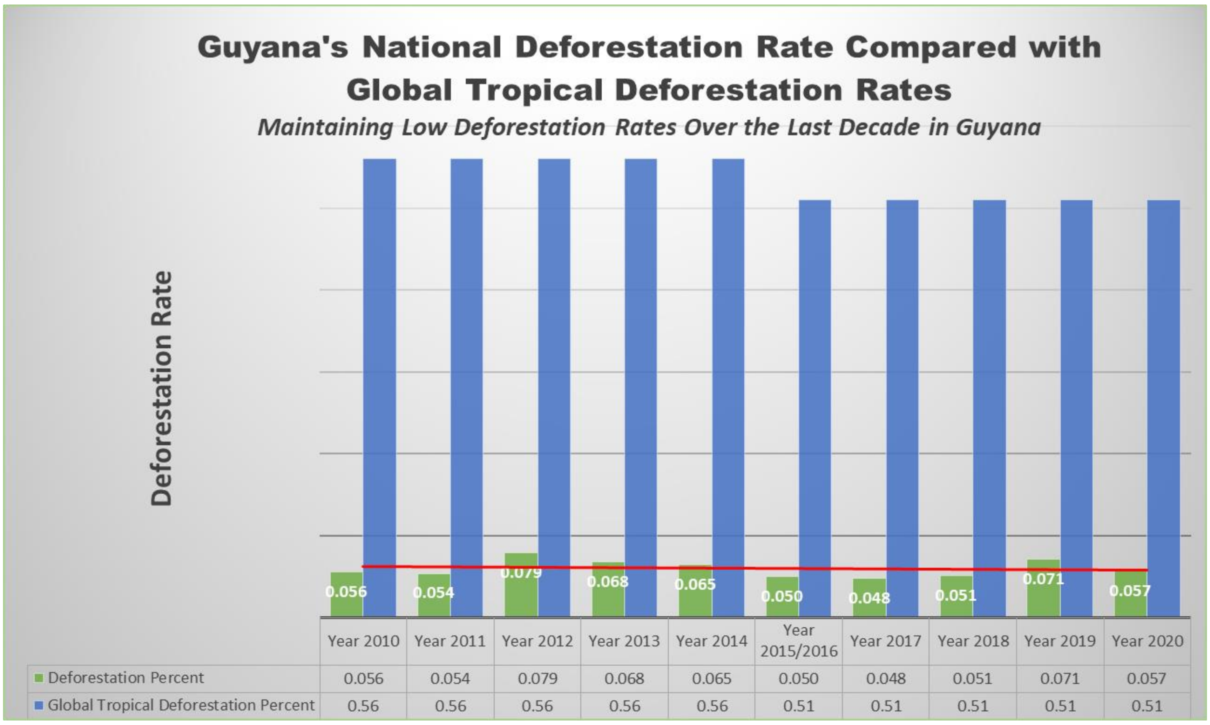


Figure 1.6. Forest lost from 2010 to 2020 [37].

According to the national Reducing Emissions from Deforestation and Degradation (REDD+) Monitoring Reporting and Verification System, also known as the MRVS, gold mining stands out as the predominant driver behind deforestation in Guyana. Additional factors impacting on deforestation include fires, agricultural conversion, infrastructure development for forestry, and settlements change [38].

There are numerous products derived from the forest resource that are both timber and non-timber in nature [39]. Guyana's forest resource is dominated by mixed forest types.

From the 12.5 million hectares of state forest, 4.8 million ha are allocated for sustainable production, with 59.9% of that allocated area for large concessions. In 2021, the Forestry Sector contributed 1.2% to the non-oil GDP. Production in 2021 was 380,000 m^3. The sector is estimated to employ around 22,000 people.

Guyana continually enhances a policy and regulation framework that aims to maintain the forest with very low levels of deforestation and degradation. Guyana has established a selective logging procedure in all concessions, including a system for log tagging allowing the tracking of any log back from where it has been cut in the forest. The deforestation associated to logging is practically zero, and the greenhouse gas (GHG) emissions associated to logging are accounted as degradation. Guyana signed a Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement (FLEGT VPA) with the European Union (EU) in December 2022.

Preserving Guyana's forests is critical for mitigating climate change, given their significant role in absorbing carbon dioxide. The country actively engages in the REDD+ (Reducing emissions from deforestation and forest degradation) framework, part of the Paris Agreement, enabling it to receive payments for reducing deforestation and pursuing climate-friendly activities [40]. Guyana's focus on trading forest carbon stocks brings economic benefits, notably through its partnership with Norway, from which Guyana received over US$220 million in result-based payments, followed by entry into the voluntary carbon markets which has seen Guyana receive a total of US$187.5 million by the end of

January 2024 and a further US$100 million anticipated for the remainder of the period covered by this BTR (up to end 2022) [41].

Arable Land and Agriculture

Cultivated through regular ploughing or tilling, and following a crop rotation system, arable land is an important natural resource for Guyana. According to the data from the World Bank, in 2021 it accounts for approximately 420,000 hectares (2.1% of Guyana's total land area), which computes to approximately 0.52 hectares per person [43]. The arable land is the basis for Guyana's enviable food security, agriculture's contribution to its GDP, rural employment, exports, and foreign exchange earnings. The bulk of the arable land is located on the coast and along the banks of the main rivers.

A pillar of the national economy, the agricultural sector contributed 13% to Guyana's GDP in 2021 and 25% for the non-oil GDP [44]. In Ministry of Agriculture's Performance Report 2015-2020, is estimated that it was close to 16% of GDP, providing over 17.8% of employment, and constituting almost 26% of Guyana's export earnings [45]. Furthermore, an average of approximately 5% of the national budget is dedicated to the agricultural sector [45].

The substantial contributions of agriculture are expected to endure. An estimated 1.74 million hectares are under agrarian production with rice, sugar, and coconut (90,000, 48,000, and 25,000 hectares, respectively) (Figure 1.7). Non-traditional crops (crops other than rice and sugarcane) occupy 40,000 hectares. Roughly 68% of the country's land can accommodate agricultural activity. Most of the agricultural activities are carried out on the Coastal Plain in Regions 2, 3, 4, 5, and 6 [24].

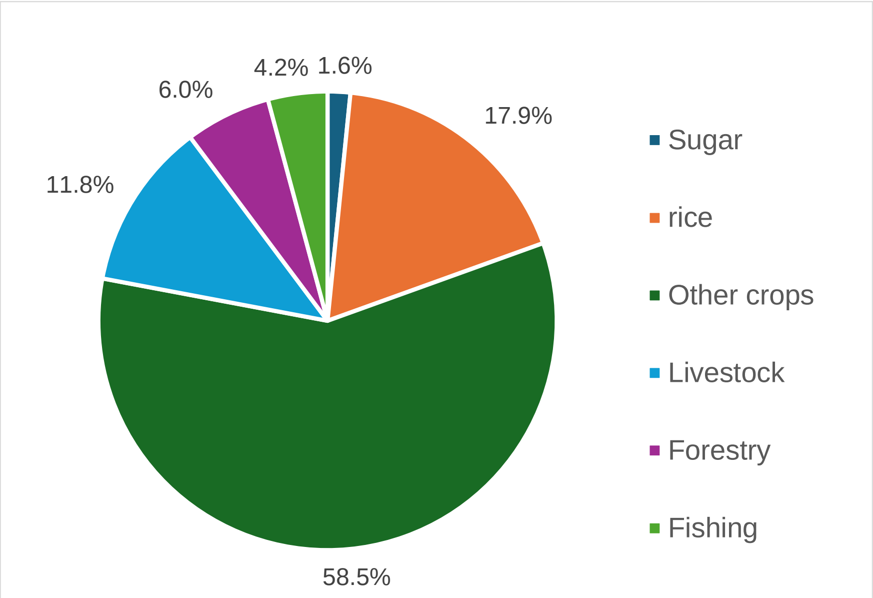


Figure 1.7. Economic contribution to Agriculture Share in GDP [46].

Agriculture has expanded in the Intermediate Savannahs, Rupununi Savannahs, other hinterland areas, and riverine communities. These areas will be in addition to Canal Polder 1, 2 and 3 (areas designed and modified specifically for large-scale production). Agricultural diversification and product transformation have also been promoted in areas such as Bina Hill, Ebini, Manari, and Hosororo. Drought has negatively affected agriculture in Region 9 - Upper Takutu-Upper Essequibo over the past few years.

Agriculture is one of the key sectors for the diversification of the economy. The government plans are to increase production of agriculture without deforesting the forest land.

The Ministry has followed a strategic path focusing on decreasing disaster risk, improving productivity, and encouraging exports. Programs aimed at disaster risk reduction involve activities related to drainage, irrigation, and hinterland development. Simultaneously, endeavours to amplify productivity and exports centre around utilizing technology and extension support to enhance agricultural productivity and fostering market-driven production through initiatives promoting exports and substituting imports [45]. These efforts to enhance the national capacity to contain disaster risks are reflected in the Guyana country work programme for comprehensive disaster management 2021-2025 [47] implemented under the Sendai Framework [48]. Under the programme a detailed analysis of the quality and readiness of the Comprehensive Disaster Management (CDM) and Disaster Risk Reduction (DRR) capabilities was conducted. The outcome attests overall satisfactory results, with disaster preparedness and mitigation scoring highest.

Fisheries

This is an essential natural resource for Guyana and comprises marine fishery, inland fishery, and aquaculture. It serves as one of the primary sources of relatively cheap protein for the country and contributes 1.2% to 2% to Guyana's GDP [49, 50].

In 2017, the fisheries sector employed an estimated 8,386 people, reflecting a growing trend from 2015 when the total was 7,760 individuals. Numerous individuals derived indirect benefits from occupations associated with fishing, including boat building, supply, and repair [51].

Freshwater or inland fishing activities are conducted in the rivers, lakes, swamps, and flooded plains mainly for subsistence. The only commercial exploitation in this sector is for ornamental fishes. Aquaculture is pursued on a small scale on the coast in empoldered areas bordering the seashore and in ponds. In marine fisheries, the target species is mainly shrimp and prawns [52].

Water

Guyana´s enormously rich hydrological profile includes renewable internal freshwater resources per capita of 314,963 m^3, ranking Guyana the country with the third highest quantity of freshwater per capita globally. Most other countries around the world have renewable internal freshwater resources per capita of fewer than 100,000 m^3. This is a critical resource for domestic purposes as well as for the country's economically essential industries, such as agriculture and mining. Agriculture utilizes an estimated 94% of extracted water [53].

In terms of the total estimated freshwater supply, the Essequibo, Demerara, and Berbice Rivers contribute an estimated 55.8 % of the freshwater supply for the country. The plentiful supply of freshwater is enormous (defined as >400,000 litres/min) quantities for 8 months annually (wet seasons) and large (4,000-40,000 l/min) to very large (40,000-400,000 l/min) quantities for 4 months annually (Table 1.3).

Table 1.3. Fresh water flow of three main rivers in Guyana [54].

Name of River	Total Annual Flow (km3/yr)	% freshwater in Guyana
Essequibo River	1,247	40.4
Demerara River	153	5.0
Berbice River	322	10.4
Total	1,722	55.8

Despite having institutions, agencies, policies, and regulations dedicated to fostering effective water management, Guyana continues to confront various water-related challenges. These include insufficient irrigation water supply during dry seasons, flooding in farming and residential areas during wet seasons, and the contamination of potable water supplies [55].

Biodiversity and Protected Areas

Guyana is estimated to have more than 8,000 plant species, including numerous endemic species. According to the Convention on Biological Diversity, 6,500 of the total floral diversity have been identified and 50% are considered endemic [56].

There are also unique landscapes, such as the Kaieteur National Park, which hosts a unique assemblage of plants. The rich fauna encompasses around 1,815 recognized species of fishes, amphibians, birds, reptiles, and mammals [57].

Guyana has more than 400 species of fish with at least 10 new species found annually for the last five years in areas such as the Mazaruni Basin [58]. There are over 130 species of amphibians with several endemic species: 814 species of birds and over 200 species of mammals [59]. There are more than 1,600 species of arthropods with significant discoveries being made within the last five years. The count on the number of fungal and bacteria species is 1,200 and 33, respectively. In terms of nematodes and algae, there are 13 and 44 species, respectively; 17 molluscs, and an estimated 30 viruses [30].

Guyana, as one of the eight nations in the Amazonian Cooperation Treaty (ACTO), plays a role in preserving the extensive biodiversity of the Amazon, recognized as the world's largest tropical rainforest [56].

In terms of agricultural biodiversity, 85% of the fruits and vegetables that are cultivated are landrace varieties. Currently, 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 [61].

For livestock, various types are reared including poultry, goats, sheep, cattle, swine, horses, and mules. Although the different kinds of livestock reared are not as diverse, there is a high diversity in terms of breeds. These breeds are mostly exotic and are interbred with local breeds to improve production. Livestock and crop breeding falls within the purview of the Guyana Livestock Development Authority (GLDA) and National Agricultural Research and Extension Institute (NAREI) respectively.

Guyana has several protected areas which include the Kaieteur National Park, Iwokrama International Centre for Rain Forest Conservation and Development, Shell Beach and Kanuku Mountains Protected Areas, and Kanashen Amerindian Protected Area, as well as the urban parks including the National Park, Botanical Gardens, Zoological Park, and Joe Viera Park. Guyana’s protected areas currently account for approximately 8.4% of the country’s landmass [62].

Climate Profile

Guyana's climate, defined by tropical conditions, the influence of northeast trade winds, and notable regional variations, significantly moulds the nation's ecosystems and susceptibility to climate-related hazards. This intricate interplay of winds, convection currents, and orographic lifting, give rise to a Tropical Marine Climate, nurturing persistent humidity and resilience within Guyana's ecosystems [63].

The mean temperature is 27.5°C [64]. The average daily temperatures vary across regions, ranging from 20°C to 32°C [12] approximately. Coastal areas maintain temperatures between 25°C and 27.5°C, while highland regions have temperatures ranging from 20°C to 23°C [65]. Guyana's climate features a Tropical Savannah Climate in the Savannahs. Humidity is high all year round.

Guyana experiences two distinct rainy seasons influenced by the annual migration of the Inter-Tropical Convergence Zone (ITCZ): mid-April to mid-August and mid-November to January in the north, and a singular wet season from May to July in the south [66]. Rainfall during the rest of the year is influenced by northeasterly winds coming from the Atlantic as well as convection currents and Orographic lifting. The northward movement of the ITCZ generally brings heavy rainfall [65]. The Upper Mazaruni Mountains, receiving over 4,000 mm of rainfall, contribute to the country's intricate humid climate [67], as well as the 2,200 mm average rainfall along the coast. The city witnesses an average annual rainfall of approximately 2,300 mm, while in the Savannahs, only one wet season occurs [66].

According to the 2022 World Bank report [10], recurrent flooding from rainfall impacts Guyana's residents during two annual rainy seasons. Projected economic repercussions of rainfall-induced flooding are anticipated to surge by approximately 60% toward the middle of the 21st century due to climate change. By mid-century, an estimated tidal flood with a 20% chance of occurring in any given year could lead to a $150 million USD economic damage, and a storm with a similar probability may flood nearly 5,000 households and over 1,000 commercial or industrial buildings in Georgetown alone, resulting in around $ 30 million USD of economic damage. To address these challenges, key strategies include emergency and extreme events/flood control and management, sea defence enhancement and maintenance, and the reinforcement of drainage and irrigation systems. This complex interplay of geographical, geological, and climatic factors provides the backdrop for a comprehensive examination of Guyana's National Circumstances amid the ongoing challenges posed by climate change.

Climate Change Trends

The climate in Guyana varies significantly across the country and between seasons. According to Guyana’s Second National Communication on Climate Change, the following climate trends were observed since 1960:

- Mean annual air temperature has increased with up to 0.3°C, or an average rate of 0.07°C per decade [68].
- Mean annual precipitation has increased at an average rate of 4.8 mm per month per decade, or 2.7% per decade.
- Sea level rise has increased at a rate more than 10 mm/year, which is 2 to 5 times faster than the global estimate.
- Change in seasonality: Rainy seasons have become shorter and more intense, leading to a reduction in agricultural production and events such droughts in dry areas and floods and saltwater intrusion in areas experiencing heavy rains and/or in coastal settings. Seasonal changes in temperature and variability in precipitation are very sensitive to the El Niño-Southern Oscillation (ENSO) cycle resulting in rainfall deficits (e.g. 2023-2024 El Niño) and excesses (e.g. 2020-2023 La Niña).

Climate Impacts and Vulnerabilities

Guyana has been impacted by a number of climate-related disasters in recent decades that have resulted in major economic losses and infrastructural damages. Climate sensitive sectors such as agriculture are not only important in terms of export revenue earnings, but critical to safeguarding local food security and nutrition for the Guyanese. High-intensity rainfall events and tidal action have resulted in several major floods, such as in 2005 where an estimated $52.6 million USD worth of damages was felt by Guyana's agriculture sector, impacting 69,560 thousand mainly rural households. The country-wide damages from the same event amounted to $465 million USD, or 60% of the GDP [69]. The rice sub-sector was impacted the most with flood damages of $8.8 million USD, while other crops (including fruit, vegetables and tubers) faced losses of $7.8 million USD. Severe floods and damages occurred in subsequent years making the ability to recover and build back stronger, very challenging, flooding were experienced in 2006, 2009, 2010, 2015, 2017 and 2021. The first half of 2021 saw catastrophic flooding and impacted large parts of the population, over 29,900 hectares (17,500 hectares of cash crops and 12,500 hectares of rice) of farmlands and over 20,000 farmers were affected.

While sea levels are rising on a global scale at a rate of 2-4 mm/yr [70], past model results indicate that sea level in the region of Guyana is increasing at a rate in excess of 10 mm/yr - or 2 to 5 times faster than the global estimate [71]. Model predictions for Guyana indicate that mean sea level is projected to rise in Guyana by up to 26 cm by the 2030´s, 43 cm by the 2050´s, 5 cm by the 2070´s [69] and by as much as 80 cm by the year 2100 [72]. When storm surge heights are incorporated in the projections, expected storm surge heights may be close to 3 m in the minimum scenario, and close to 6 m in the maximum scenario by the 2030´s [73].

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.

Drought events have also become more pronounced in recent years. In 2010, drought also caused severe losses and damage to the country's agriculture sector with overall costs estimated at $14.7 million USD and over 4,050 hectares of rice, livestock and other crops lost. In a recent report published by the United States Department of Agriculture Foreign Agriculture Service, it was indicated that in 2016 up to 20% of the first-crop rice [74] that was grown in the month of January was affected by prevailing drought conditions and another 15% was impacted by saltwater intrusion. In 2023, Guyana has gone through a drought period, with low rainfall during the two wet seasons [75].

The coastal zone's sensitivity to climatic changes is a function of its geographic setting, biophysical characteristics and its economic importance. In terms of geographic setting, the area is situated along a low-lying coastal plain that is highly susceptible to the impacts of sea level rise and saltwater intrusion. Regions 2 through 6 are generally flat and significant sections of the coastline are below sea level, measuring up to a meter below mean sea level in some places [69]. Even Georgetown, the country's capital, is mostly below sea level and depends on dikes and other forms of coastal protection to avoid inundation from the Demerara River and the Atlantic Ocean. The area is also vulnerable to storm surge, coastal erosion, and riverine flooding. Much of the coastal plains already flood during high tide. In response to these ongoing threats, the GoG has had to spend millions of dollars in recent years to rehabilitate seawall defences, a situation that will be made worse as mean sea level continues to rise.

The physical characteristic of the area also heightens its vulnerability, particularly to saltwater intrusion. The coastal plain is made up largely of alluvial mud swept out to sea by the Amazon River, carried north by ocean currents, and deposited on the Guyanese shores. As such, Guyana does not have a well-defined shoreline and a significant portion of the coastal zone is made up of reclaimed land. The area is therefore highly susceptible to saltwater intrusion which threatens an already fragile underground freshwater system. Added to this, drainage throughout most of the coastal zone is poor and river discharge is slow owing to the flat topography of the area. The average gradient of the main rivers is only about one meter every five kilometres. This low gradient and poor drainage account for the highly dense network of irrigation canals seen throughout most of the coastal region. Without these drainage infrastructures most land in the coastal region would not be suitable for crop cultivation.

Socioeconomic Profile

Economy

Guyana´s traditional economy was based in agriculture and mining, yet at the end of 2019 oil extraction started, and the economic profile is changing. Over the last 16 years, the average Constant growth rate GDP in constant 2012 prices have been 11.1%, with a minimum of 0.7% in 2015 and a maximum in 2022 at 63.3%. This demonstrates that Guyana's economy has tripled over the past years. The notable spikes (Figure 1.9) in recent years are primarily attributed to the expansion of oil production since 2019 and substantial growth in the non-oil economy including a significant scale-up of infrastructure investment to support growth in other industries. In fact, the GDP growth of the non-oil sector was 4.6% in 2021 and 11.5% in 2022 [77].

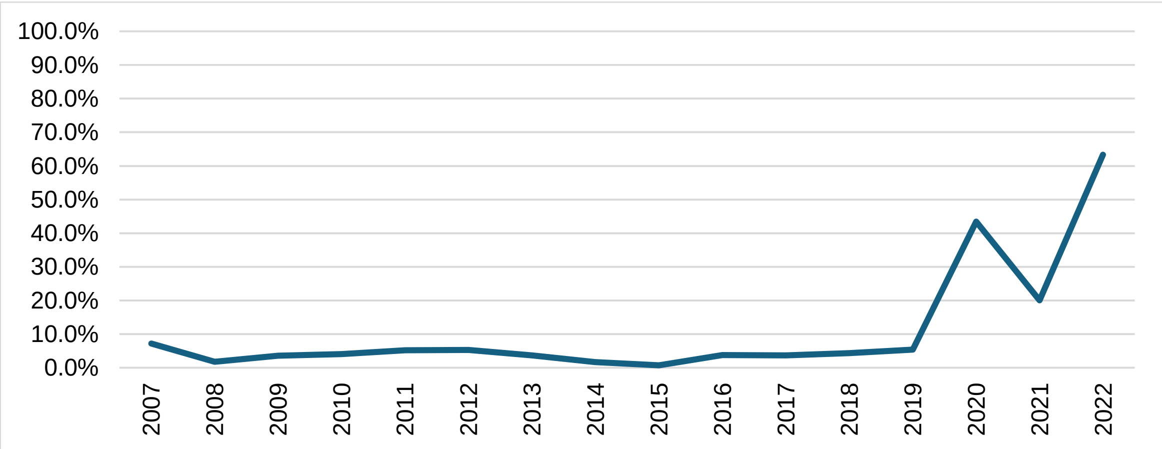


Figure 1.8. Constant growth rate GDP at purchaser prices [78].

Guyana stands as one of the fastest-growing economies, according to the World Bank [10], with promising indicators and a dynamic economic structure. The official currency is the Guyanese dollar, and the exchange rate is regularly adjusted, currently standing at G$210.34 (Jun 2023) to $1 USD [75] (.

As per the Bureau of Statistics, in terms of inflation, the monthly average hovers at a modest 0.3% (August 2023 - September 2023). The provisional data for the year reveals a robust economic performance, with exports reaching $11.3 billion USD and imports at $3.61 billion USD. This trade dynamic results in a substantial surplus of $7.69 billion USD in the overall commercial balance [75].

Guyana's economic structure is diverse, with key sectors including agriculture (focused on rice and Demerara sugar), bauxite mining, gold mining, timber, shrimp fishing, minerals, tourism, and services. According to the data until 2021, the agricultural sector was contributing over a quarter to the GDP. Additionally, the service sector contributed to more than half of Guyana's non-oil GDP in 2019, with tourism being the second largest export sector after gold, and sugar (and its by-products) and rice accounted for most of the agricultural exports [80]. However, 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.

Historically rooted in natural resources and agriculture, Guyana is advancing a diversification programme of its domestic economy. While the oil and gas sector present opportunities, there is an early recognition of the risks associated with overreliance on this industry. Sustained real non-oil GDP growth is also expected, as the government continues to invest in human capital, lower energy costs, and build infrastructure, including for climate change adaptation [4]. 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. The diversification of the economy will include agriculture development.

Data from the World Bank [10] indicates that oil exports alone accounted for about 88% of total exports in 2022. Excluding oil, the major contributors to exports are sugar, gold, bauxite, shrimp, timber, and rice, representing nearly 90% of the country's non-oil exports. This emphasizes the importance of economic diversification for long-term sustainability and resilience against external shocks.

The public sector gross debt was 26% of the GDP and is expected to continue in the same levels over next years.

Guyana’s Human Development Index (HDI) in 2021 was 0.714, position Guyana in 108 out of 191 countries [82]. Between 1990 and 2021 Guyana’s HDI increased by 40.3%. Guyana’s Gender Inequality Index was 0.454 ranking 114 [83]. Women usually participate in agricultural production; however, some are not remunerated in family run businesses. Women represent a higher percentage of Unpaid Family Workers in the agricultural sector [84] compared to the percentage of men Unpaid Family Workers.

Population and Demographics

The Guyana Bureau of Statistics conducts population census approximately every 10 years with the latest census conducted in 2012 [85]. The following figure illustrates population growth between 1946 to 2022. According to the Pan American Health Organization [86], the population structure has evolved irregularly due to various migrations, resulting in certain age groups predominating national demographics. Once expansive until 1980, population growth stagnated until 2012 with occasional episodes of decline, until a recent 8% growth observed in the past decade attributed to significant economic development, manifesting in Guyana's current demographic landscape, with a population of 808,726 (Figure 1.10).

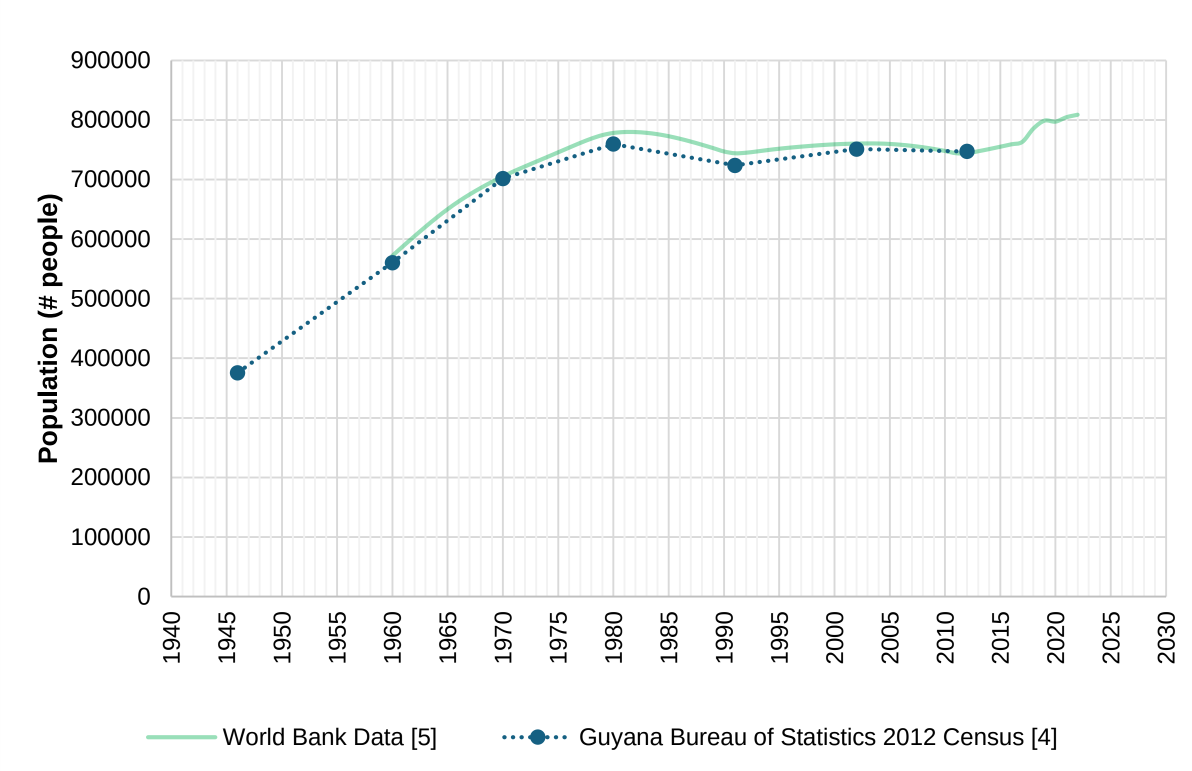


Figure 1.9. Estimated Population by year [78].

As illustrated in Figure 1.11, the population evolution resulted in a structure by 2015 featuring an expansive group older than 40 years of age and below 20 years of age, with a notable 88% of the population being younger than 55 years. Such pattern is observed from elevated fertility rates and relatively low life expectancy, coupled with bi-directional migratory patterns.

The crude birth rate was 20 and 19 per 1,000 population in 2012 and 2014, respectively. The rate remained constant at around 8 per 1,000 population in the years 2012 through 2015. Infant mortality rates experienced fluctuations during the period 2010-2013, reaching a peak of 23.9 per 1,000 live births in 2014. The total fertility rate in 2012 stood at 2.6 children per woman in the 15-49 age group, while life expectancy at birth in 2014 was reported at 66.4 years by the Pan American Health Organization [86].

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, with 49.7% male and 50.2% female as of 2012 [87] (Figure 1.12).

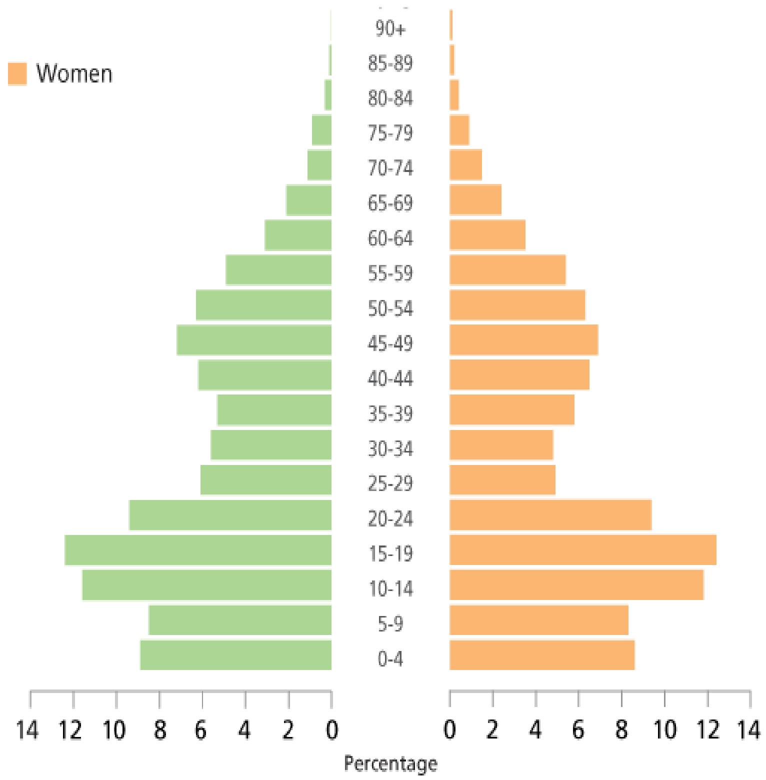


Figure 1.10. Population Age-Sex distribution 2015 [87].

Approximately 89% of the national population resides on the narrow coastal strip, constituting only 10% of the country's total land area [88]. The highest population density occurs in Region 4: Demerara-Mahaica, accounting for over 41% of the total national population. The Administrative Regions with the lowest population densities are those most distant from the coast, namely Region 7: Cuyuni-Mazaruni, Region 8: Potaro-Siparuni, and Region 9: Upper Takutu-Upper Essequibo (Figure 1.12).

Continued urbanization migration patterns are observed as challenges persist in the hinterland. Such high population density in the coastal strip increases the potential impact of climate change-induced events, such as flooding and sea-level rise, posing substantial challenges for the well-being and resilience of the population in these vulnerable areas.

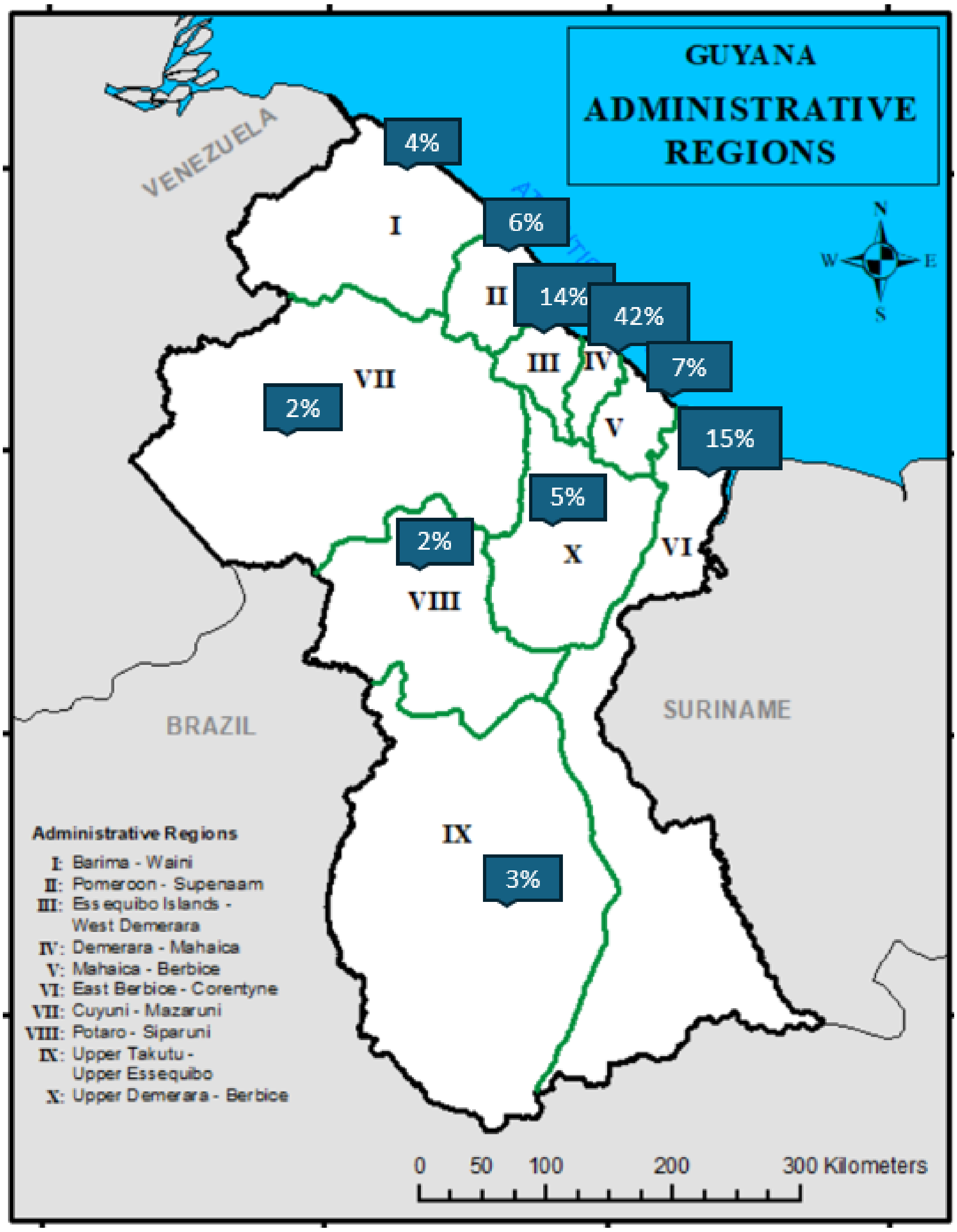


Figure 1.11. Regional population distribution [89].

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 Indigenous peoples, the original inhabitants. These include Indo-Guyanese (40%), Afro-Guyanese (26%), Amerindian (11%), and ethnically mixed individuals (20%). Minor ethnic groups such as the Chinese, Portuguese, and white populations collectively constitute less than 1% of the total population [90].

Ethnic groups also exhibit distinct territorial distribution, with Indigenous populations more prevalent in rural areas. The country has migrants from Suriname, Brazil, Venezuela, and Caribbean countries.

The languages spoken include English, Amerindian dialects, Creole, Hindi, and Urdu [91].

Education plays a pivotal role in societal advancement, and in 2022, Guyana reported an average national illiteracy rate of 10% [87]. Overall, the country's illiteracy rates for males and females were 11.1% and 10.2% respectively.

As per the latest available figures, in 2022, the overall unemployment rate, calculated from the workforce aged 15-64, was 12.4%, while the unemployment rate of the 15- to 24-year-old workforce (youth) stood at about 25%.

Infrastructure

Improving the existing infrastructure is one of the key development objectives of the Government of Guyana, with large investments over last 2 years. As a result, the numbers discussed below are expected to change in the coming years.

Road network

There is a total of 2,604 km of roads in the national network (428 km primary roads, 583 km secondary roads, and 1,593 km interior roads). Paved roads only account for 35 % of the total road network and unpaved 65%.

Sea defences

The main area of focus is from Pomeroon to the Corentyne River (230 km). The country has 169 km of earthen embankments, 69 km of masonry seawalls, and 78 km of sand banks protected by the 80,432 hectares of mangroves in several places. The sea defence is supported by an intricate drainage and irrigation system consisting of dams, canals, and sluices.

The Government is working to develop green-grey solutions (engineered infrastructure-mangroves). Green-grey technologies use a combination of engineered infrastructure and natural solutions such as mangrove ecosystems to capture sediments and speed up the natural process to reclaim areas and later naturally regrow the coast. Beside the additional area reclaimed to the sea, the green-grey solutions provide other benefits, like reduction in flooding and other ecosystem services like carbon capture, increase fishing stock, increase biodiversity, apiculture, or ecotourism opportunities [41].

Drainage and irrigation

Guyana's drainage and irrigation system is a network of conservancies, canals, sluice gates/kokers, and puMoPWng stations for flood control, and water storage and distribution for agricultural and domestic purposes and drainage. In the event of heavy rainfall, which may result in the conservancies becoming full or near capacity, water is released using a gravity-dependent drainage system of canals leading to the sea (or rivers). The release of water to the Atlantic Ocean is regulated by the 136 sluice gates/kokers located in the 109.27 km of seawall. The conservancies store water during the dry seasons.

The drainage and irrigation system has 500 km of main irrigation canals, 1,100 km of secondary canals, 500 km of main drainage channels, and 1,500 km of secondary drainage channels. The National Drainage and Irrigation Authority (NDIA) operates 58 D&I pumps supported by earth moving equipment for maintenance and rehabilitation.

Deterioration of drainage and irrigation and sea defence structures is due to both anthropogenic factors (poor maintenance, mangroves deforestation) and natural factors (longshore drift).

Energy

Current Energy Usage

According to the report from Guyana Light and Power (GPL), the exclusive electricity provider in Guyana, 97% of the energy produced in the country is generated using fossil fuels, specifically Heavy Fossil Fuel and diesel [95]. These petroleum-based products are simultaneously dependent on Guyana importing them, indicating a heavy reliance on imported petroleum-based fuels for the country's energy sector. Import of petroleum-based fuels include products such as diesel, fuel oil, motor gasoline, avjet (jet fuel), avgas (aviation gasoline), kerosene, liquefied petroleum gas (LPG), and liquefied natural gas (LNG).

The table and figure below (Table 1.6, Figure 1.13) illustrate the total annual fuel imports by product for the years 2017-2022 and tracks the changes in fuel imports over this period.

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 [7]. 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 [7].

Table 1.6. Total annual imports of petroleum-based products for 2017-2022 (barrels) [7].

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

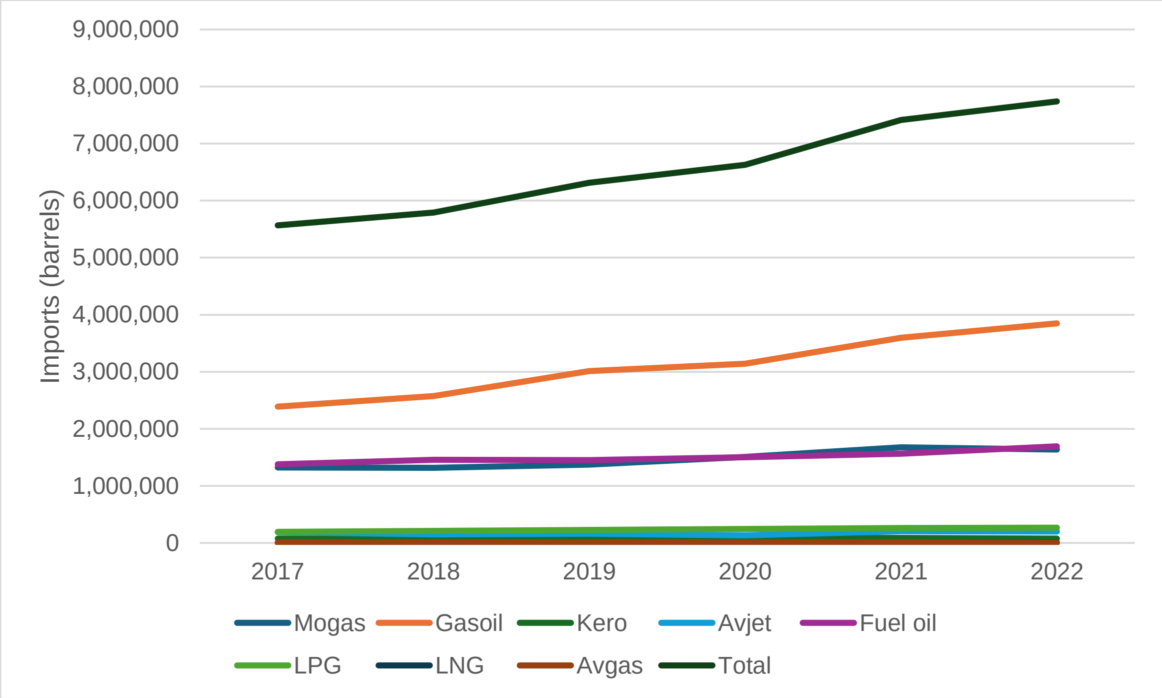


Figure 1.12. Total annual imports of petroleum-based products for 2017-2022 (barrels) [7].

Over the past five years, the most imported products were gasoil, accounting for 46.8% of the total fuel products imported in 2017-2022, followed by fuel oil at 23.1% and mogas at 22.5% (Figure 1.14). 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.

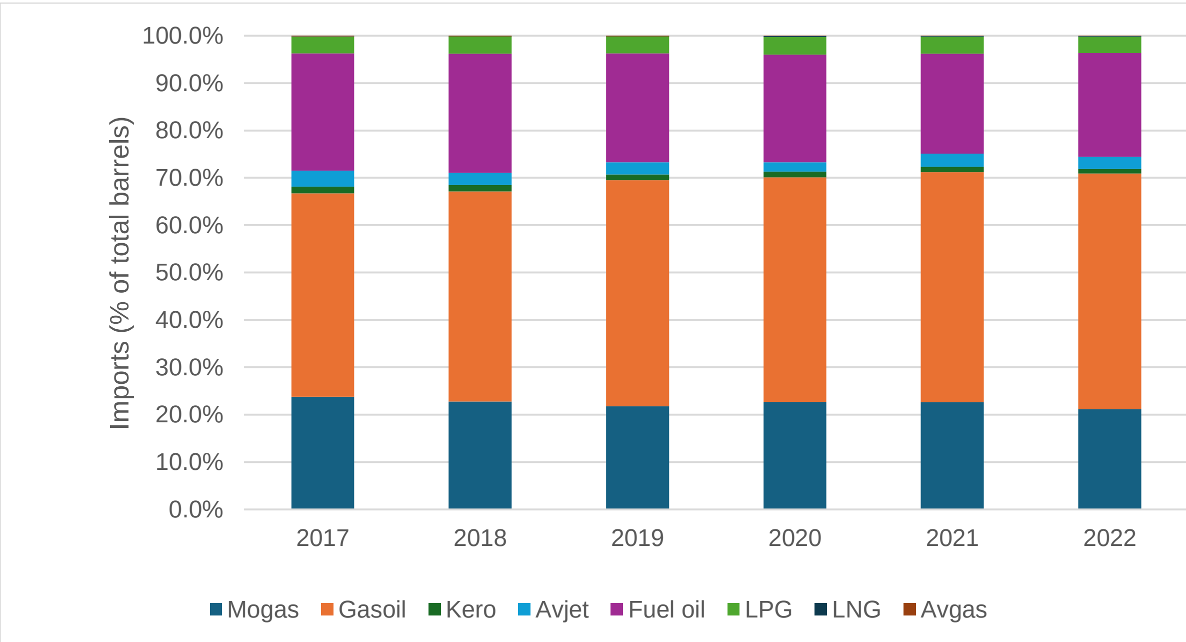


Figure 1.13. Average annual imports of petroleum-based products for 2017-2022 (barrels) [7].

All of Guyana's oil production is directed towards exports. In the year 2021 alone, the country exported a total of 42 million barrels of oil [7].

A comparable upward trend of total annual consumption of petroleum-based products, as observed in imports, is evident from 2017 to 2022. The provided data (Table 1.7, Figure 1.15) illustrates total fuel consumption by product for the period 2017-2022 and the corresponding changes over time. 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. The evidence 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 1.7. Total annual consumption of petroleum-based products for 2017-2022 (barrels) [7].

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**

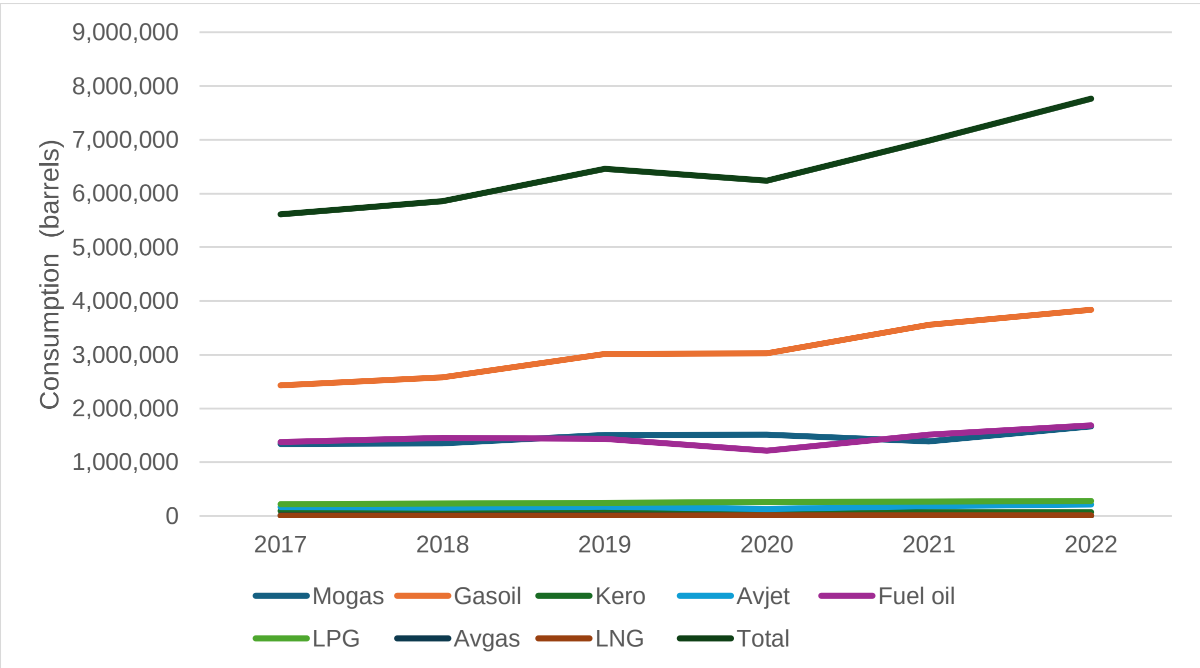


Figure 1.14. Total annual consumption of petroleum-based products for 2017-2022 (barrels) [7].

Over the past five years, 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 1.16). 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.

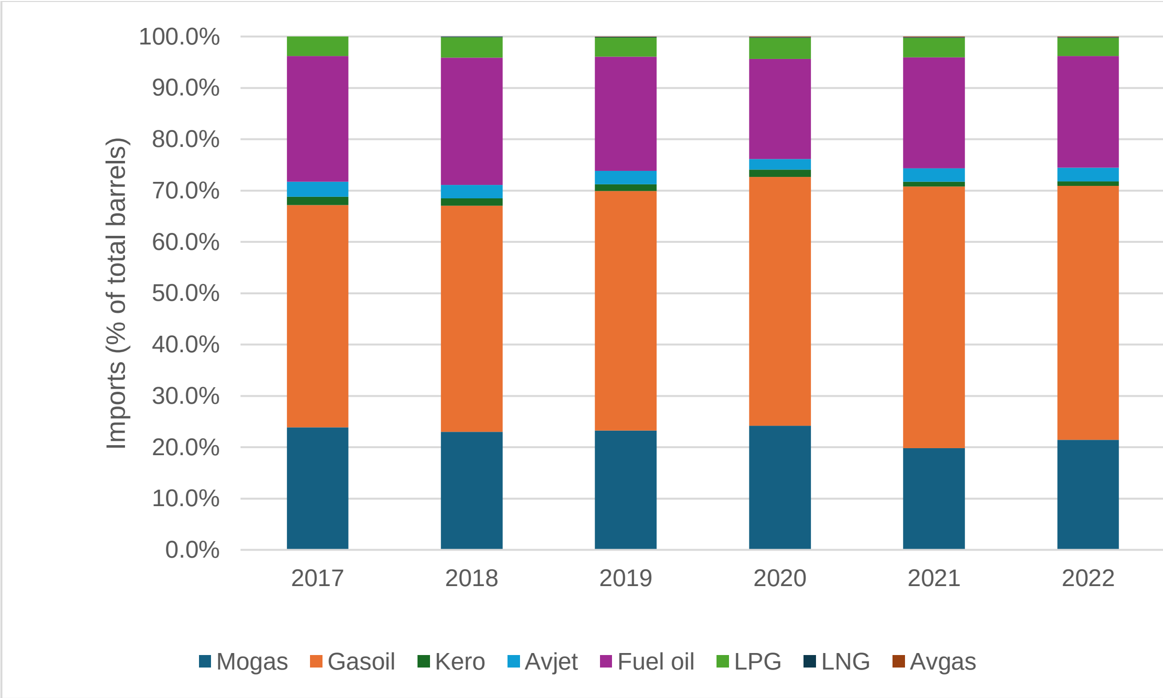


Figure 1.15. Average annual consumption of petroleum-based products for 2017-2022 (barrels) [7].

Guyana's energy dependency rate on imports (Table 1.8) is exceptionally high. 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. This underscores Guyana's substantial reliance on imported petroleum-based products, which constitute the primary source of its energy.

Table 1.8. Imports and consumption of petroleum-based products for 2017-2022 (barrels) [7].

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%

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. The accompanying figure (Figure 1.17) illustrates the final consumption by sector for Guyana from 1990 to 2020.

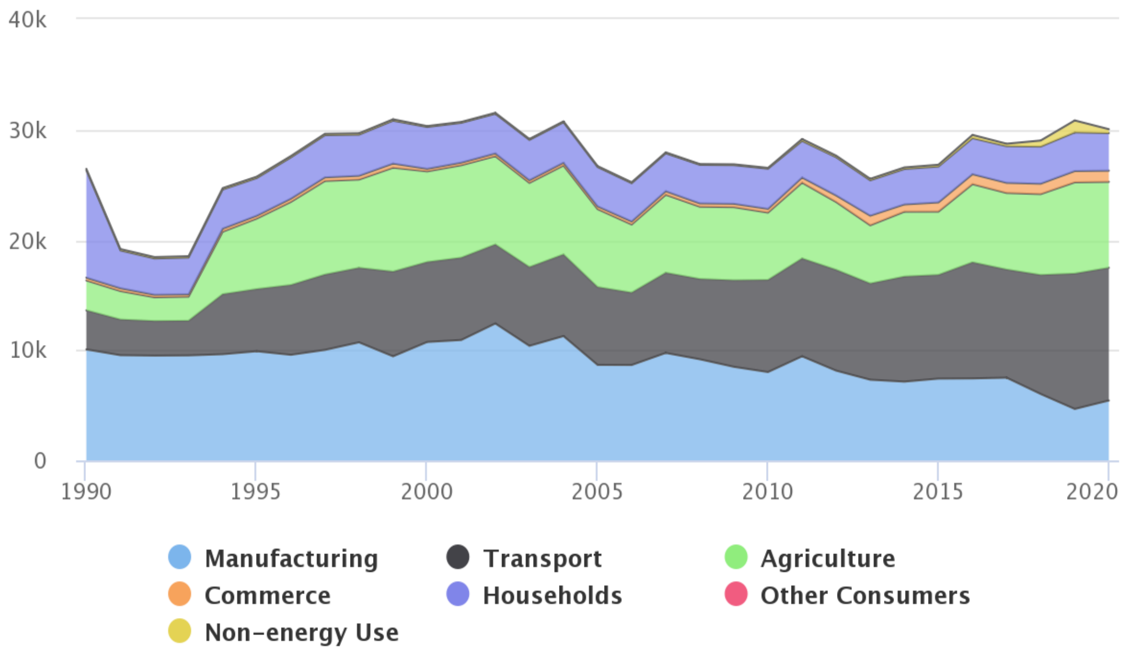


Figure 1.16. Final consumption by sector in terajoules (TJ) [97].

Aligned with the reported trends, the United Nations Economic Commission for Latin America and the Caribbean indicates that in 2020, nearly 75% of total fuel products were allocated to the transportation and electricity generation sector. In 2021, the breakdown shifted with 37% of fuel consumed for transport, 32% for electricity generation, 26% for agriculture, forestry, and fishing, and 6% for non-electric building purposes. The electricity generated in total amounted to 1,138 GWh [95].

The Energy Agency's Annual Report [98] anticipates increased gasoline consumption in 2022, likely due to heightened public transport use following the full reopening of schools. A notable uptick in LPG usage suggests a preference for cooking gas over kerosene. The overall surge in fuel oil consumption is linked to expanded bauxite production, increased manufacturing, and higher energy demand from the electric utility. The rise in jet fuel usage corresponds to an increase in international flight travel, while there is a simultaneous decline in the consumption and sales of aviation gasoline.

Recently, more than 80% of the electricity demanded is in the Demerara-Berbice Interconnected System (DBIS) and the rest is consumed in 12 other isolated grids across Guyana. The main grid has currently a cost of generation that varies with the fuel cost. In 2021 the cost of generation of electricity in DBIS was $150 USD/MWh, and grid losses accrued to staggering 24.7% (including technical and commercial losses). The electricity is sold to the end-users at prices between $0.20-0.25 USD/kWh [99]. The other isolated grids have higher generation cost, as they use more percentages of diesel (which is more expensive than heavy fuel oil) and the transport of fuel further increases the total the generation cost. All the grids are operated by public utilities which receive financial support from the central government to keep customer tariffs at lower levels. These subsidies are bigger for isolated grids.

Planned Energy Transition

As set out above, Guyana's historic energy supply has been carbon-intensive and expensive. However, as set out in the LCDS 2030, the country is on the threshold of an ambitious energy situation to change this reality.

Due to rapid economic growth, the demand for electricity has been increasing significantly and is expected to continue growing at a fast pace, (Figure 1.17).

The LCDS 2030, endorsed by the National Assembly in July 2022, includes a transition plan to reduce the dependency of imported fossil fuel and to reduce GHG emissions [100].

The plan outlines the incorporation of natural gas as a transitional fuel for electricity generation, with a gradual integration of solar, wind, and hydro sources to achieve a 60% renewable energy share by 2030. Despite an anticipated sevenfold increase in demand by 2030 compared to 2021, the goal is to maintain GHG emissions at the 2021 levels.

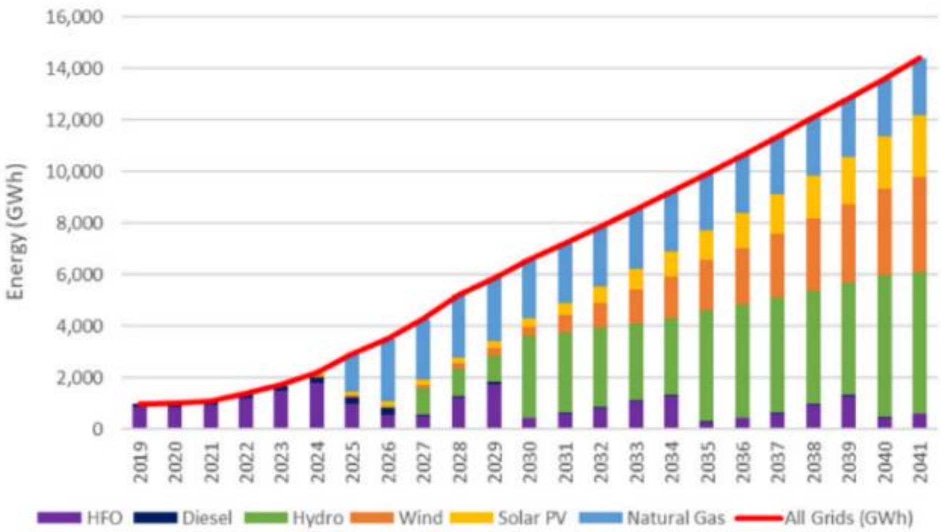


Figure 1.18. Projection of Energy Mix in all public grids (left) and GHG emissions (right) [100].

Guyana has actively pursued an increased share of renewable energy sources and energy efficiency initiatives, incorporating wind and solar farms, small hydropower projects, and promoting energy efficiency in various sectors. Measures include the replacement of inefficient lighting technology with energy-efficient light emitting diodes (LEDs) in households, businesses, and public buildings [26].

Tourism

The tourism sector in Guyana is skewed towards ecotourism which is concentrated mainly in the hinterland regions. The geography of these regions, the geomorphological features, and the array of exquisite fauna and flora make Guyana a prime destination for tourism. As from the Guyana Office for Investment, in 2021, the sector's economic contribution is modest, estimated at 2.3% of GDP, generating 15,700 indirect jobs. The number of tourists increased by 82.1% over 2021, totalling 288,322 in 2022. Tourism contributes to Guyana's Low Carbon Agenda and all 17 United Nations Sustainable Development Goals (SDGs) [101].

Climate Change Policy and Institutional Framework

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 1.9).

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.

Table 1.9. 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
United Nations Convention on Biological Diversity (UNCBD)	Signed on 5 June 1992, entered into force in 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
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (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
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	Adopted on 24 March 1983; Entered into force on 11 October 1986	Ratified on 14 July 2010

Marine Environment of the Wider Caribbean Region and its Oil Spill Protocol		
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 (CITES)	Opened for signature on 3 March 1973; entered into force on 1 July 1975	Acceded on 27 May 1977
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

Department of Environment and Climate Change

The Department of Environment and Climate Change (DECC) supports Guyana's transition to a low carbon state and works closely with agencies such as the Guyana Forestry Commission, Environmental Protection Agency (EPA), Protected Areas Commission (PAC), National Parks Commission (NPC), and the Wildlife Conservation and Management Commission (WCMC). The DECC coordinates all reporting to the UNFCCC.

National Constitution of Guyana

The Constitution of the Co-operative Republic of Guyana of 1980 provides for the protection of the environment by the state and by the people; 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.”

Environmental Protection Act

The Environmental Protection Act of 1996 and its amendment in 2005 serve as the legislative framework for implementing environmental provisions outlined in the Constitution. Encompassing ten sections, these acts address the management, conservation, protection, and enhancement of the environment, pollution prevention and control, impact assessment of economic development on the environment, and sustainable use of natural resources. The Environmental Protection Agency (EPA) was subsequently established in 1996 under these acts, tasked with implementing effective measures for the management of the natural environment and its components. The EPA's jurisdiction spans various sectors, including waste, health, and the environment, with a legislative focus on mitigation efforts.

The EPA also ensures that developmental activities which have the potential to cause adverse effects on the natural environment are assessed before the activities are implemented. 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 greenhouse gas emissions, making a significant contribution to the fight against climate change.

Protected Areas Act

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 aims 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.

Wildlife Conservation and Management Act

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.

Other Key Legislation

There are some other natural resources legislation and those that ensure the country's environment is protected. Among these are:

- Fisheries Act, 20023;
- Amerindian Act, 20064;
- Forest Act, 20095; and
- Mining Act, 19896 and its regulations, particularly, Mining Regulations, 2005.

National Plans/Policies/Strategies

Guyana's commitment to sustainable development is evident through various strategic frameworks and plans.

The LCDS, launched in 2009, positions Guyana on a low carbon, green trajectory. The LCDS, updated in 2013 and subsequently in 2022, aims to transform the economy while providing a model for addressing climate change. Notably, the strategy addresses climate change mitigation, adaptation, and resilience-building priorities [41].

The National Biodiversity Strategy and Action Plan (NBSAP), aligned with the UNCBD, guides biodiversity conservation efforts until 2020 [102]. Additionally, the Aligned National Action Plan (ANAP) works against land degradation, aligning with the UNCCD Strategic Plan [103]. The National Land Use Plan (NLUP) strategically guides land development, promoting multiple land uses [104].

The Draft Climate Resilience Strategy and Action Plan (CRSAP), spanning 2016-2020, outlines key objectives and actions to enhance resilience to climate change across various sectors. This draft Plan informs the development of Guyana's National Adaptation Plan (NAP) [155].

Several pre-existing strategies and plans contribute to Guyana's comprehensive approach, including the National Development Strategy (2001), Integrated Coastal Zone Management Action Plan (2000), National Mangrove Management Action Plan (2001), National Agricultural Sector Climate Change Adaptation Policy (2009), Guyana Climate Change Action Plan (2001), and the National Action Plan for Combating Land Degradation (2006). In 2018, the National Forest Policy Statement and National Forest Plan were revised. The overall objective goal of the National Forest Policy Statement and Plan is "The conservation, protection and utilization of the state's forest, by ensuring its social, economic and environmental attributes and benefits are sustained and enhanced for the benefit of cur-rent and future generations of Guyanese, whilst fulfilling Guyana's commitments under international agreements and conventions".

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

These collectively reflect Guyana's dedication to sustainable development, conservation, and climate resilience.

Mainstreaming Rio Convention Implementation

The Department of Environment and Climate Change, initiated a project funded by the Government of Guyana (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, UNCBD, and UNCCD. 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 (NCSA) to align with post-2015 sustainable development goals.

Following the project, the Guyana Forestry Commission (GFC) has successfully enhanced its capacity, achieving a detailed analysis of emissions through the REDD+ MRVS. The MRVS has significantly improved accuracy and specificity in the commitment to preserving forests. Notably, the MRVS has established a crucial link between indigenous communities and the national level, fostering community engagement. An important impact of the MRVS creation is the recognition by other sectors of the value in establishing similar systems for their respective work. [106].

Development Priorities and Objectives

The key policies, strategies and development plans that were being implemented after Guyana´s third national communication to the UNFCCC published in 2021 are summarized in Table 1.10 – 1.13 by sector. This section provides a comprehensive overview of Guyana's development priorities and objectives across four crucial areas: Agriculture, Natural Resources, Energy, and Climate Change. 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.

Agriculture Sector

Table 1.10. Agriculture 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.
A 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. – Fibre 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:** – 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.
Technology Actions Plan	2018	**Objectives:** – Mitigation and adaptation through prioritized technologies. **Priorities (technologies for agriculture):** – Freshwater Harvesting: Empoldering of Water Collection Areas. – Agrometeorology for Forecasting and Early Warning.
Agriculture Development Strategy 2021-2025 (Draft)	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. – 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.

Forestry Sector

Table 1.11. Forest objectives and priorities.

Forest	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.
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.
National Mangrove Action Plan (NMAP) 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.

Energy Sector

Table 1.12. Energy 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 using a green development strategy. – 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. **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

Climate Change

Table 1.13. Climate change objectives and priorities.

Title	Year	Description
National Determined Contributions (NDCs)	2015	**Objectives:** – Outline Guyana's conditional and unconditional contributions to the UNFCCC's Paris Climate 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.
Technology Needs Assessment project	2016-2018	**Objectives:** – Identify and prioritize technologies for mitigation and adaptation in line with national sustainable development goals. – Identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies. – Develop Technology Action Plans (TAP) to overcome barriers and facilitate technology transfer, adoption, and diffusion. **Priorities:** – Prioritize adaptation technologies in agriculture, water, and coastal zones. – Prioritize mitigation technologies in forests (including mining) and energy.
Climate Change Adaptation Program (CCAP) **Climate Resilient Strategy and Action Plan (Draft)**	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.
Low Carbon Development Strategy (LCDS) 2009 and 2013	2009 and 2013	**Objectives:** – Advance low-carbon development. – Conservation of forest resources and enhance carbon sequestration. – Expand access to low-carbon and clean energy sources. – Engage in international cooperation. **Priorities:** – Implement sustainable land use practices.

		– Invest in green technologies. – Build climate resilience. – Promote stakeholder engagement.
Guyana-Norway Agreement	2009	**Objectives:** – Maintenance of deforestation rates against a set target. – Promote sustainable land use practices. – Performance based payments. **Priorities:** – Effective monitoring and reporting. – Multi-stakeholder 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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Chapter 2 - National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

Introduction

As a Party to the United Nations Framework Convention on Climate Change (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 coMoPWled using comparable methodologies to be agreed upon by the Conference of the Parties (COP).

In this context, national GHG inventories can be defined as a comprehensive account of the annual 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 [1].
- 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 [2].
- The national GHG emissions inventory for the period 1990-2016 reported in the third NC according to the Revised 1996 IPCC Guidelines for National GHG Inventories (in draft) [3].

In this first Biennial Transparency Report (BTR), Guyana presents its 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).

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.

Overview of the National GHG Inventory

Institutional Arrangements for Inventory Preparation

Guyana is actively working on establishing a GHG inventory MRV system that encompasses all relevant sectors.

In the context of the preparation of the GHG emissions inventory prepared as part of this BTR 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 coMoPWle 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 further institutionalise the procedures, roles, and responsibilities for future national GHG inventories.

Definitions and Scope

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)

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.

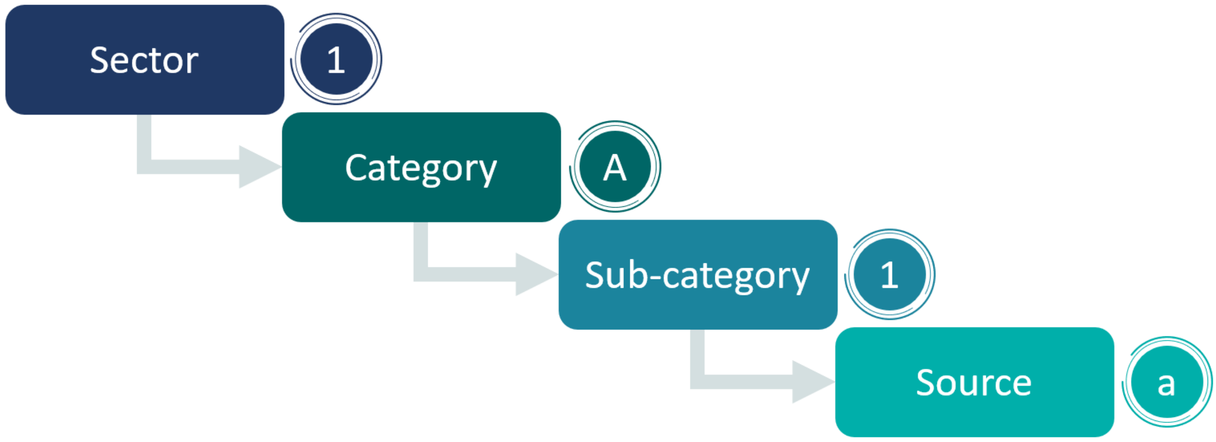

Figure 2.1. Nomenclature of the 2006 IPCC Guidelines.

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 km2. This area includes four biophysical regions: the Coastal Plain, Hilly Sand and Clay, Forested Highland, and Interior Savannahs. The distribution comprises 196,850 km2 of land and 18,120 km2 of water. Notably, Guyana features a 430-kilometre Atlantic coastline to the northeast and extends continentally for about 724 km.

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 used IPCC inventory methodology 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. CO2 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												
Forest Land Remaining Forest Land	T3/T2	CS												
Land Converted to Forest Land	NE	NE												
2. Cropland	T3/T2	CS												
Cropland Remaining Cropland	NE	NE												
Land Converted to Cropland	T3/T2	CS												
3. Grassland	NE	NE												
Grassland Remaining Grassland	NE	NE												
Land Converted to Grassland	NE	NE												
4. Wetland	NE	NE			NE	NE								
Wetland Remaining Wetland	NE	NE			NE	NE								
Land Converted to Wetland	NE	NE			NE	NE								
5. Settlements	T3/T2	CS												
Settlements Remaining Settlements	NE	NE												
Land Converted to Settlements	T3/T2	CS												
6. Other Land	T3/T2	CS												
Other Land Remaining Other Land	NE	NE												
Land Converted to Other Land	T3/T2	CS												
C. Aggregate sources and non-CO2 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 N2O Emissions from managed soils					T1	D								
5. Indirect N2O emissions from managed soils					T1	D								
6. Indirect N2O 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								
CO2 emissions from biomass	T1	D												
CO2 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.
N2O, PFC, and SF6 Emissions from Category 2G – Other Product Manufacture and Use were not estimated due to a lack of data for this category.
CO2 Emissions from Category 3B3 – Grassland were not estimated due to a lack of data for this category.
CO2 Emissions from Category 3B4 – Wetland were not estimated due to a lack of data for this category.
N2O 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.
CH4, and N2O Emissions from Category 4B – Biological Treatment of Solid Waste were not calculated due to the lack of data for this category.
CO2, CH4, and N2O 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.

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 CO2. 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 CO2 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 CO2, and therefore, GWP-weighted emissions are expressed in units of CO2 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 AR5 [4].

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

Quality Control and Quality Assurance Procedures

The national GHG inventory of Guyana is prepared ensuring the quality throughout all steps of the inventory coMoPWlation, 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 coMoPWlation process:

- **Transparency:** There is sufficient and clear documentation such that individuals or groups other than the inventory coMoPWlers can understand how the inventory was coMoPWled 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 coMoPWled. Quality assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory coMoPWlation/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 coMoPWlation of the GHG inventory included in the first BTR, 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 coMoPWlation 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, 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 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 coMoPWlation 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.

Cross-cutting Elements

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 [5].
1A2 Manufacturing Industries and Construction	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request [5].
1A3 Transport	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request [5].
1A4 Other Sectors	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request [5].
1A5 Other	Amount of fuel consumption (TJ)	OLADE Guyana supply and demand data obtained upon request [5].

1B1 Solid Fuels	Charcoal production (kt)	OLADE Guyana supply and demand data obtained upon request [5].
1B2 Oil and Natural Gas	Offshore oil produced	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) [6].
	Offshore oil loaded onto tanker ship	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) [6].
	Offshore gas produced	Oil and natural gas production data obtained from the Environmental Protection Agency (EPA) [6].

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 [7].

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 [8].
3A2 & 3C6 Manure Management & Indirect N_2O emissions from Manure Management	Livestock population (number of heads) from 1990 to 2022.	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 [8].
3B1a Forest Land Remaining Forest Land	Total forest area (ha)	Guyana ART Workbook for REDD+ for period 2011-2022 [9]. Guyana Forestry Commission for period 1990-2010 [10].
	Buffer area (ha)	Guyana ART Workbook for REDD+, held constant for 1990-2015 [9]
	Logging-Skid trail length (km)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
	Logging volume harvested (m3)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
	Total area deforested due to fire and biomass burning (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
3B2b Land Converted to Cropland	Total area deforested due to agriculture (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
	Total area deforested due to shifting cultivation (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2016 [9].

3B5b Land Converted to Settlements	Total area deforested due to settlement (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
	Total area deforested due to infrastructure (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
	Total area deforested due to forestry infrastructure (ha)	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
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 [9].
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 [11].
	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 [12].
	Area burnt of forest from 1990 to 2010	Guyana ART Workbook for REDD+, held constant for period 1990-2010 [9].
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. [11]
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 FAO [13].
	Total urea imported from 1990 to 2021	FAO [14].
3C4 & 3C5 Direct and Indirect N2O Emissions from Managed Soils	Synthetic fertilizers usage for sugarcane from 1990 to 2016	GUYSUCO (Ministry of Agriculture). Complete time series forecasting to 2022. [11]
	Harvested rice area from 1990 to 2022	Guyana Rice Development Board (Ministry of Agriculture) [12].
	Paddy production from 2011 to 2022	Guyana Rice Development Board (Ministry of Agriculture) [12].
	Harvested sugarcane area from 1990 to 2022	GUYSUCO (Ministry of Agriculture). [11]
	Sugarcane production from 2000 to 2022	GUYSUCO (Ministry of Agriculture). [11]

	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 [15].
	Livestock population (number of heads) from 1990 to 2022	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 [8].
3C7 Rice Cultivations	Annual harvested area of rice cultivations in Guyana from 1990 to 2022	Guyana Rice Development Board (Ministry of Agriculture) [12].
	Water cultivation period	Guyana Rice Development Board (Ministry of Agriculture). [16].

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 2012 Census [17] 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 [18].
	Percentage population distribution by region.	Percentage population distribution by region in Guyana was obtained from the Guyana Bureau of Statistics 2002 Census [19] 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 [17]. Projected regional population change rates over 2010-2024 were obtained from the Guyana National Solid Waste Management Strategy 2013-2024 [20]. 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 [20]. 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 in 2010 [21] 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.
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 [3].
	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 [20] and cross-checked with the Analysis of Waste at the Local Level research paper [22], assumed constant throughout the time series.
	Description of Guyana´s SWDS.	SWDS description obtained from Guyana´s Solid Waste Management Strategy 2013-2024 [20], 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 [2].
	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 [20] and cross-checked with the Analysis of Waste at the Local Level research paper [22].
	Annual quantity of CH4recovered 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 [2].
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 [22], 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 [20].
	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 [2], 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 coMoPWIers 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 [2] and held constant throughout the time series.
4D1 Domestic Wastewater	Description of Guyana´s wastewater	Description of historic evolution obtained from the WHO Country Estimate on SDG6 Monitoring Report [23].

Treatment and Discharge	treatment systems.	
	Degree of utilization of wastewater treatment system (U).	Data for the year 1991 were obtained from the Guyana Bureau of Statistics 2002 Census [19]. Data for 2002 and 2012 obtained from the Guyana Bureau of Statistics 2012 Census [17]. Data for 2020 was obtained from the WHO Country Estimate on SDG6 Monitoring Report [23]. 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 [3].
	Correction factor for additional industrial BOD discharged into sewers (I).	Default values from Equation 6.3 of Volume 5 from the 2006 IPCC Guidelines [2].
	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 [2].
	Annual quantity of CH4 recovered.	No CH4 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 [3].
	Protein Supply.	Per capita protein supply was obtained from FAO Stat Data over the time period 1990-2013 [24] and 2010-2021 [25]. 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 [3].
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).	

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 [2].
1A2 Manufacturing Industries and Construction	kg/TJ	Default values from Table 2.3 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines [2].
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 [2].
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 [2].
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 [2].
1A5 Other	kg/TJ	Default values from Table 2.4 and Table 2.5 from Chapter 2, Volume 2 of the 2006 IPPC Guidelines [2].
1B1 Solid Fuels	kg/kt	Default values from Table 4.3.3 from Chapter 4, Volume 2 of the 2019 Refinement [3].
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 [3].
	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 [3].
	tonnes/1,000,000 m3 offshore gas produced	Default values from Table 4.2.4G from Chapter 4, Volume 2 of the 2019 Refinement [3].

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 [26].

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 [3].
3A2 & 3C6 Manure Management &	Live weights for animal categories	Default values from the 2019 Refinement, Table 10A.5, Chapter 10, Volume 4 [3].

Indirect N2O emissions from Manure Management	CH4 emission factors by animal category, manure management system and climate zone	Default values from the 2019 Refinement [3], 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.
	Volatile solid excretion rate	Default values from the 2019 Refinement, Table 10.13A, Chapter 10, Volume 4 [3]. 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 [3]. Using default data for Latin America and low productivity systems.
	Emission factors for direct N2O emissions from manure management	Default emission factors of the 2019 Refinement [3], Table 10.21, Chapter 10, Volume 4.
	Nitrogen loss fractions due to volatilisation of NH3 and NOX and leaching of nitrogen from manure management	Default values from the 2019 Refinement [3], Table 10.22, Chapter 10, Volume 4.
	Volatilisation and leaching factors for indirect soil N2O emissions	Default emission factors of the 2019 Refinement [3], 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 [27].
	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 [9].
	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) [9].
	Annual biomass decrease by degradation from logging (tC/m3)	Country specific emission factor for volume harvested, Logging Damage Factor (LDF) [9].

	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 [9].
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 [9].
	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) [9].
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 [9].
	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 [9].
	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 [9].
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 [9].
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 [2].
	Emission factors for various types of burning	Default emission factors from the 2006 IPCC Guidelines, Table 2.5, Chapter 2, Volume 4 [2].
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 [2].
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 [2].
3C4 & 3C5 Direct and	Emission factors to estimate	Default emission factors from the 2019 Refinement, Table 11.1, Chapter 11, Volume 4 [2].

Indirect N2O Emissions from Managed Soils	direct N2O emissions from managed soils	
	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. [3].
	Volatilisation and leaching factors for indirect soil N2O emissions	Default emission factors of the 2019 Refinement, Table 11.3, Chapter 11, Volume 4 [3].
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 [3].
	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 [3].
	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 [3].
	Conversion factors for different types of organic amendments (CFOA)	Default emission factors of the 2019 Refinement, Table 5.14, Chapter 5, Volume 4 [3].

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 [3] and held constant throughout the time series for each SWDS type.
	Degradable organic carbon (DOC)	Default values obtained from Table 2.4 of Volume 5 from the 2006 IPCC Guidelines [2], 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 [3], held constant throughout the time series.

	CH4 generation rate constant (k)	Default values obtained from Table 3.4 of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	Delay time	Default value from Section 3.2.3 of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	Fraction of CH4 in developed gas (F)	Default value from Section 3.2.3 of Volume 5 of the 2019 IPCC Refinement [3], held constant throughout the time series.
	Oxidation factor (OX)	As per default assumption in Table 3.2 of Volume 5 the 2019 IPCC Refinement [3], 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 [3], held constant throughout the time series.
	CH4 emission factor (EFCH4) for MSW open burning	Default value from Page 5.13 of Volume 5 from the 2019 Refinement [3], held constant throughout the time series.
	N2O emission factor (EFN2O) for MSW open burning	Default value from Table 5.6 of Volume 5 from the 2019 Refinement [3], 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 [3], held constant throughout the time series.
4D1 Domestic Wastewater Treatment and Discharge	Maximum CH4 producing capacity (Bo)	Default values obtained from Table 6.2 of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	Fraction of Nitrogen in protein (FNPR)	Default value from Equation 6.10 of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	Additional Nitrogen from household chemicals (NHH)	Default value from Equation 6.10 of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	Factor for non-consumed protein added to the wastewater (FNON-CON)	Default value from Table 6.10A of Volume 5 from the 2019 IPCC Refinement [3], held constant throughout the time series.
	N2O emission factor from effluent	Default value from Table 6.8A of Volume 5 from the 2019 IPCC Refinement [3], 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).	

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:

- 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 is 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.

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

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 CO_2-eq		%	%	%		%	%	%	%	%
1A1 – Energy Industries	CO2	332.98	838.97	10	7	12	0.006	-0.004	0.006	-0.026	0.060	0.004
1A1 – Energy Industries	CH4	1.10	1.45	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A1 – Energy Industries	N2O	1.61	2.41	10	100	100	0.000	0.000	0.000	-0.001	0.000	0.000
1A2 – Manufacturing Industries and Construction	CO2	301.18	76.54	20	7	21	0.000	0.001	0.001	0.010	0.011	0.000
1A2 – Manufacturing Industries and Construction	CH4	12.46	5.30	20	100	102	0.000	0.000	0.000	0.005	0.001	0.000
1A2 – Manufacturing Industries and Construction	N2O	15.91	6.73	20	100	102	0.000	0.000	0.000	0.006	0.001	0.000
1A3a – Domestic Aviation	CO2	34.56	37.39	10	7	12	0.000	0.000	0.000	0.000	0.003	0.000
1A3a – Domestic Aviation	CH4	0.01	0.01	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A3a – Domestic Aviation	N2O	0.26	0.28	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1A3b – Road Transport	CO2	231.33	1094.72	10	7	12	0.010	-0.006	0.008	-0.043	0.078	0.008
1A3b – Road Transport	CH4	2.09	9.71	10	100	100	0.000	0.000	0.000	-0.005	0.001	0.000
1A3b – Road Transport	N2O	2.97	14.10	10	100	100	0.000	0.000	0.000	-0.008	0.001	0.000
1A4 – Other Sectors	CO2	242.31	878.97	25	7	26	0.029	-0.005	0.006	-0.032	0.156	0.025
1A4 – Other Sectors	CH4	76.20	11.79	25	100	103	0.000	0.000	0.000	0.043	0.002	0.002
1A4 – Other Sectors	N2O	9.99	2.83	25	100	103	0.000	0.000	0.000	0.005	0.001	0.000
1A5 – Other	CO2	0.92	33.78	10	7	12	0.000	0.000	0.000	-0.002	0.002	0.000
1A5 – Other	CH4	0.00	0.05	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000

1A5 – Other	N2O	0.00	0.06	10	100	100	0.000	0.000	0.000	0.000	0.000	0.000
1B1 – Solid Fuels	CH4	0.00	0.00	25	121	124	0.000	0.000	0.000	0.000	0.000	0.000
1B1 – Solid Fuels	N2O	0.00	0.00	25	163	165	0.000	0.000	0.000	0.000	0.000	0.000
1B2a - Oil	CO2	0.00	873.44	15	40	43	0.078	-0.006	0.006	-0.248	0.093	0.070
1B2a - Oil	CH4	0.00	1540.15	15	40	43	0.241	-0.011	0.011	-0.437	0.164	0.218
1B2a - Oil	N2O	0.00	0.93	15	100	101	0.000	0.000	0.000	-0.001	0.000	0.000
1B2b – Natural Gas	CO2	0.00	37.81	15	20	25	0.000	0.000	0.000	-0.005	0.004	0.000
1B2b – Natural Gas	CH4	0.00	648.52	15	20	25	0.015	-0.005	0.005	-0.092	0.069	0.013
1B2b – Natural Gas	N2O	0.00	0.17	15	100	101	0.000	0.000	0.000	0.000	0.000	0.000
3A1 – Enteric fermentation	CH4	381.22	535.68	20	40	45	0.032	-0.001	0.004	-0.049	0.076	0.008
3A2 – Manure management	CH4	36.75	65.51	20	30	36	0.000	0.000	0.000	-0.007	0.009	0.000
3A2 – Manure management	N2O	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	CO2	-152319.30	-148875.77	21	70	73	6600.6 30	0.029	1.056	2.055	22.177	496.020
3B2b –Land Converted to Cropland	CO2	564.80	476.21	21	35	41	0.021	0.000	0.003	0.015	0.071	0.005
3B5B –Land Converted to Settlements	CO2	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	CO2	7716.75	5534.47	21	35	41	2.845	0.013	0.039	0.446	0.824	0.879
3C1 – Emissions from biomass burning	CH4	63.16	111.48	28	161	163	0.019	0.000	0.001	-0.059	0.022	0.004
3C1 – Emissions from biomass burning	N2O	16.26	28.04	28	161	163	0.001	0.000	0.000	-0.014	0.006	0.000
3C2 – Liming	CO2	11.35	15.11	60	50	78	0.000	0.000	0.000	-0.002	0.006	0.000
3C3 – Urea application	CO2	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	N2O	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	N2O	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	N2O	6.89	12.02	54	110	123	0.000	0.000	0.000	-0.004	0.005	0.000
3C7 – Rice cultivations	CH4	227.31	708.62	10	52	53	0.079	-0.003	0.005	-0.182	0.050	0.036

4A1– Managed Waste Disposal Sites	CH4	0.00	147.73	52	52	73	0.007	-0.001	0.001	-0.054	0.054	0.006
4A3 – Uncategorized Waste Disposal Sites	CH4	215.51	159.25	52	75	91	0.012	0.000	0.001	0.024	0.059	0.004
4C2 – Open Burning of Waste	CO2	8.05	6.62	52	40	66	0.000	0.000	0.000	0.000	0.002	0.000
4C2 – Open Burning of Waste	CH4	12.00	9.86	52	100	113	0.000	0.000	0.000	0.001	0.004	0.000
4C2 – Open Burning of Waste	N2O	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	CH4	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	N2O	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 (%)

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 can utilise 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:

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

Where:

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

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

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

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 BUR.

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	CO2				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 N2O Emissions from Managed soils	N_2O				X	X	X
3C5 – Indirect N2O 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

Summary of GHG Emissions

National GHG Emissions Profile

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

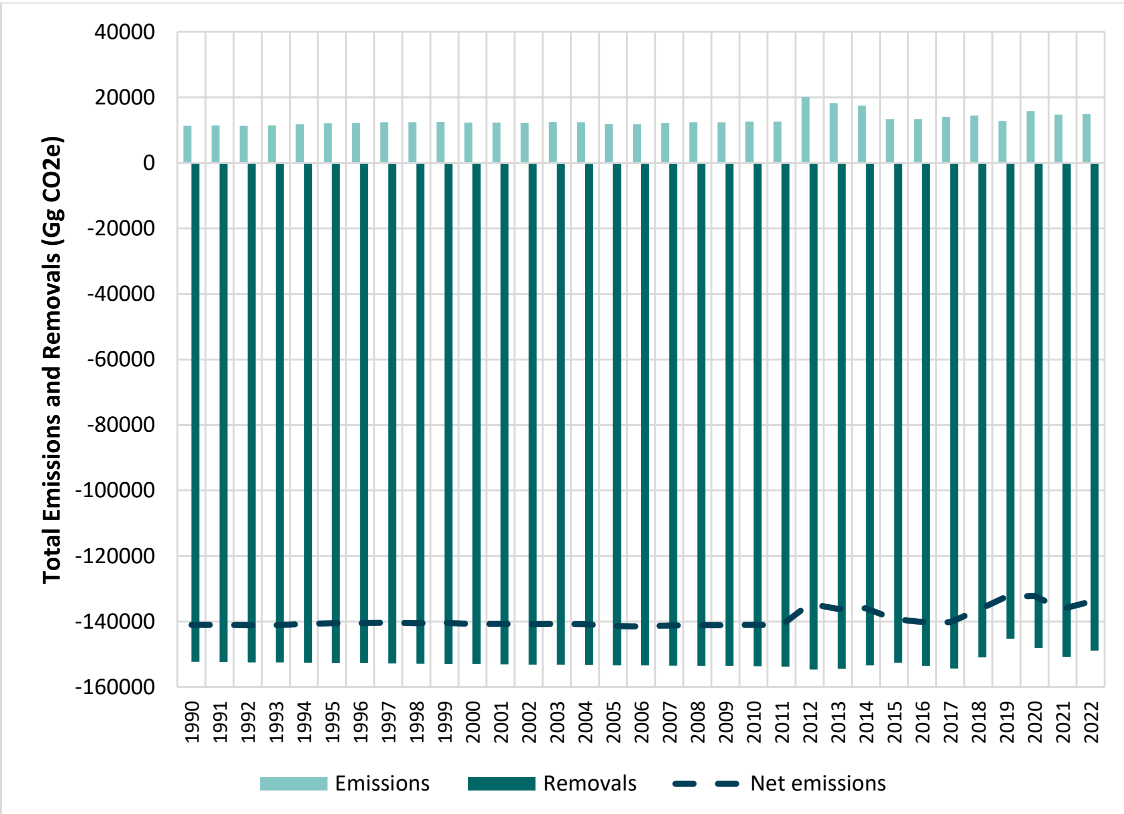

Figure 2.2. Total emissions and removals in Guyana.

Between 1990 and 2022, total GHG removals for managed forests remained stable, amounting 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.

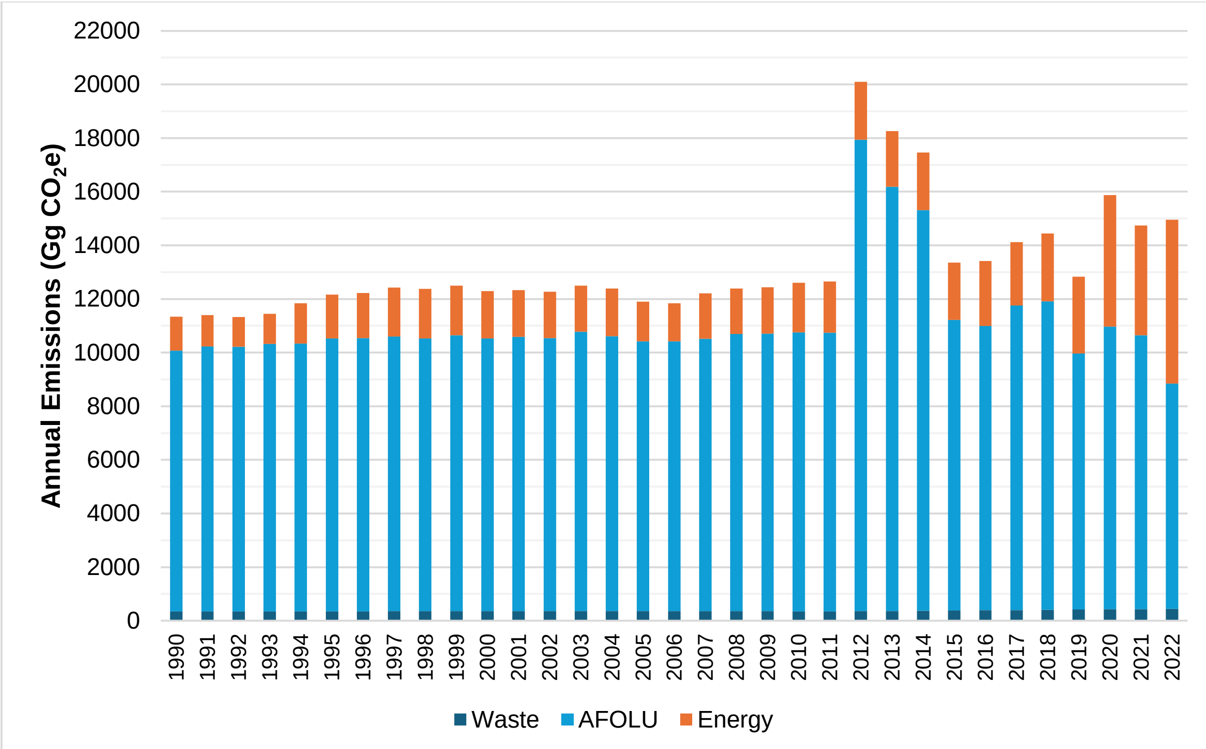

Figure 2.3. Sectoral contribution to total emissions in Guyana.

Reporting Tables

The UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention (BTR Guidelines) specify that the inventory section of the BTR 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 CO2 equivalent conversion factors (3)	Other halogenated gases without CO2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO2
	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 CO2	NO								NO	NO	NO	NO
1C2. Injection 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

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
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
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. N2O 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
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-CO2 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
3C4. Direct N2O Emissions from Managed Soils			1.13						NA	NA	NA	NA
3C5. Indirect N2O Emissions from Managed Soils			0.52						NA	NA	NA	NA
3C6. Indirect N2O 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
5. OTHER	NO	NO	NE, NO	NO	NO	NO	NO	NO	NE, NO	NE, NO	NE, NO	NE, NO
5A. Indirect N2O 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 CO2 equivalent conversion factors (4	NOx	CO	NMVOCs	SO2
	Gg			CO2 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
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-CO2 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 N2O 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

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 NC.
- Period 1990-2004 reported in the second NC.
- Period 1990-2016 reported in the third NC (in draft).
- Period 1990-2022- reported in the first BUR

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. 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 coMoPWlation. 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. 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. CH4 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. N2O emissions were recalculated on the basis of updated information on the historical evolution on nitrogen consumption available from FAO statistics.

Emission Trends by GHG

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

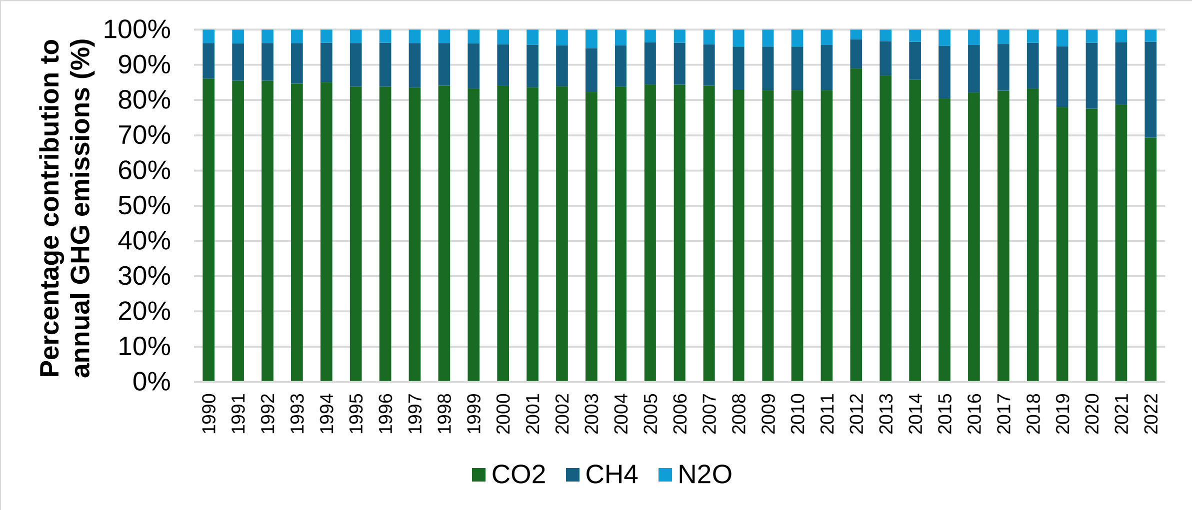

Figure 2.4. GHG contribution to total emissions in Guyana.

Emission Trends by Sector

Energy

The energy sector covers GHG emissions arising from the combustion 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.

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.

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.

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.

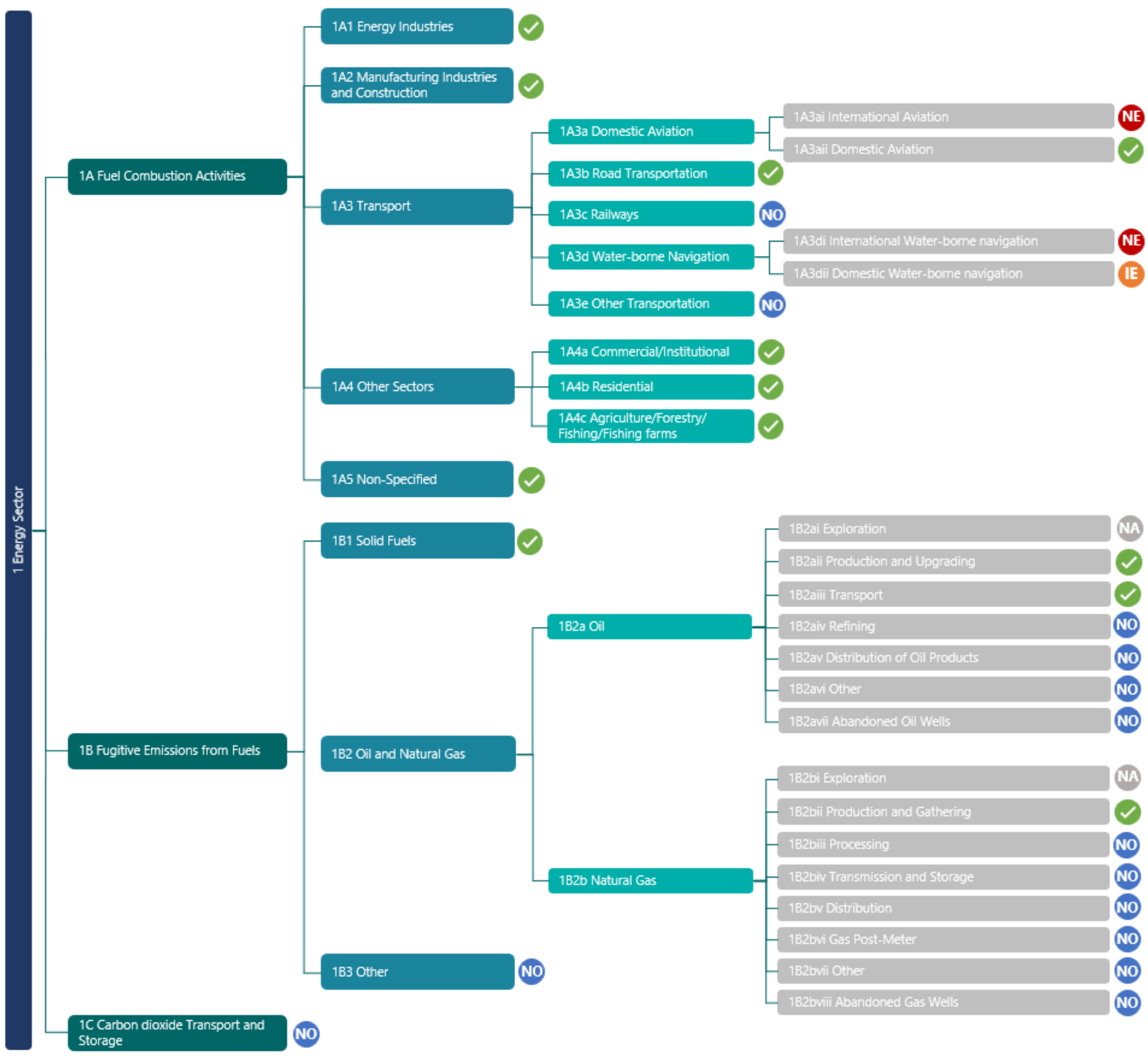

Figure 2.5. Coverage of the energy sector in Guyana.

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.

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 CH4 emissions, and 5.31% of the total national N_2O emissions.

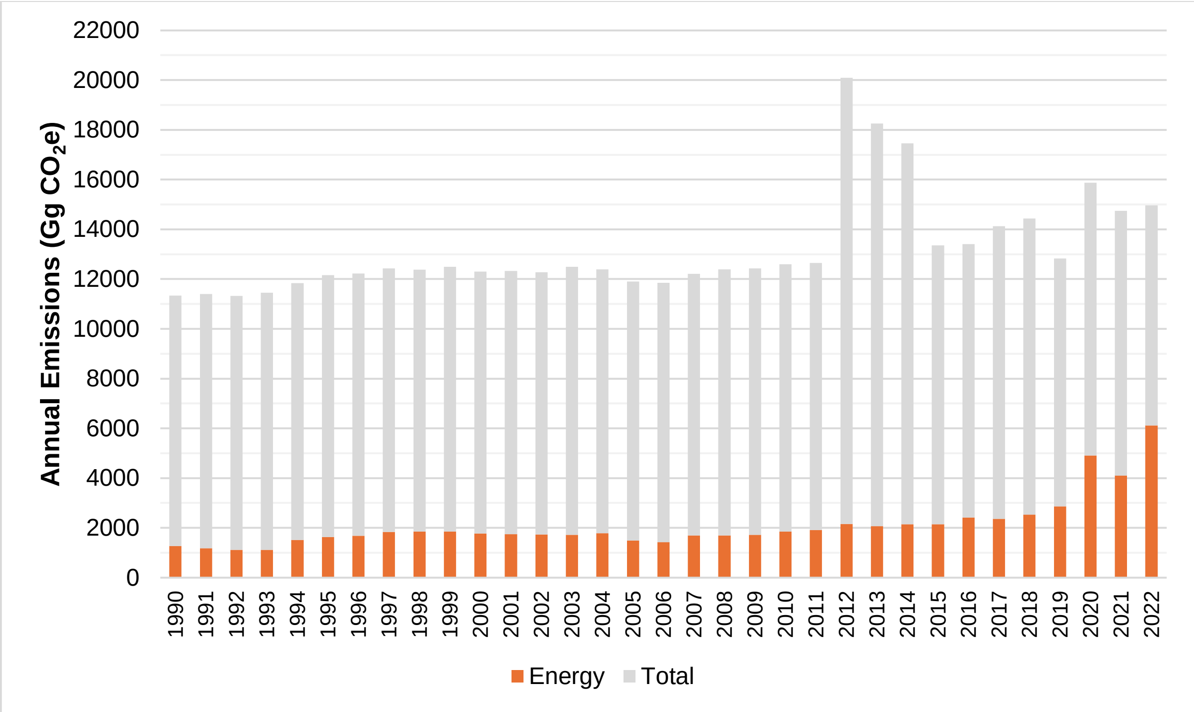

Figure 2.6. Contribution of energy sector emissions to national emission totals.

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

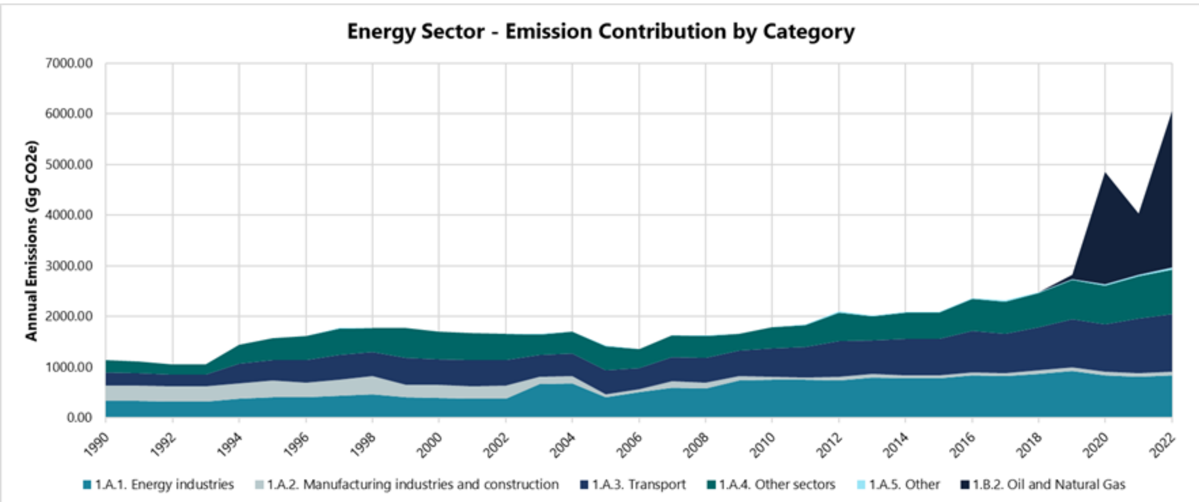

Figure 2.7. Total GHG emissions from the energy sector by category.

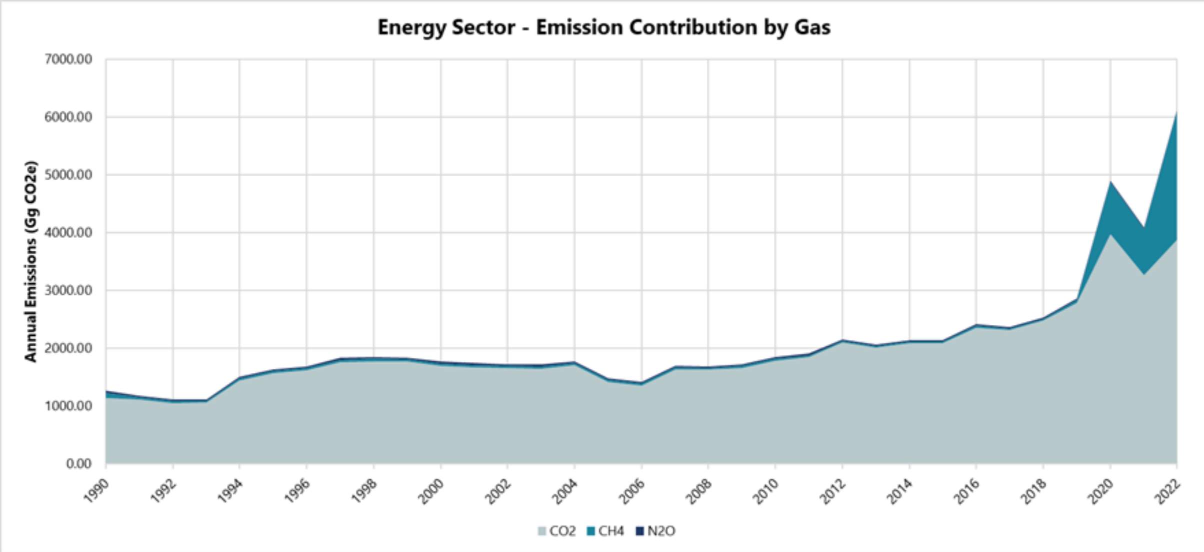

Figure 2.8. Total GHG emissions from the energy sector by gas.

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. 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 surge, 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% surge 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.

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

Category	Gas	Annual emissions in Gg CO2e															
		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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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 CO2 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 CO2 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

Description of Emissions by Category

Energy Industries (1A1)

This category encompasses emissions arising from fuels combusted by the fuel extraction or energy-producing industries. Diesel, fuel oil, and gasoline constitute the principal imports, predominantly utilised by the transportation and electricity sectors.

This dependence on petroleum imports is mirrored in the greenhouse gas (GHG) emissions originating from energy industries, which have demonstrated a consistent upward trend over the period spanning 1990 to 2022, as illustrated in Figure 2.9 and detailed in Table 2.20.

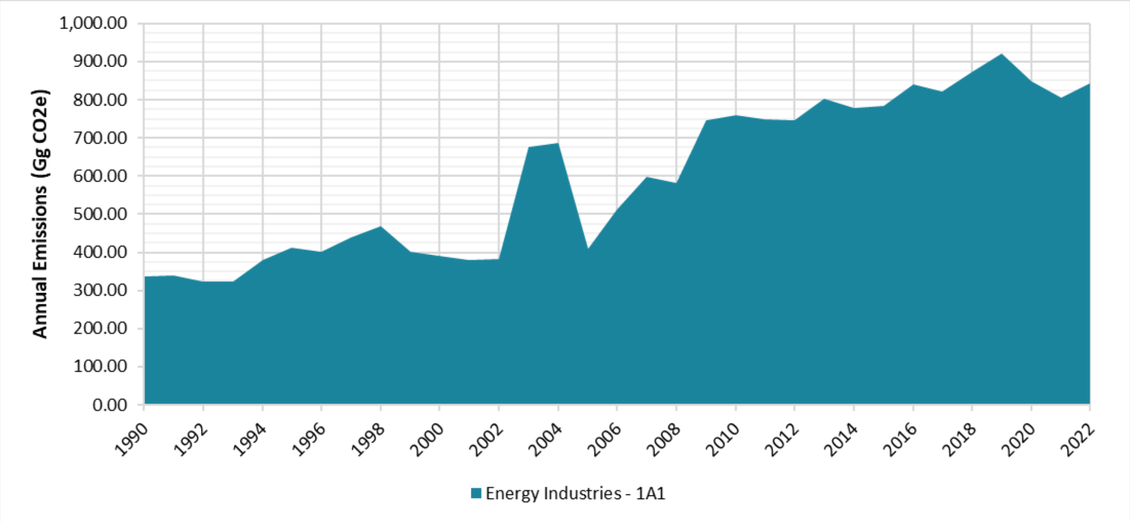

Figure 2.9. Category 1A1 GHG emissions.

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.

Regarding 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	CO2	332.98	838.97	10	7	12
1A1 – Energy Industries	CH4	1.10	1.45	10	100	100
1A1 – Energy Industries	N2O	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

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 CH4 and N2O. Meanwhile, for CO2, 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 CO2-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 surge 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.

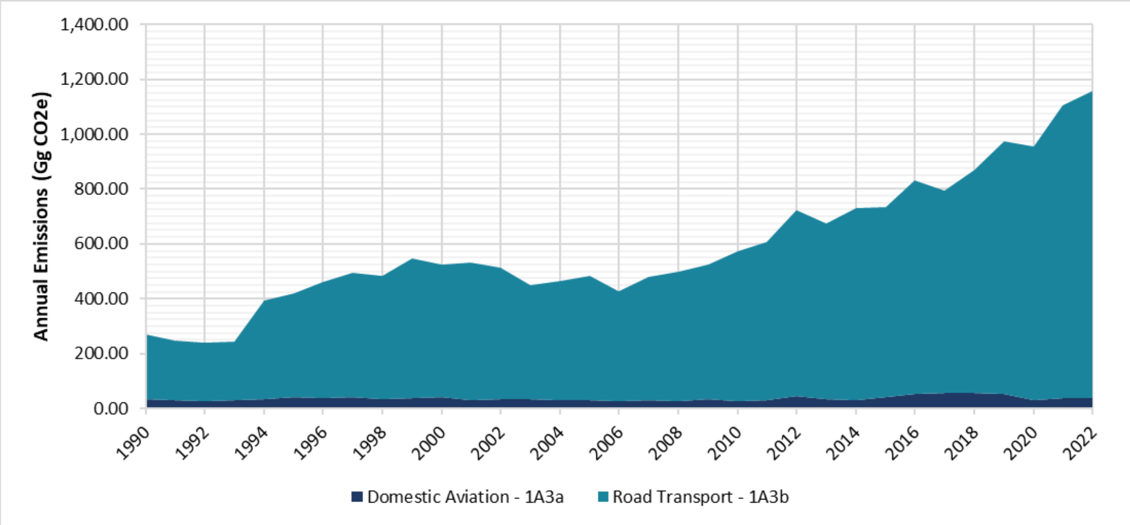

Figure 2.11. Category 1A3 GHG emissions.

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

Annual Emissions in Gg CO2e											
	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 CH4 and the midpoint value for N2O. For CO2, 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.

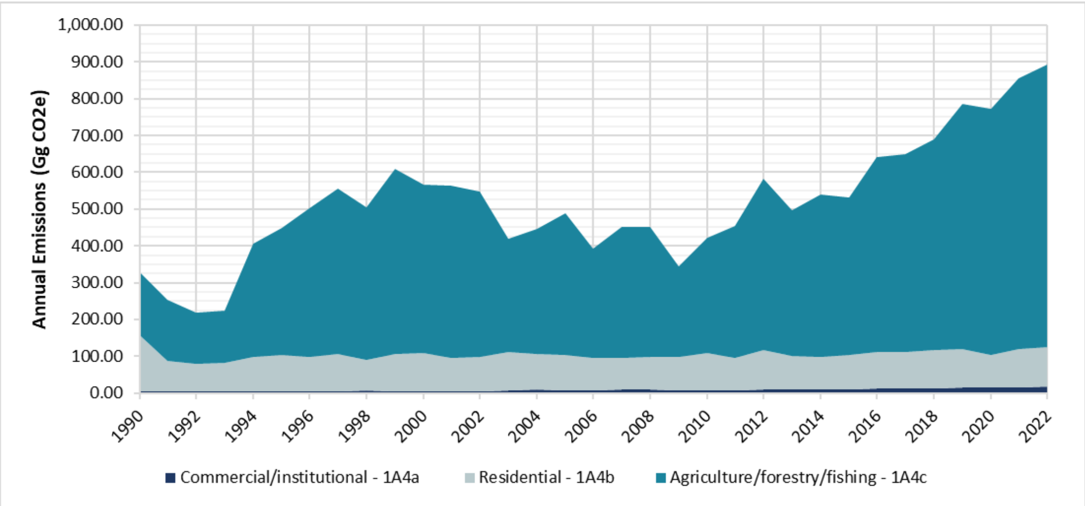

Figure 2.12. Category 1A4 GHG emissions.

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

Annual Emissions in Gg CO2e											
	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 CO2-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.

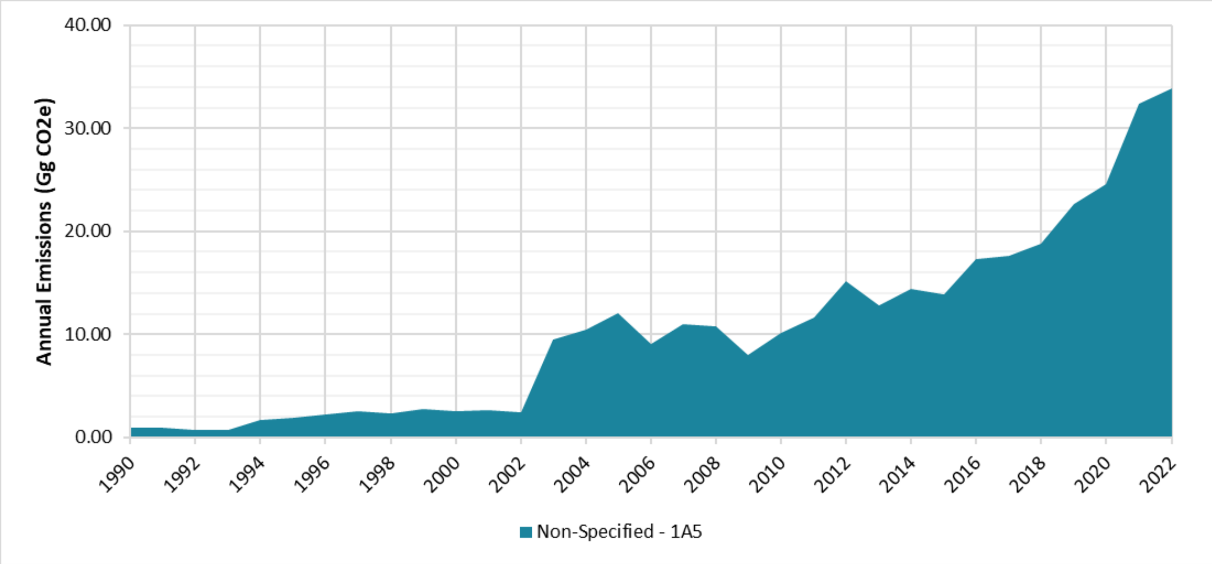

Figure 2.13. Category 1A5 GHG emissions.

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

Annual Emissions in Gg CO2e											
	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 CH4 and N2O. Meanwhile, for CO2, 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 CO2-eq		%	%	%
1A5 – Other	CO2	0.92	33.78	10	7	12
1A5 – Other	CH4	0.001	0.05	10	100	100
1A5 – Other	N2O	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. CO2 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.

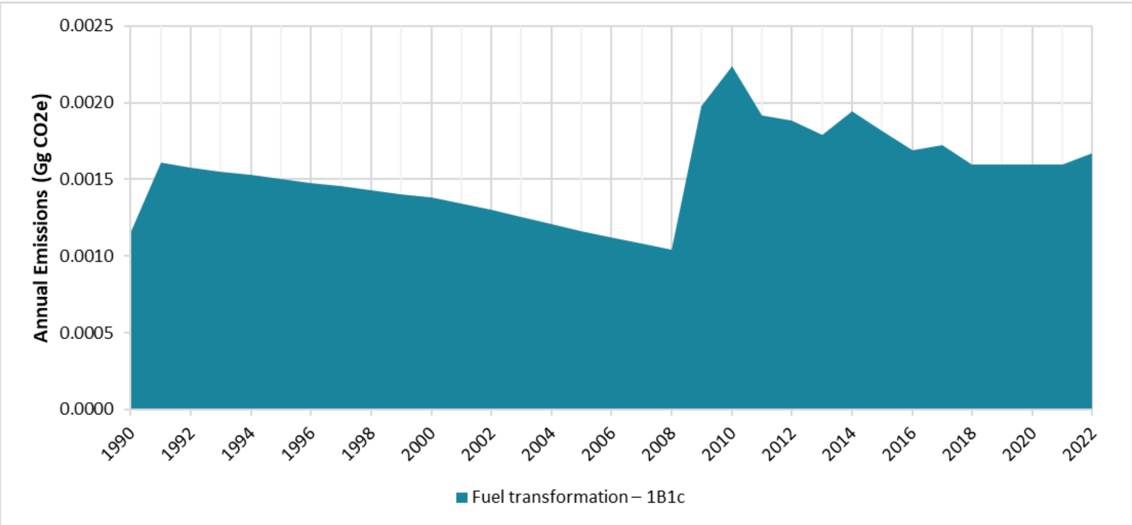

Figure 2.14. Category 1B1c GHG emissions.

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

Annual Emissions in Gg CO2e											
	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. 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 and the related impacts are illustrated in Figure 2.15 and outlined in Table 2.32.

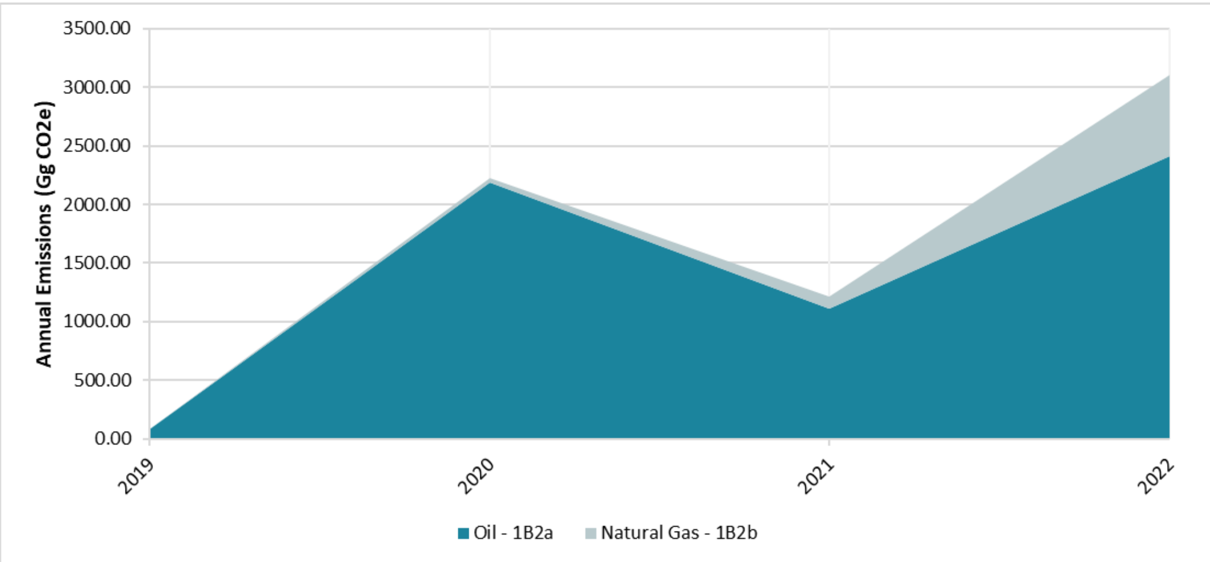

Figure 2.15. Category 1B2 GHG emissions.

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.

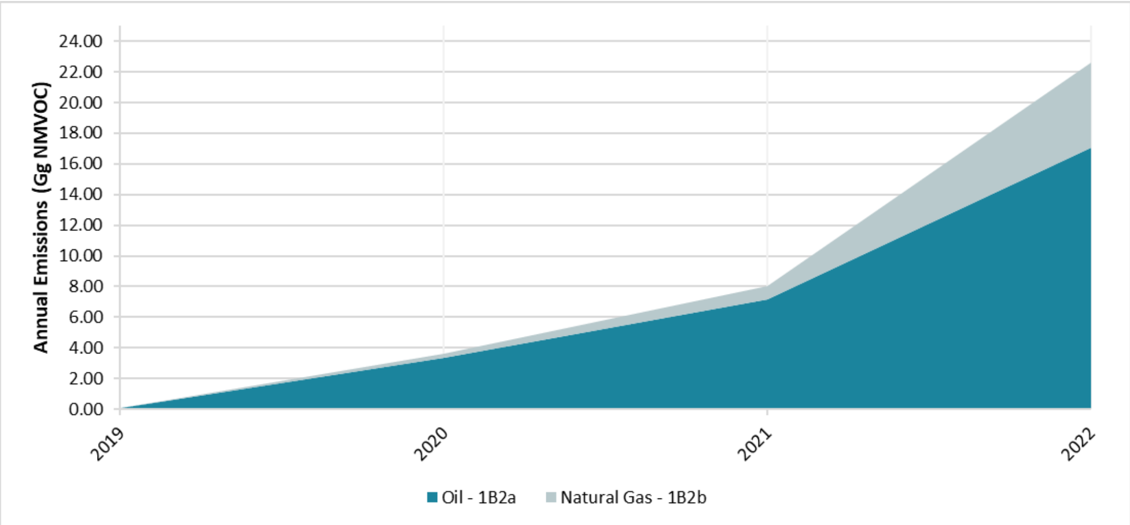

Figure 2.16. Category 1B2 NMVOC emissions.

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

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

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. 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.

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.

Description of Sector

The IPPU sector in Guyana is limited, with no ongoing industrial activities in the country. 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 (SF6) 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.

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.

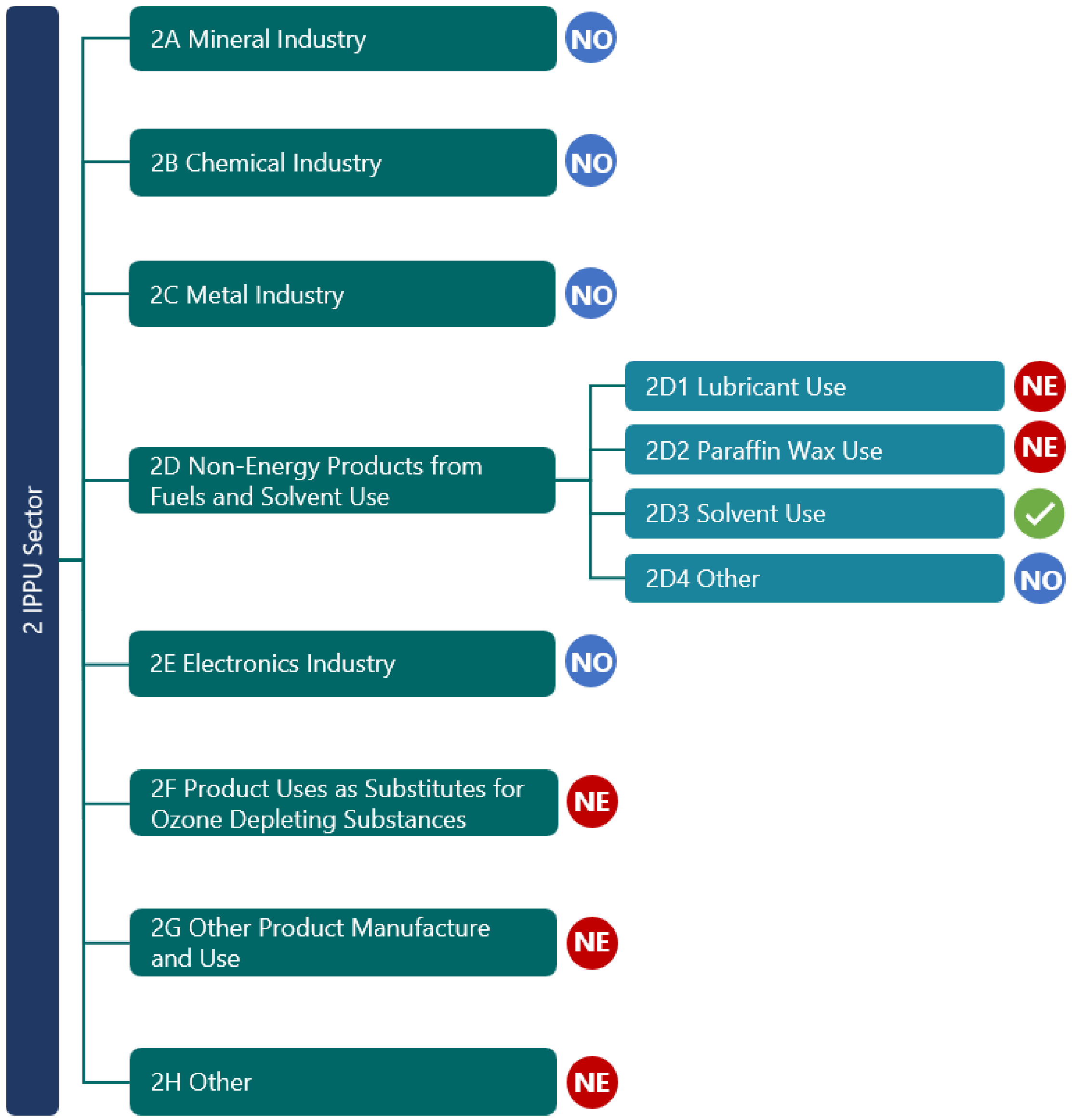

Figure 2.17. Coverage of the IPPU sector in Guyana.

The national GHG inventories in Guyana's initial NC, second NC, and the currently drafted third NC 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 significant constraint on the IPPU sector, especially given that emissions from product uses as substitutes for ODS are anticipated to be substantial and will have a notable impact on the overall national GHG emissions of Guyana.

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 this first BTR, the IPPU sector emissions represent 0% of the national total GHG emissions of the country.

However, as previously stated, HFCs and PFCs emissions, which have high GWPs, are anticipated to have some impact on the overall national GHG emissions of Guyana once estimated.

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

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.

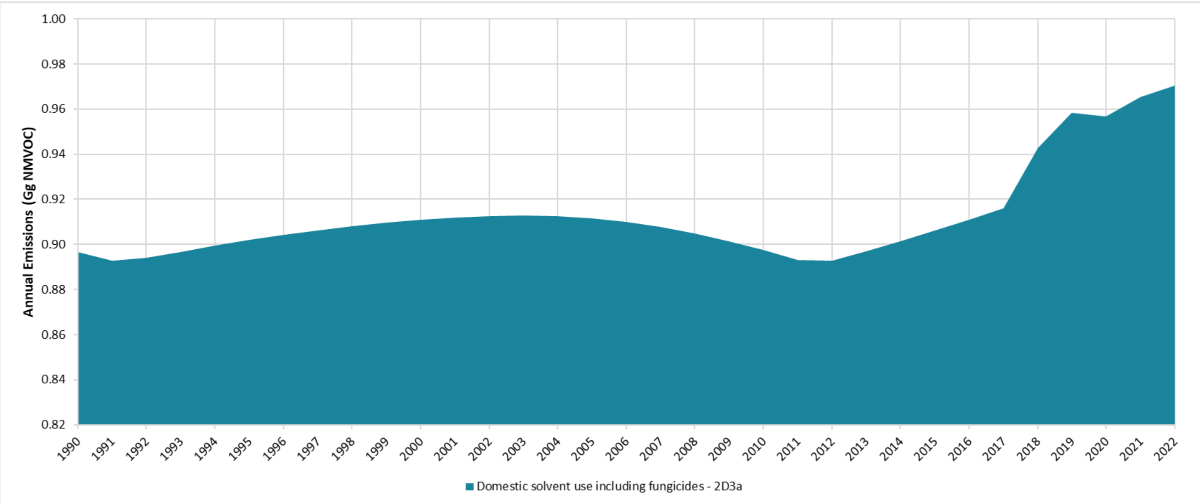

Figure 2.18. Category 2D3a NMVOC emissions.

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

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.

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 [28]. 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 significantly to greenhouse gas emissions and removals in the country. The CH_4 emissions, especially when expressed as CO_2e, 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 [29].

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-CO_2 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 CO2 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). [30]

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. [31]

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. [32]

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. [33]

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. [31] They take place along the Coastal Plain and in the Intermediate and Rupununi Savannahs and is largely self-sufficient [35]. 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. [31]

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 total forest area estimated at 18 million hectares and a historic deforestation rate of less than 1% (0.02-0.079%) for the past twenty years. [31] There is a total of 1.1 million ha designated as Protected Areas [36].

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 illegal harvesting) and forest degradation surrounding mining sites and road infrastructure [36].

The FOLU sector generates significant annual removals in Guyana. The largest removals of CO2 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.

Coverage of Sector

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

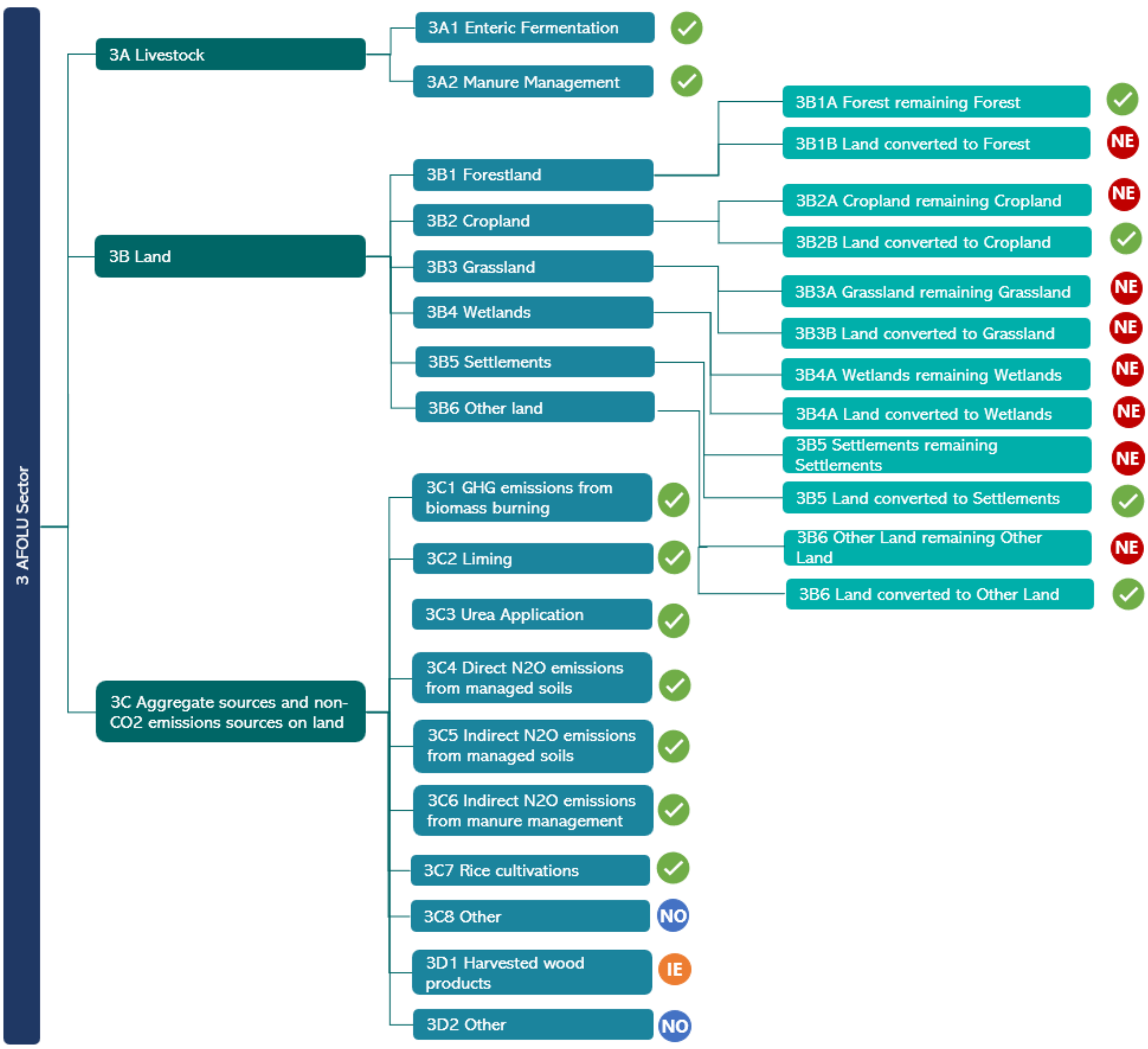

Figure 2.19. Coverage of the Guyana AFOLU sector GHG emissions inventory. NE – not Estimated; NO – not occurring; IE – included elsewhere; NA – not applicable.

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 CO_2 emissions and non-CO_2 emissions (CH_4, CO, N_2O, NOX) 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 CO_2 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 CO_2 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 CO_2 emissions and non-CO_2 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 CO2, N2O and CH4 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 N_2O 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 N_2O emissions from managed soils are the synthetic N fertilisers (FSN), the organic N applied as fertiliser (only the animal manure was considered due to lack of data on other types of organic fertilizers) (FON), the urine and dung N deposited on pasture, range and paddock by grazing animals (FPRP) and the N in crop residues (above-ground and below-ground), including various crops in the country (FCR).

Category 3C5 – Indirect N_2O Emissions from Managed Soils covers volatilisation of NH_3 and NOx and leaching and runoff of nitrogen. The parameters considered equal the ones in Category 3C4.

Category 3C6 – Indirect N_2O 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.

Summary of Sector 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.

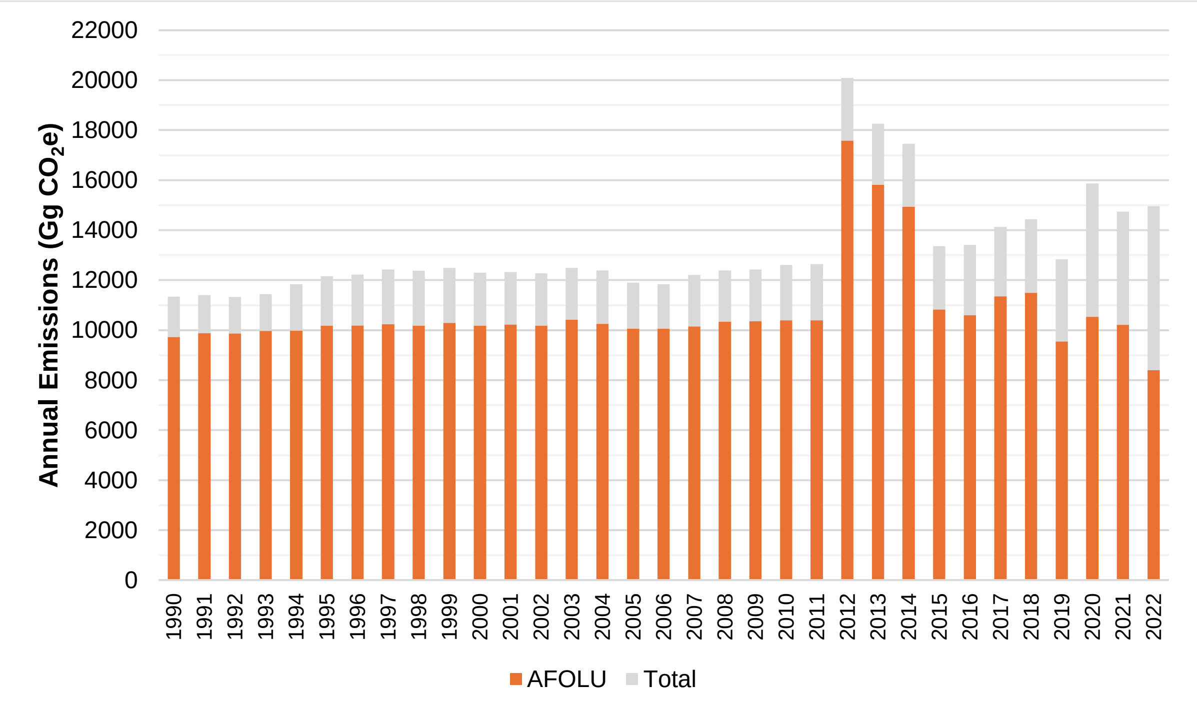

Figure 2.20. Contribution of AFOLU sector emissions to national emission totals.

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.

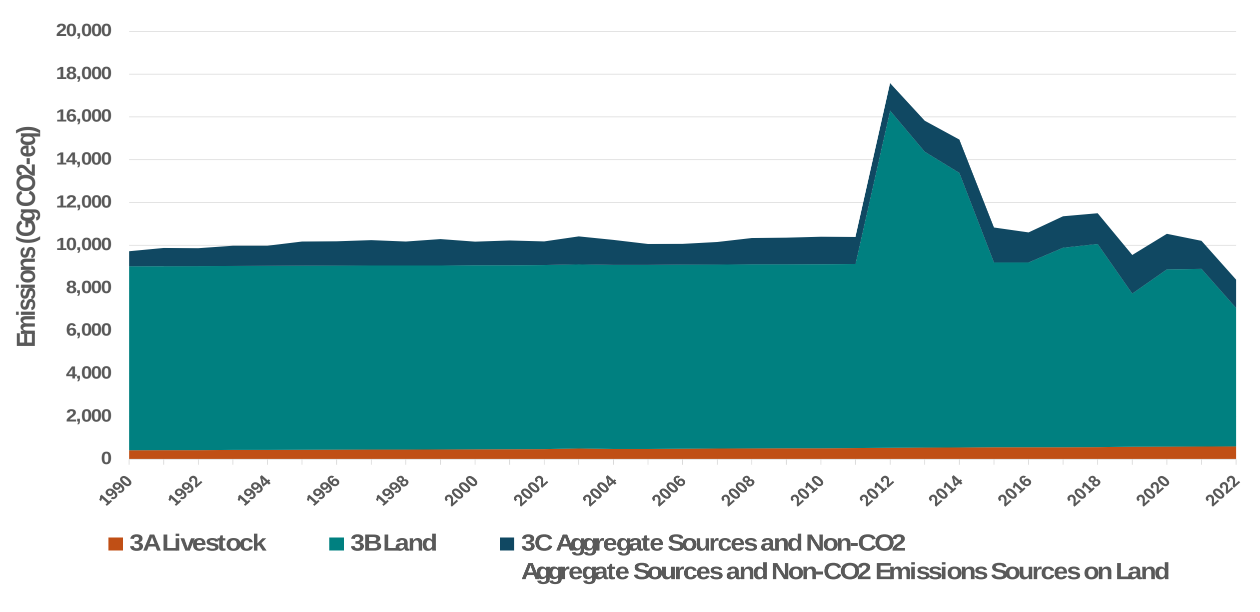

Figure 2.21. Total GHG emissions from the AFOLU sector by category.

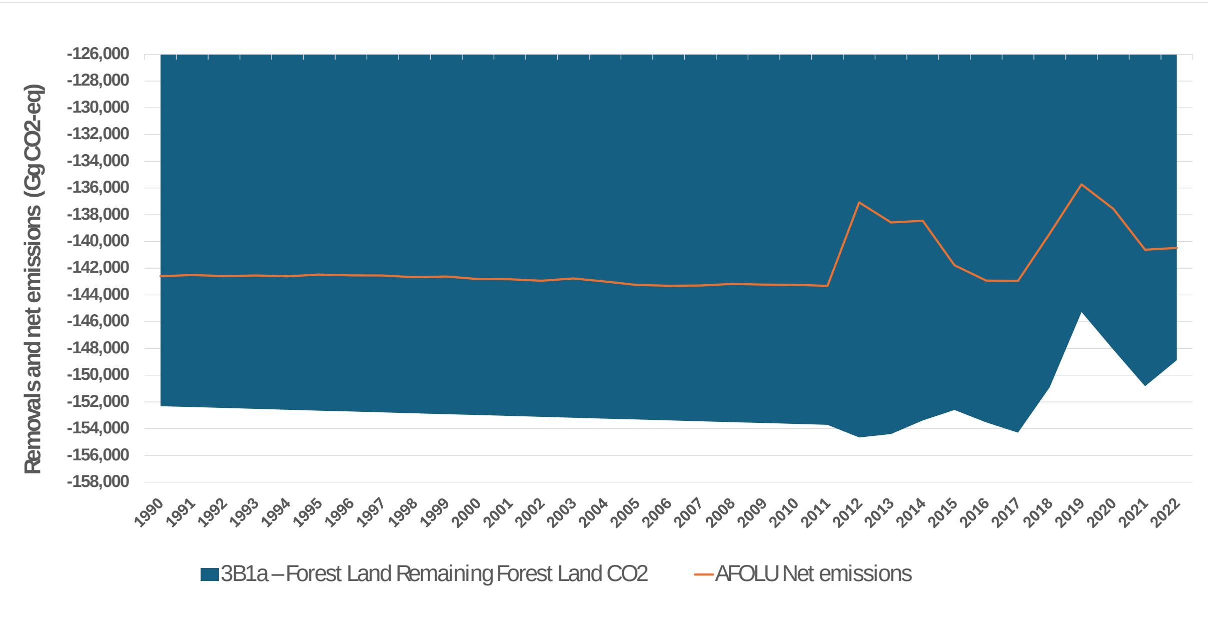

Figure 2.22. Total removals from the AFOLU sector.

Figure 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	CO2	-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
	CH4	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
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	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
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	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
	N2O	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	CO2	-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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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)
	CH4	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
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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
	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	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
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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 Prod	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	-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
	CH4	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
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	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
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	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
	N2O	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	CO2	-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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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)
	CH4	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
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	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
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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 Managed Soils	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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
3C6 Indirect N2O Emissions from Manure Management	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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	CO2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	CH4	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
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	CH4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	N2O	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

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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
	CH4	0.0011	0.0016	0.0016	0.0015	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
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	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
	CH4	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
	N2O	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	CO2	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
	CH4	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
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	51.11	1346.93	436.41	911.25
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	28.30	875.33	773.61	2188.66
	N2O	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	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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 CO2 Transport and storage	CO2	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	CH4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	N2O	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

Description of 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.

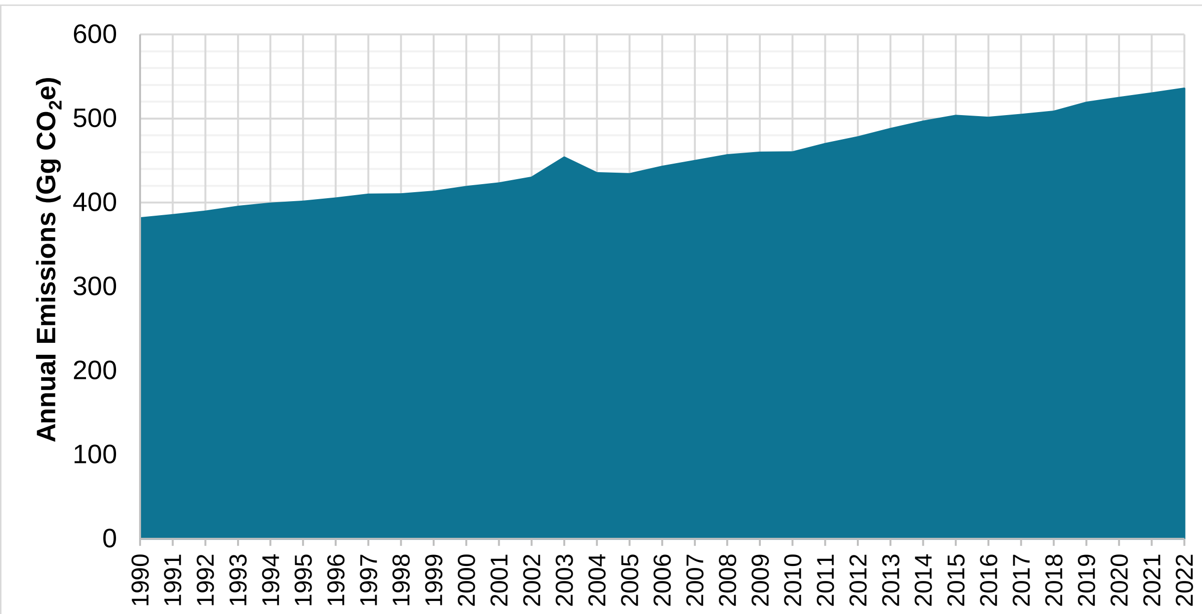

Figure 2.23. Category 3A1 GHG emissions.

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 CO2 eq. to 535,68 Gg CO2 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 N_2O emission factors, default nitrogen excretion data, and default manure management system data.

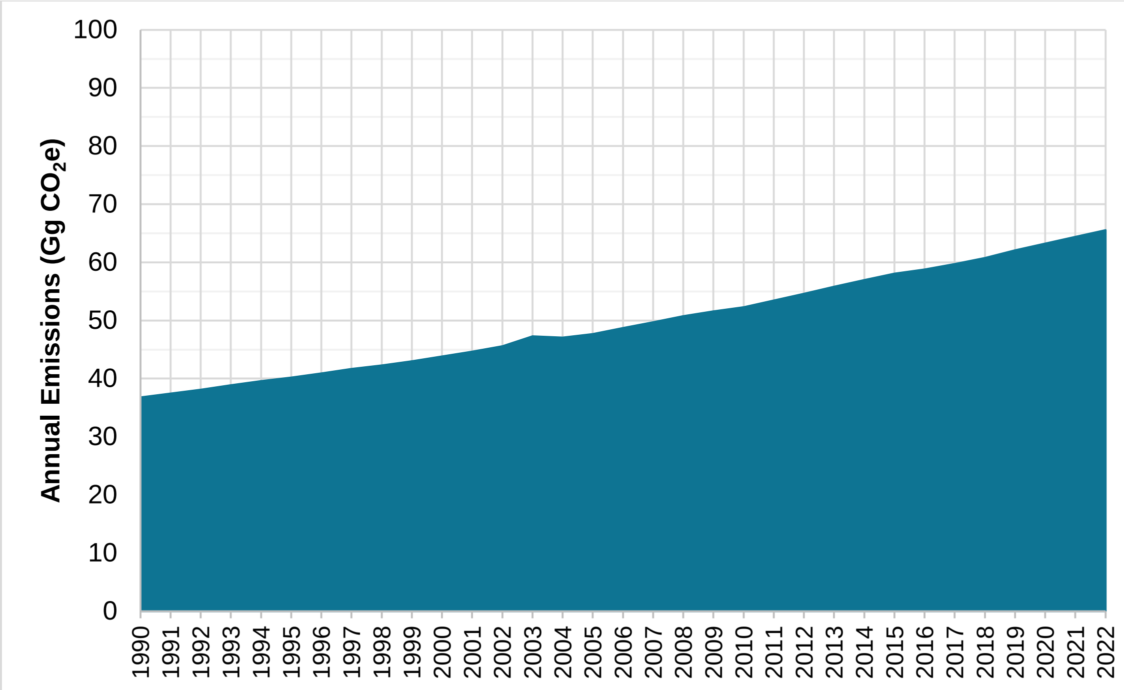

Figure 2.24. Category 3A2 GHG emissions.

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 (Nrate)	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.

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 this chapter. 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.

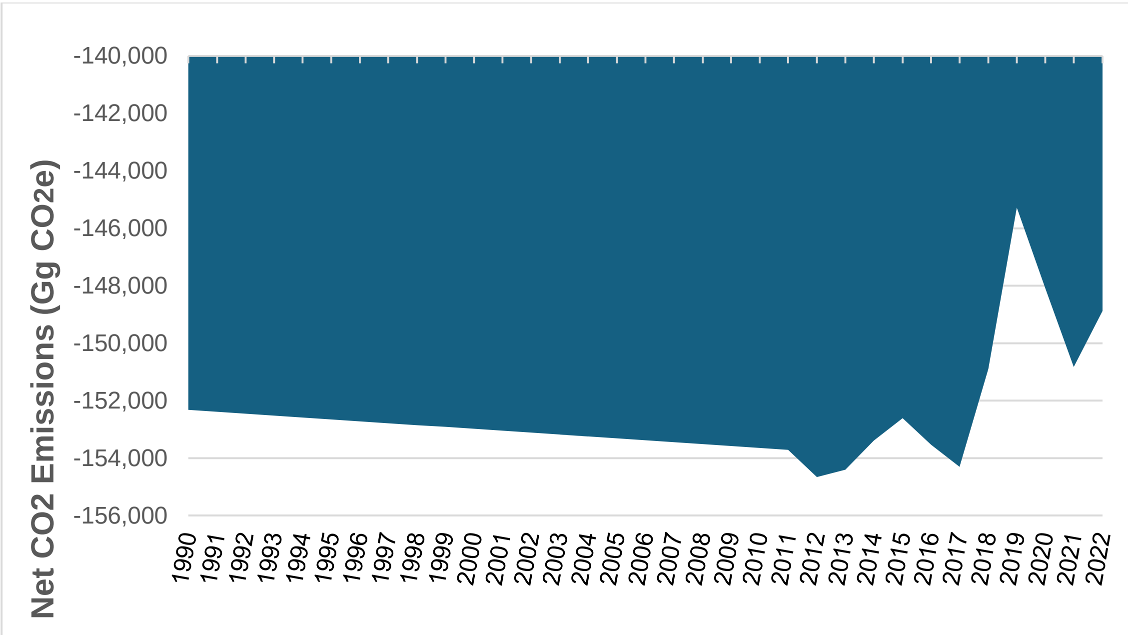

Figure 2.25. Category 3B1a GHG emissions.

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. Sinks grew until 2017, with peaks in 2012, 2013, and 2017. Post-2017, there is increased fluctuation, hitting a low in 2019. 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 CO2 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.

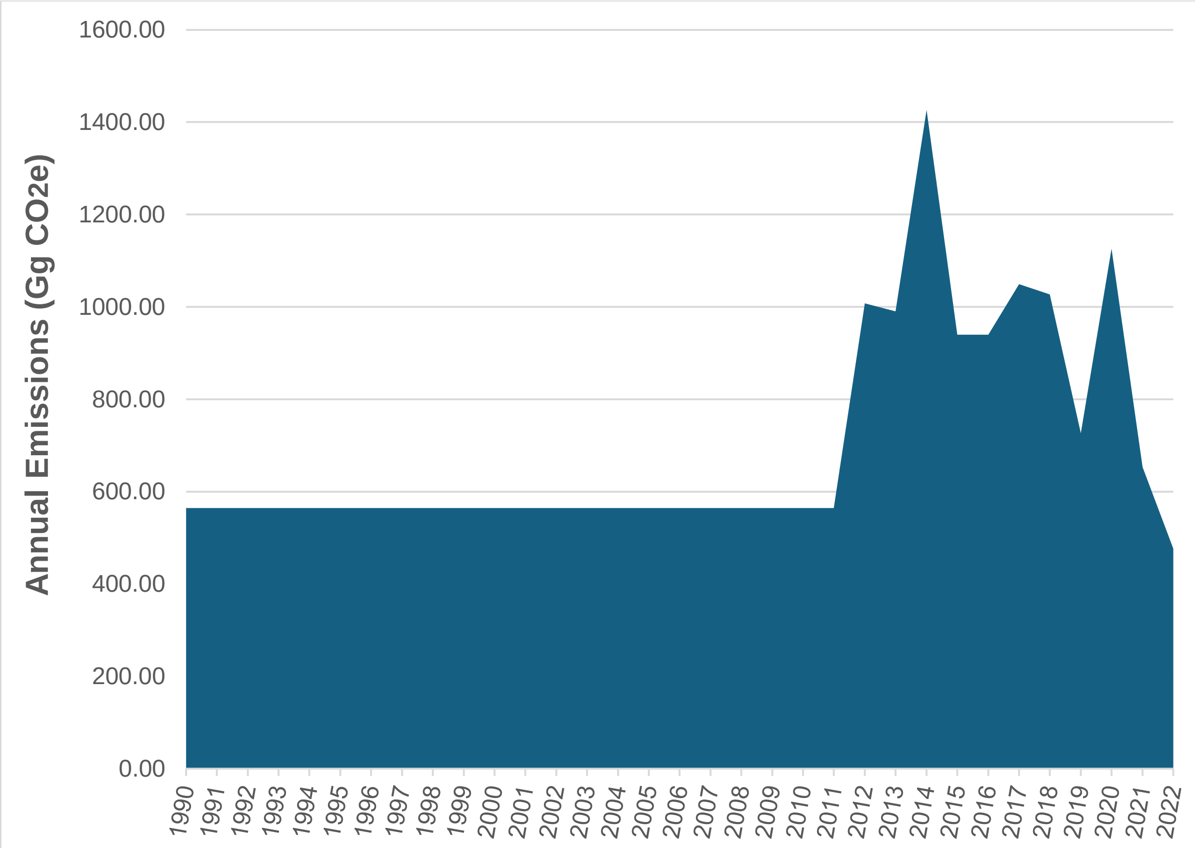

Figure 2.26. Category 3B2b GHG emissions.

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.

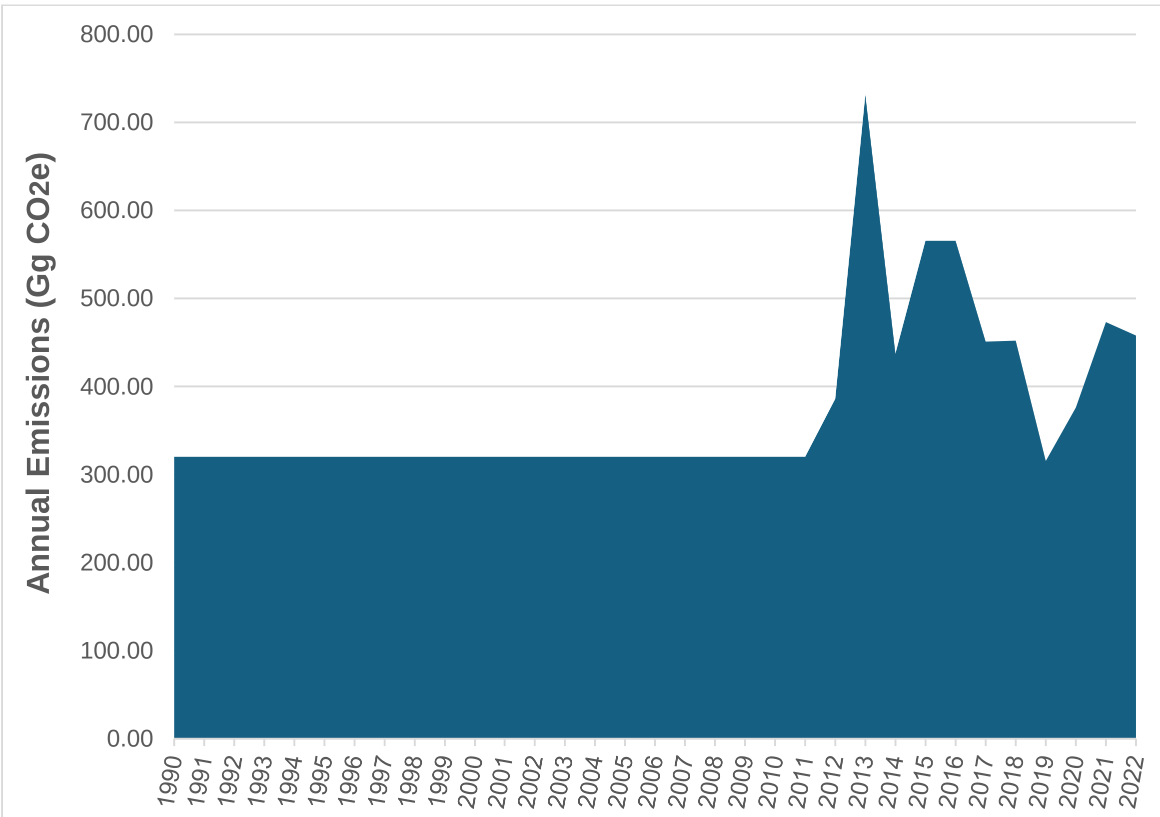

Figure 2.27. Category 3B5b GHG emissions.

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 CO2, significantly higher than the gap-filled 2011 value. The highest annual emissions occur in 2013, while the lowest is in 2019. 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 medium and large-scale mining activities.

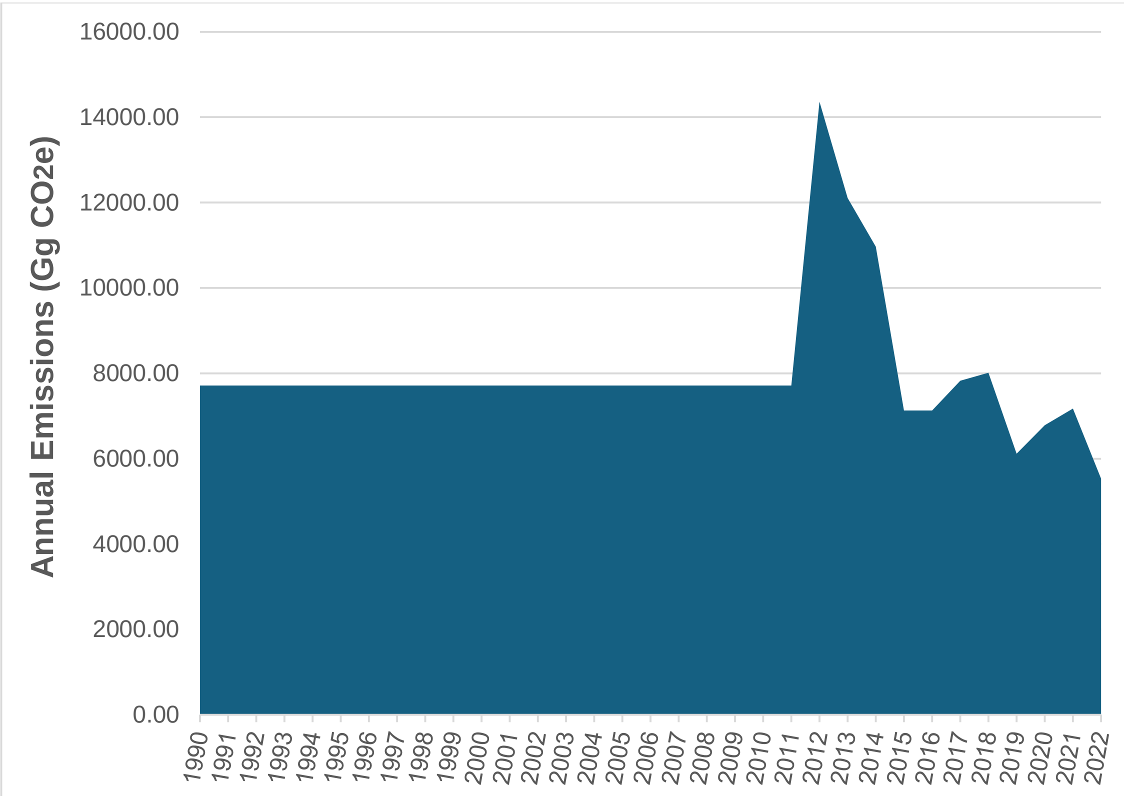

Figure **2.28. Category 3B6b GHG emissions.**

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

Annual Emissions in Gg CO2e											
	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 an erratic trajectory, averaging 8468.77 units annually. Notably, emissions surged in 2012, nearly doubling compared to 2011, and remained elevated 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.

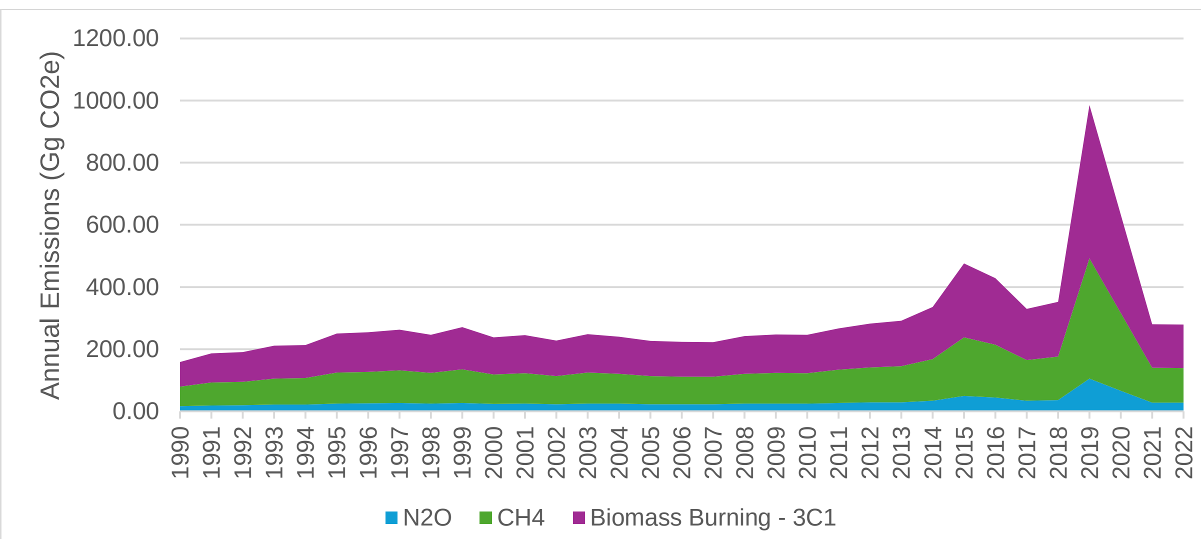

Figure 2.29. Category 3C1 GHG emissions.

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

Annual Emissions in Gg CO2e											
	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.

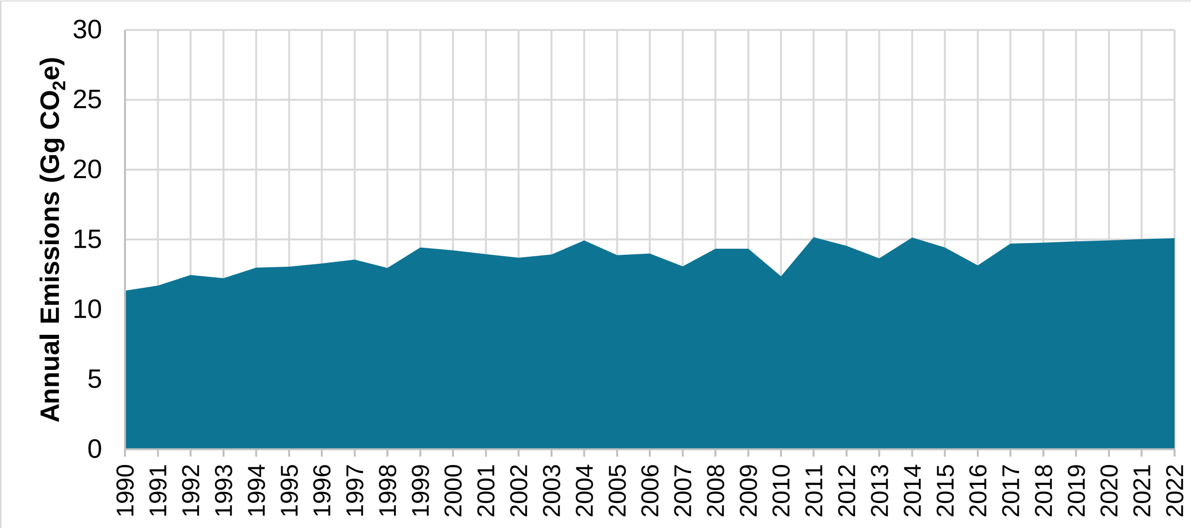

Figure 2.30. Category 3C2 GHG emissions.

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

Annual Emissions in Gg CO2e											
	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.

Urea application (3C3)

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 ($CO(CH_2)2$) is converted to ammonium (NH_4+), 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.

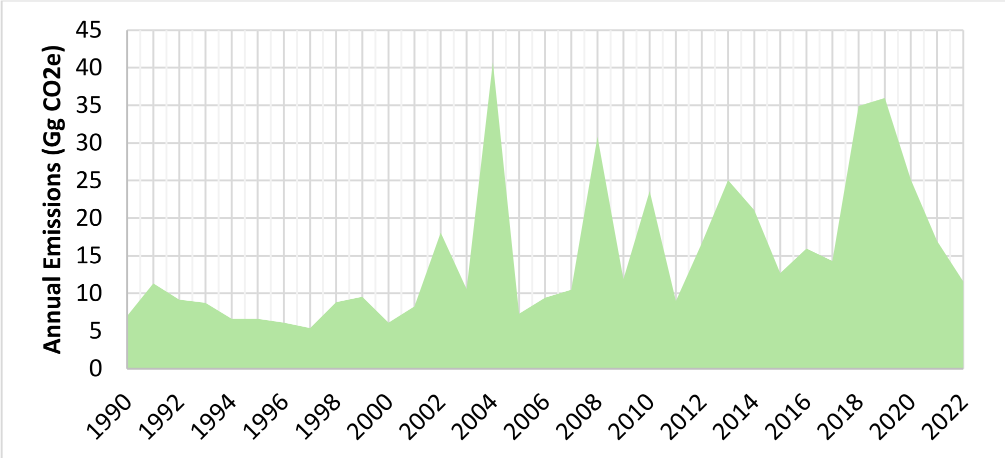

Figure 2.31. Category 3C3 GHG emissions.

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 CO2 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 inconsistency in 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 is crucial. 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 N2O 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});
- 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.

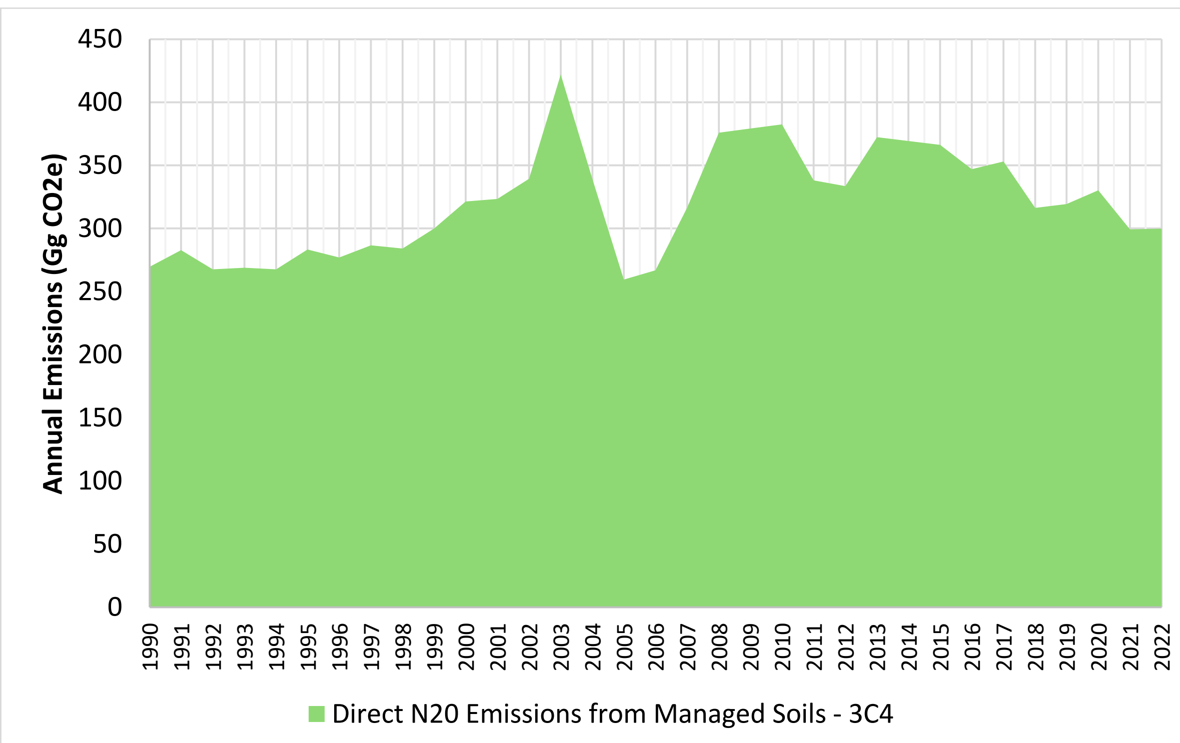

Figure 2.32. Category 3C4 GHG emissions.

Table 2.49. Summary of GHG emissions from Category 3C4 – Direct N_2O 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 N_20 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 N_20 emissions for the AFOLU sector.

Indirect N_2O Emissions from Managed Soils (3C5)

There are two paths for indirect emissions of N2O 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.

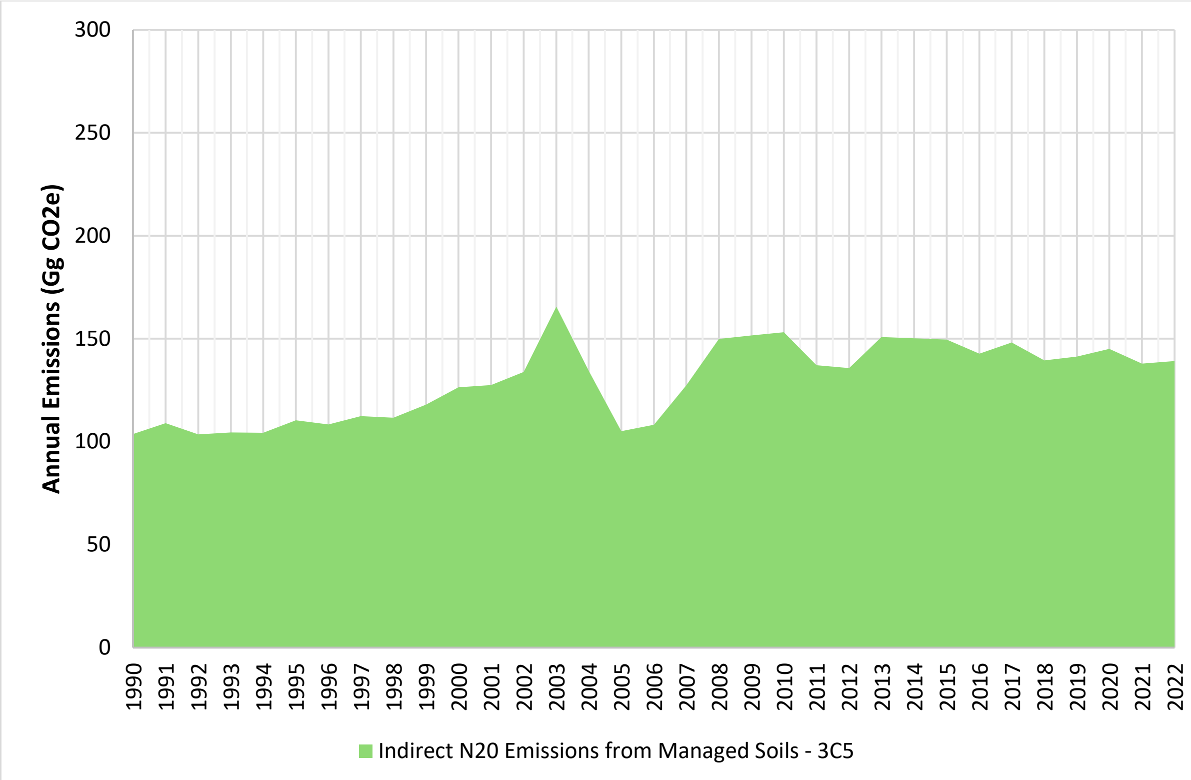

Figure 2.33. Category 3C5 GHG emissions.

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 N_2O 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 N_2O 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 N_2O 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 N_2O 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 NH_3 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.

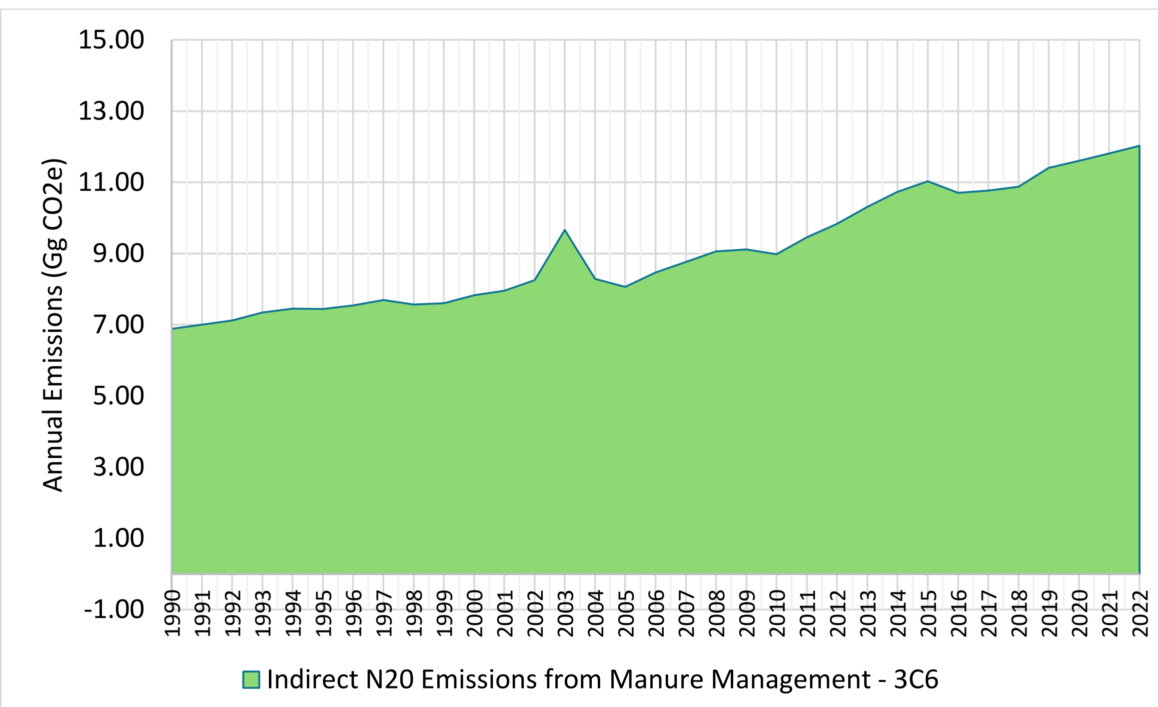

Figure 2.34. Category 3C6 GHG emissions.

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

Annual Emissions in Gg CO_2e											
	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. Remarkably, 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. 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.

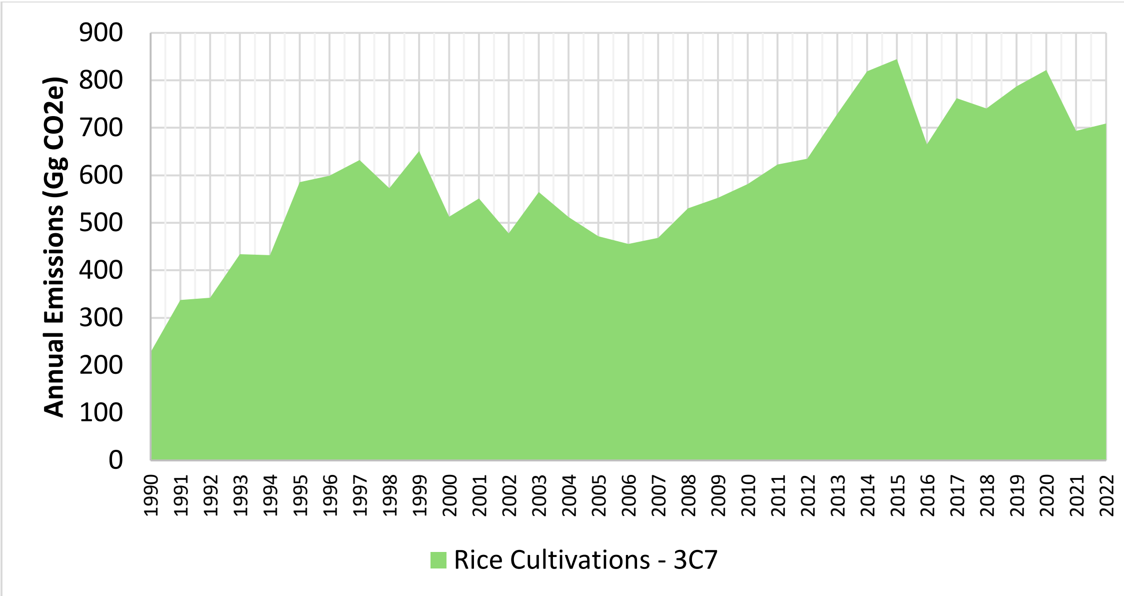

Figure 2.35. Category 3C7 GHG emissions.

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 by 212% 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 (N2O & CH4)	141%
Emission factor for dry matter burnt	116%
Global Warming Potential (N2O & CH4)	71%
Emission factor for liming	-50%
Emission factor for urea	-50%

EF1 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%
EF1FR for flooded rice fields	363%
EF3PRP, CPP for cattle (dairy, non-dairy and buffalo), poultry and pigs	175%
EF3PRP, SO for sheep and 'other animals'	167%
Default values for N excretion rate (Nrate)	50%
Default values for live weights for animal categories (TAM)	30%
Emission factor N volatilisation and re-deposition (EF4)	21%
Emission factor N leaching/runoff (EF5)	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%

Waste

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 CH4 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 CH4 and N2O emissions, in addition to CO2 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 [20], 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 [21], 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 reliable data.

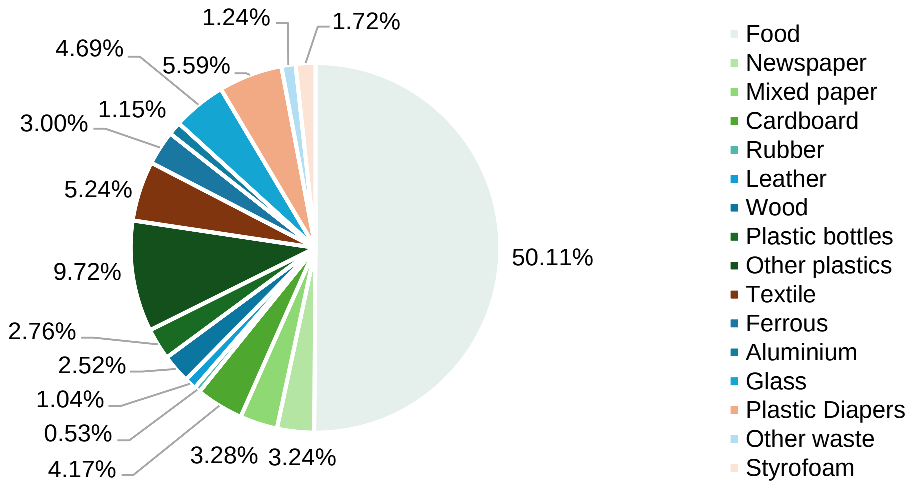

Figure 2.36. Municipal solid waste composition in Georgetown in 2010 [21].

The main MSW disposal methods in Guyana are sanitary landfilling, controlled duMoPWng, open duMoPWng, 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. Efforts are being made to enforce existing legislation marking the illegality of such activities and several ongoing nationwide anti-litter 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 CH4 recovery or flaring takes place at the site. Since commissioning in 2011, the landfill maintains detailed records [37] 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 [22].

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 [20]. 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.

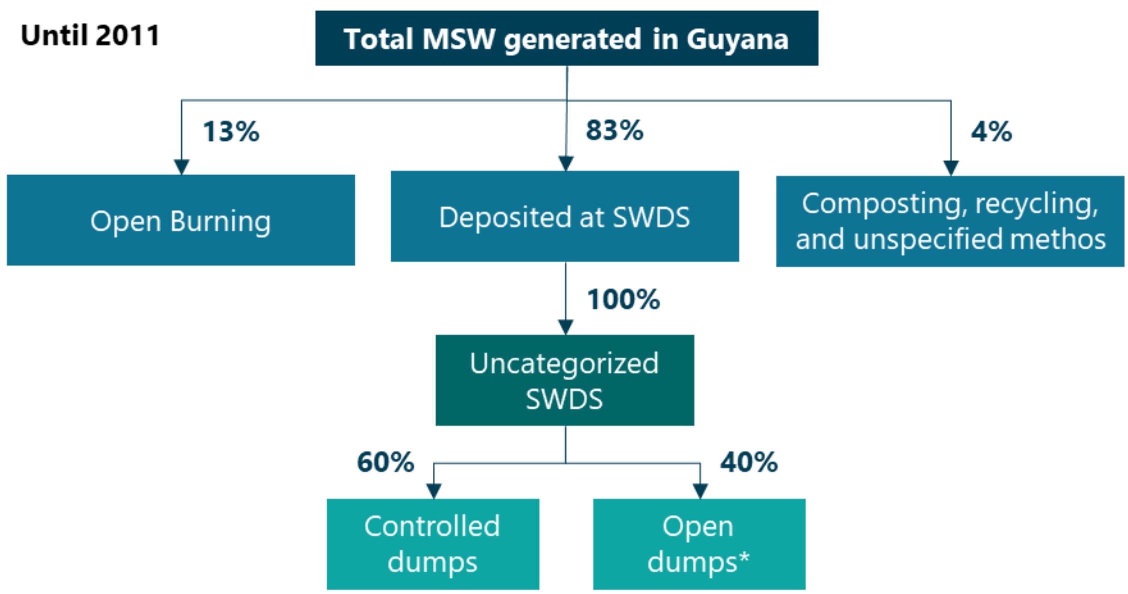

Figure 2.37. MSW treatment systems in Guyana until commissioning of Haags Bosch Landfill in 2011. *Assuming sporadic occurrences of open burning at open dumps as per IPCC default.

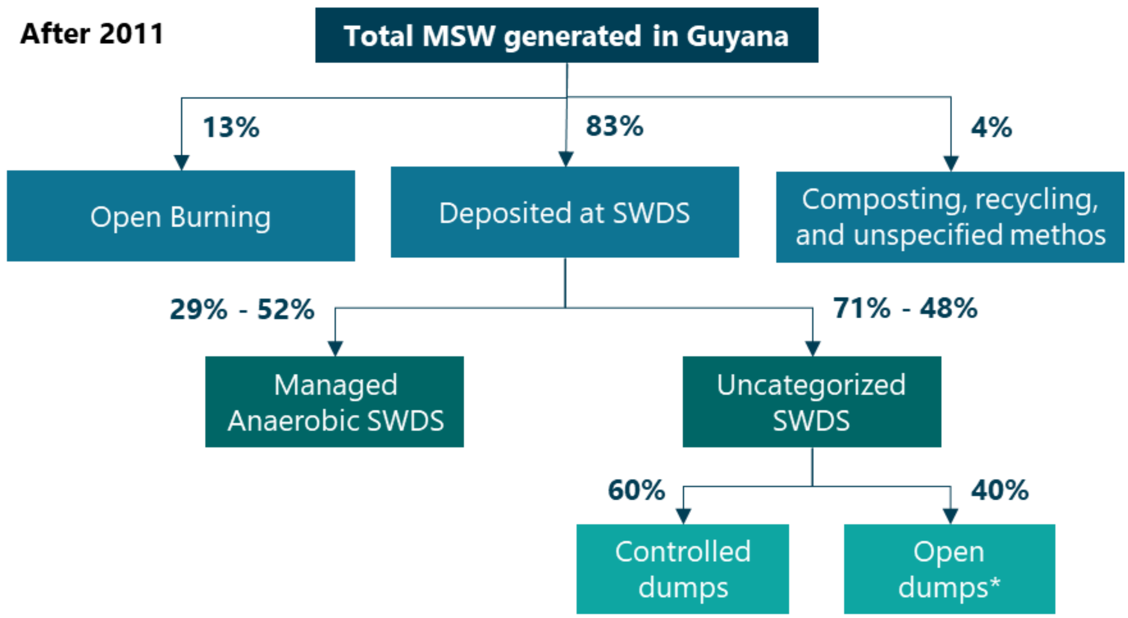

Figure 2.38. MSW treatment systems in Guyana following commissioning of Haags Bosch Landfill in 2011. *Assuming sporadic occurrences of open burning at open dumps as per IPCC default.

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 & 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 CH4 emission factor of 0.0065 kg CH4/ kg MSW wet basis and N2O emission factor of 0.00015 kg N2O/ 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, incomplete, and outdated 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 [38] 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 [39] 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%) [40].

More information is needed 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 [40] 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 [41], 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.

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 CH4 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.

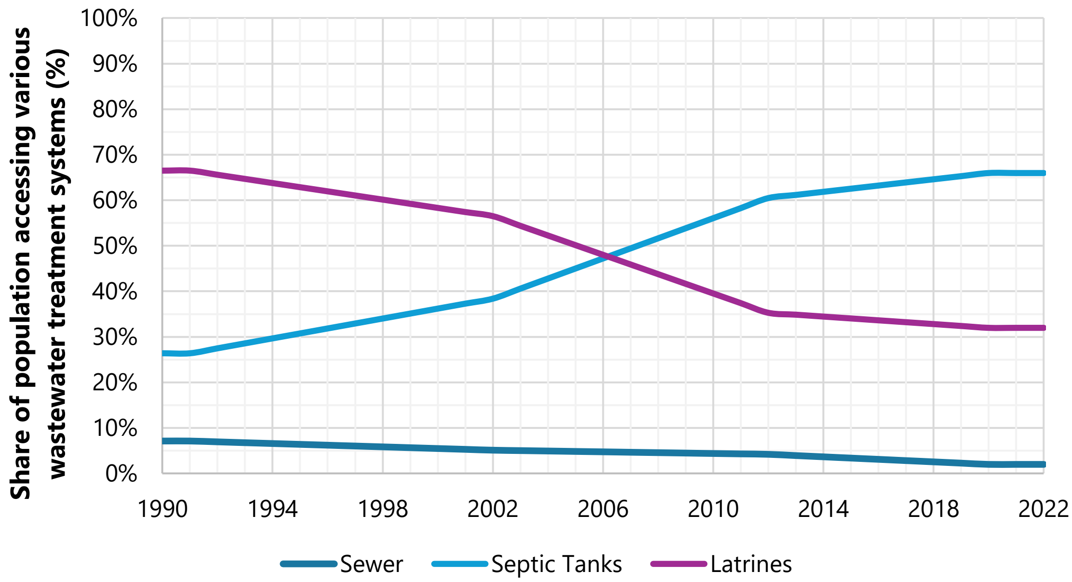

Figure 2.39. Share of population accessing various wastewater treatment systems in Guyana, extracted from the Guyana Bureau of Statistics 2002 and 2012 census [19, 17], and the Guyana Country Estimate report for SDG6 Monitoring [23].

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 [24, 25], 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, $F_{NON-CON}$ =1.04
- Factor for industrial and commercial co-discharged protein, $F_{IND-COM}$ = 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 N2O-N/kg N

Coverage of Sector

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

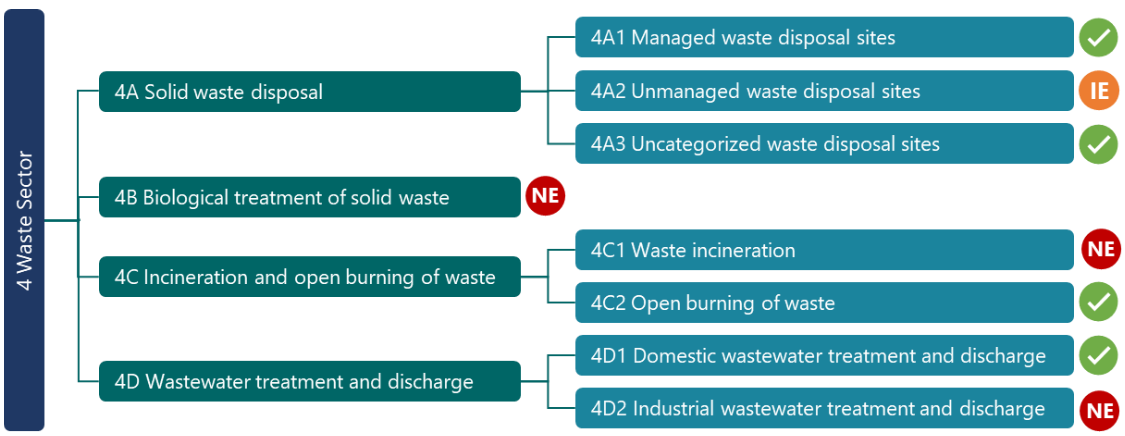

Figure 2.40. Coverage of the Guyana Waste sector GHG emissions inventory. NE – not Estimated; NO – not occurring; IE – included elsewhere; NA – not applicable.

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 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.

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.

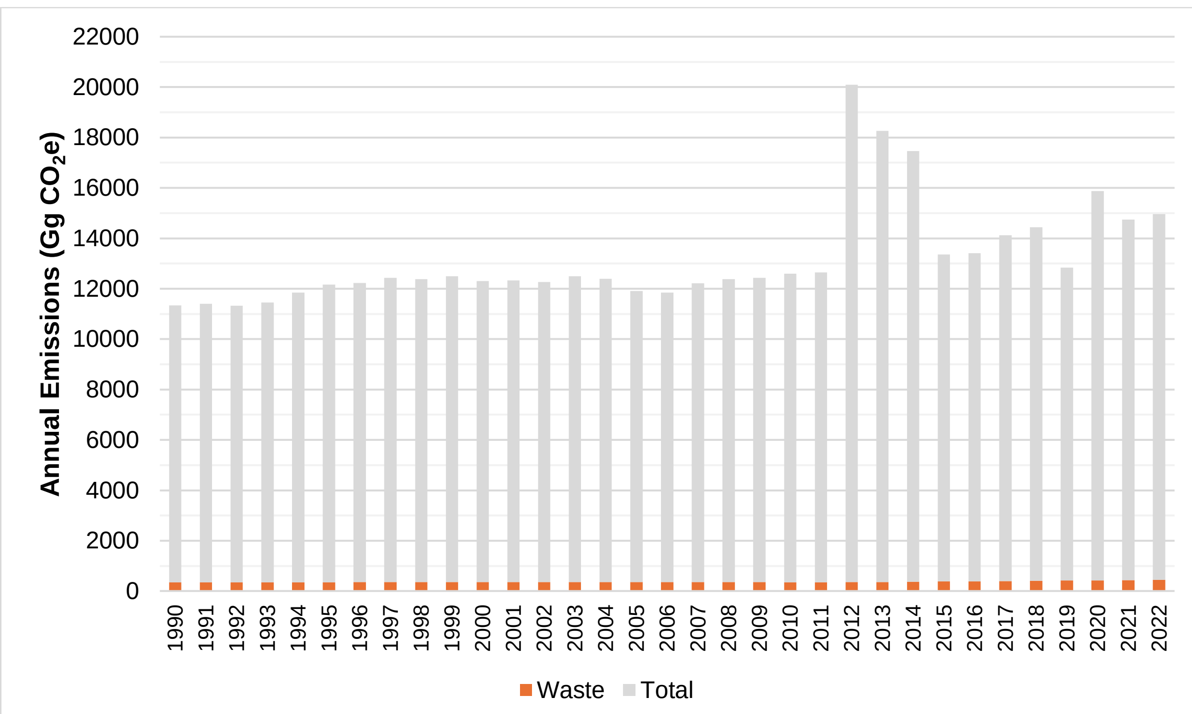

Figure 2.41. Contribution of waste sector emissions to national emission totals.

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

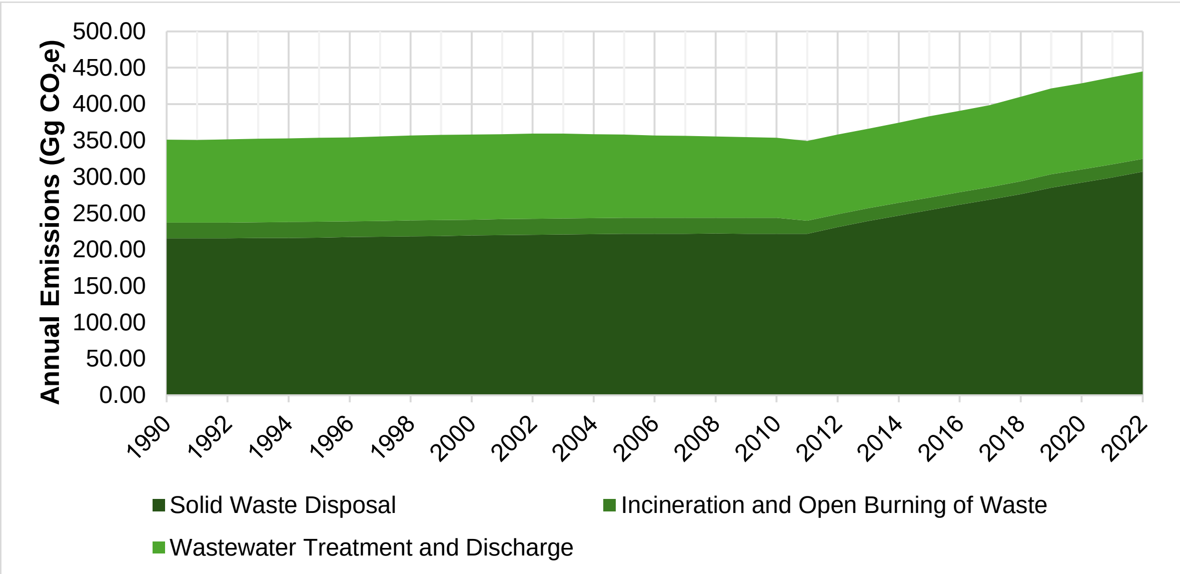

Figure 2.42. Total GHG emissions from the waste sector by category.

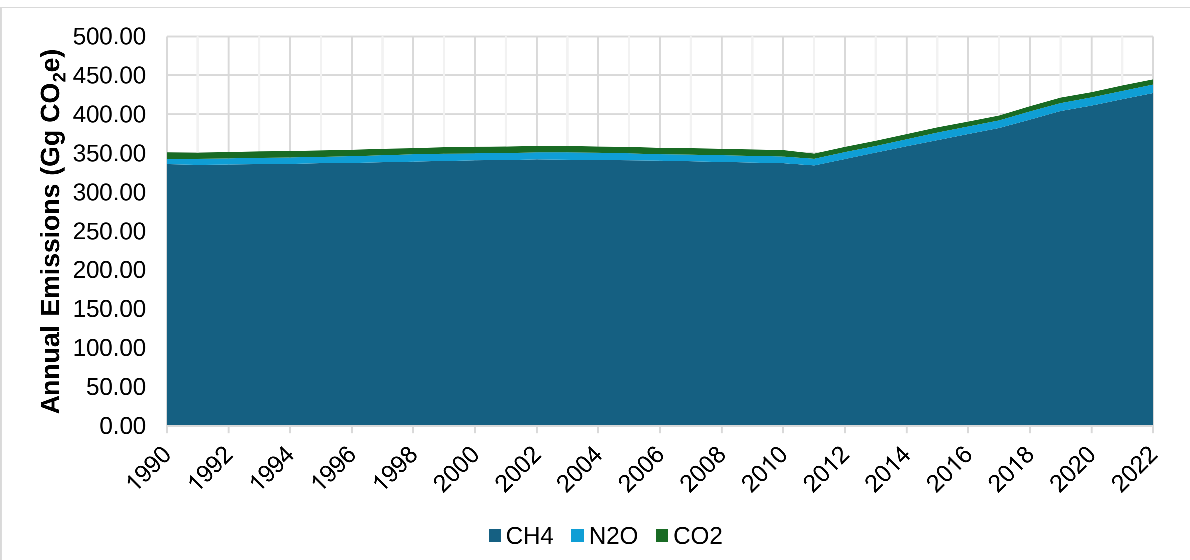

Figure 2.43. Total GHG emissions from the waste sector by gas.

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 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 duMoPWng 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 N2O 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

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.

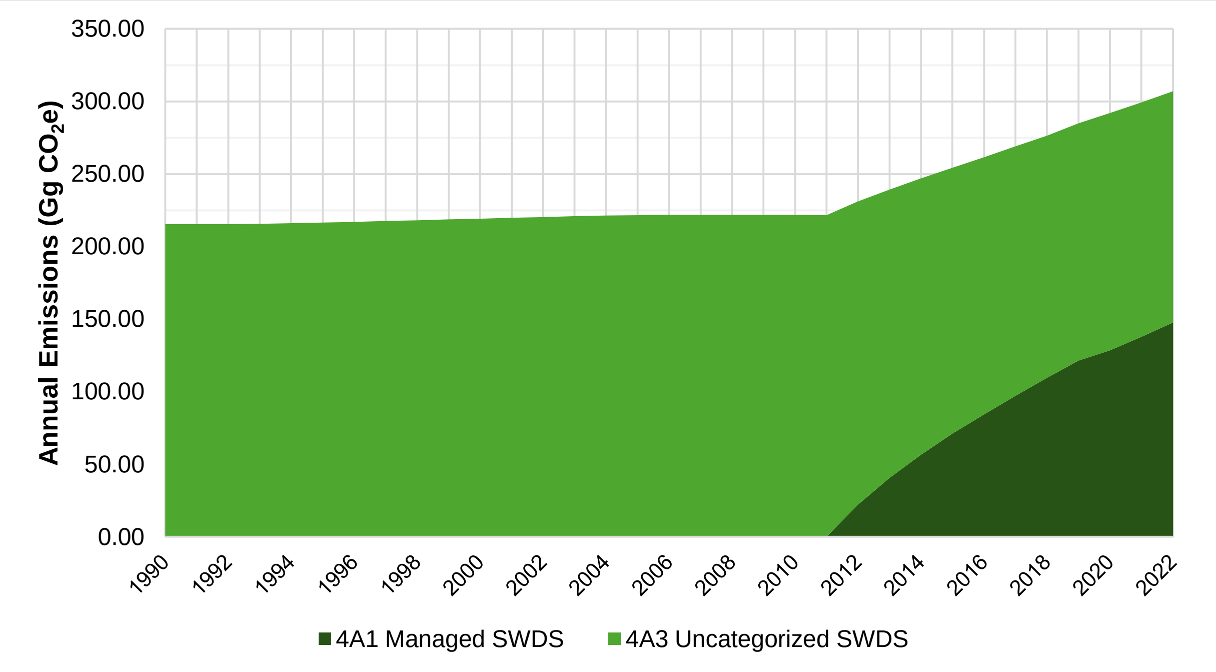

Figure 2.44. Category 4A GHG emissions by SWDS type.

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	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH4	215.51	215.59	215.59	215.80	216.16	216.60	217.11
4A SOLID WASTE DISPOSAL	CH4	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	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH4	217.64	218.20	218.76	219.33	219.89	220.45	221.00
4A SOLID WASTE DISPOSAL	CH4	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	CH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4A2 Unmanaged SWDS	CH4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH4	221.38	221.63	221.79	221.88	221.91	221.90	221.84
4A SOLID WASTE DISPOSAL	CH4	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	CH4	0.00	22.17	40.65	56.69	71.13	84.51	97.22
4A2 Unmanaged SWDS	CH4	IE	IE	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH4	221.76	208.93	198.69	190.26	183.23	177.17	171.79
4A SOLID WASTE DISPOSAL	CH4	221.76	231.10	239.35	246.95	254.36	261.68	269.00

Category	GHG	2018	2019	2020	2021	2022
4A1 Managed SWDS	CH4	109.50	121.52	128.63	137.73	147.73
4A2 Unmanaged SWDS	CH4	IE	IE	IE	IE	IE
4A3 Uncategorized SWDS	CH4	166.87	163.47	163.42	161.52	159.25
4A SOLID WASTE DISPOSAL	CH4	276.37	284.98	292.05	299.26	306.98

Solid waste disposal is the main contributor of emissions 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 emissions from the sector 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 increasingly 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%
CH4 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.

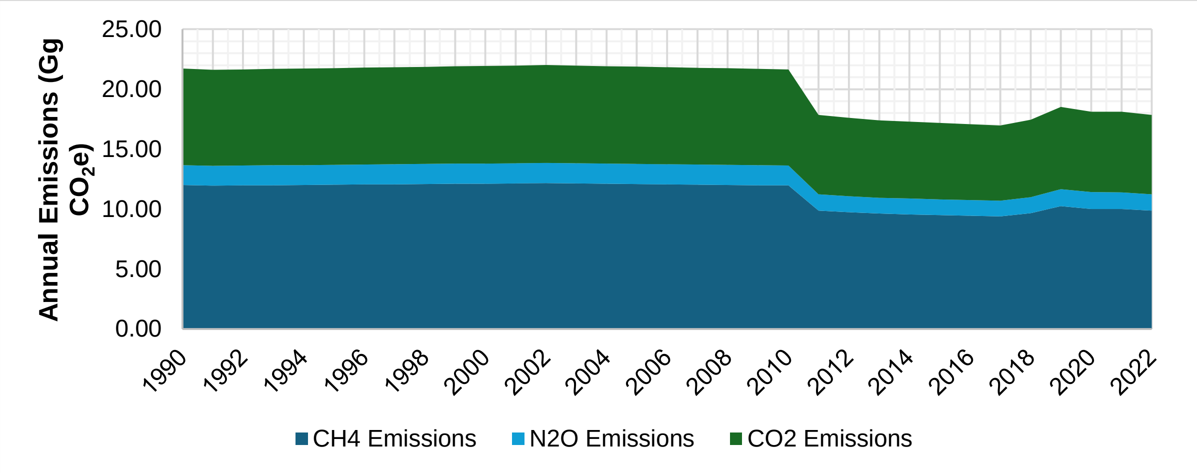

Figure 2.45. Category 4C GHG emissions by gas.

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	CO2	NE	NE	NE	NE	NE	NE	NE
	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO2	8.05	8.01	8.03	8.04	8.05	8.07	8.08
	CH4	12.00	11.95	11.97	11.99	12.01	12.03	12.05
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE
	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO2	8.09	8.11	8.12	8.13	8.15	8.16	8.14
	CH4	12.07	12.09	12.10	12.12	12.14	12.16	12.14
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE
	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO2	8.13	8.11	8.09	8.08	8.06	8.04	8.03
	CH4	12.11	12.09	12.06	12.04	12.01	11.99	11.97
	N2O	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	CO2	NE	NE	NE	NE	NE	NE	NE
	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	NE	NE	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO2	6.62	6.53	6.45	6.41	6.37	6.33	6.29
	CH4	9.86	9.73	9.62	9.55	9.49	9.44	9.38
	N2O	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	CO2	NE	NE	NE	NE	NE
	CH4	NE	NE	NE	NE	NE
	N2O	NE	NE	NE	NE	NE
4C2 Open Burning of Waste	CO2	6.47	6.87	6.72	6.71	6.62
	CH4	9.65	10.24	10.02	10.01	9.86
	N2O	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 N2O 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 duMoPWng 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 CO2 emission factors for open burning of waste	-40%,+40%
CH4 emission factor for open burning of waste	-100%,+100%
N2O 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.

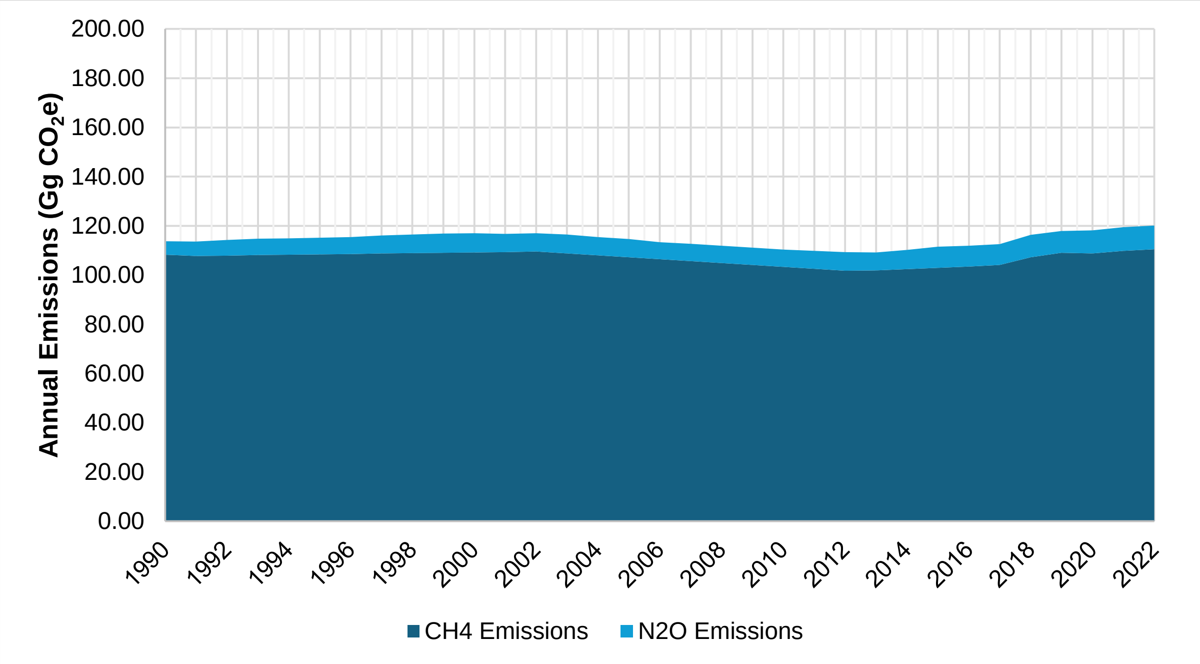

Figure 2.46. Category 4D GHG emissions by gas.

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	CH4	108.28	107.79	107.96	108.12	108.29	108.45	108.61
	N2O	5.54	5.78	6.32	6.70	6.62	6.74	6.84
4D2 Industrial Wastewater	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	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	CH4	108.77	108.93	109.08	109.24	109.39	109.54	108.76
	N2O	7.32	7.61	7.80	7.71	7.32	7.45	7.76
4D2 Industrial Wastewater	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	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	CH4	107.98	107.20	106.42	105.64	104.86	104.08	103.30
	N2O	7.44	7.41	6.94	7.07	7.11	7.08	7.10
4D2 Industrial Wastewater	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	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	CH4	102.53	101.75	101.85	102.38	102.95	103.53	104.13
	N2O	7.30	7.62	7.34	7.86	8.58	8.36	8.44
4D2 Industrial Wastewater	CH4	NE	NE	NE	NE	NE	NE	NE
	N2O	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	CH4	107.20	109.04	108.87	109.87	110.44
	N2O	9.16	8.88	9.34	9.63	9.68
4D2 Industrial Wastewater	CH4	NE	NE	NE	NE	NE
	N2O	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 CO2e) 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). N2O 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%
N2O 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 CH4 recovered and flared	0%
Maximum CH_4 producing capacity	-30%, +30%
Methane correction factors from sewerage and direct disposal	-50%, +50%

Data Gaps and Improvement Plans

During the GHG inventory coMoPWlation 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.

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

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 time series.	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 distribution of electricity are not estimated.	1	Collect data on SF6 consumption for electrical insulation and interruption in equipment utilised in electricity transmission and distribution for the entire time series.	2024-2026	GPL
Emissions from the medical use of n2o as anaesthesia are not estimated.	1	Collect the data on supply from companies that commercialize N2O for medical applications (anaesthetic use, analgesic use and veterinary use) or data on N2O consumption from the hospitals for the entire time series.	2024-2026	GRA/ Hospitals
	2	Collect data on N2O consumption for other type of product use such as use as a propellant in aerosol products, primarily in food industry for the entire time series.	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 time series.	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 time series.	2024-2026	GRA

Agriculture, Forestry, and Other Land Use

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
Forest land cover data is not disaggregated by specific vegetation types or ecological zones	1	Analyse forest cover data by specific vegetation types and ecological zones	2024-2026	GFC
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
Emission factors reported in the previous GHG inventory report were not referenced effectively, thus tracking the source and methodology followed for certain values was not easily done.	1	Ensure all data and information used for calculations are referenced correctly to enhance transparency in reporting.	2024-2026	GFC
AFOLU SECTOR – AGGREGATE SOURCES AND NON-CO_2 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 because all areas harvested are eventually burnt, before or after harvesting	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	The national data is there but only in a paper-based system so not accessible. The rec could probably be to have the data provided. 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	The classification of the fertilisers based on N content would be a legal matter currently not required by law. Maybe change rec to stat collecting N content & fertiliser Maintain accurate records of the urea imports	2024-2026	GRA

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 anaerobic”, “unmanaged deep” or “unmanaged shallow” as per IPCC definitions.	2024-2026	MLGRD
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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Chapter 3 - Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement

National Circumstances, Institutional Arrangements & Legal Framework

The adverse and potentially catastrophic impacts of climate change are already being experienced in Guyana. Since the 1960s, the country has observed marked increases in temperature, sea level, and the frequency and intensity of extreme rainfall events. The impacts on Guyanese people, the economy, and the environment during flooding and droughts are examples of the devastation climate change may cause.

The first half of 2021 saw catastrophic flooding and impacted large parts of the population. Over 74,000 acres (43,473 acres of cash crops and 30,684 acres of rice) of farmlands and over 20,000 farmers were affected. The 2021 flood is likely to be comparable to the 2005 flood which affected close to 37% of the population and caused economic damage equivalent to 60% of GDP. Some areas experienced 120-150 centimetres of standing water, which remained for several days. A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts on the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica, and Mahaica/West Berbice. Region Four was most severely affected in the 2005 flood (though less affected in the 2021 flood), experiencing close to 55% of the total damage, followed by Regions Two (23%) and Five (19%). Considerable losses were recorded in the sugar, rice, livestock, and other crops (fruits, vegetables, roots and tubers, and herbs and spices) subsectors.

Floods are not the only climate emergencies that Guyana faces. Following an extended period of dry weather in late 2014 and early 2015, the hinterland was facing drought conditions by April 2015. Region Nine (Upper Takutu-Upper Essequibo) and parts of Region One (Barima-Waini) were particularly affected, resulting in a reduction in the agricultural output in the Regions, a reduction in available water supply, and increased dust pollution, among other issues. The lack of rainfall caused decreased water levels in the wells, lakes, ponds, rivers, creeks and other water sources. Frequent bush fires destroyed several farms at Aranaputa, in Region 9. Local communities experienced limited access to potable water for domestic and agriculture use. Residents were forced to go to local rivers, including the Rupununi River, for untreated water for domestic use. The drought conditions were also linked to a resurgence of pests, including acushi ants and caterpillars, which attacked the few remaining crops. Dasheen, cassava, eddo and other cash crops were particularly severely impacted by the drought.

With increases in the number of dry spells, drought conditions and changing rainfall patterns, stress on Guyana's internal water resources, aquifers and rivers is increasing. With resources from the Guyana-Norway Partnership, Guyana developed a Climate Resilience and Adaptation Strategy to set out a comprehensive and overarching framework for adapting and building resilience to climate change impacts.

Adaptive Capacity

Potential climate impacts interact with adaptive capacity to determine levels of vulnerability to climate change. Adaptive capacity is defined as the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Adaptive capacity is a precondition for the design and implementation of effective adaptation strategies and in turn for national adaptation planning and resilience building. There are a broad range of approaches to assessing adaptive capacity and measures and indicators used vary according to circumstances.

The current status of Guyana's adaptive capacity can be described according to five broad criteria established by the IPCC, namely: informational, human, institutional, financial capacity and the policy/regulatory environment.

Informational Capacity

Making informed decisions about adaptation actions and reducing vulnerability depends largely on the availability of climate data and information; vulnerability, impact and risk assessments; and information on the costs and benefits of adaptation measures. Additionally, effective use of these data and information is partly dependent on functioning monitoring and evaluation systems.

Climate vulnerability and risk assessments have been generated for a subset of sectors and regions by a range of public and non-governmental entities. The Hydrometeorological Service monitors, collates and archives meteorological and climate data, and provides weather services to support food production and food security.

Additionally, in order to enhance informational capacity monitoring and evaluation systems have to be strengthened to capture differential impacts on and responses by men and women.

Human capacity

Human capacity, in the form of trained and skilled personnel is important to implement adaptation actions. Guyana has advanced actions to strengthen human resources and technical capacity for climate change management, specifically to:

1. Undertake and interpret regional climate change projections;
2. Conduct research on the vulnerability of key sectors and regions to the impacts of climate change;
3. Implement and maintain the technologies and equipment necessary to monitor climate and climate-related impacts;
4. Develop technologies, such as sea defences, irrigation systems and early warning systems, which are critical to successful adaptation;

There is technical knowledge on adaptation to climate change in both government and non-government institutions, and this level is being strengthened continuously, to continue to meet Guyana's needs.

Institutional Capacity

The lead government agencies and committees that have an official mandate related to climate change management are identified at the sector level:

State organisations/ committees and their climate-related mandates

Organisation/ committee	Climate-related mandate
LCDS Management Office (PMO) (within the Office of the President)	The LCDS Unit coordinates the implementation of LCDS 2030. The PMO is the GoG body responsible for managing the development and oversight the implementation of all projects funded by the Guyana REDD+ Investment Fund (GRIF).

Organisation/ committee	Climate-related mandate
LCDS 2030 Unit (Within the Office of the Vice President)	The Unit was established to support work on climate change adaptation, mitigation and forest conservation and has the overall responsibility for coordinating and aligning the efforts of various government agencies around the issue of climate change. The Unit is the UNFCCC National Focal Point and also serves as the secretariat to the Multi-Stakeholder Steering Committee (MSSC).
Guyana Forestry Commission (GFC) and REDD Secretariat (RS)	The GFC and the RS oversee the key technical aspects of REDD+, including the development and implementation of a monitoring, reporting and verification system (MRVS) for REDD+.
The Multi-Stakeholder Steering Committee (MSSC)	The MSSC supports the implementation of Guyana's LCDS and provides guidance and strategic direction for stakeholder engagement. The Committee is comprised of representatives from the government, indigenous NGOs, the private sector, labour, forestry, mining, youth, women, academia, NGOs and civil society.
Hydrometerological Service (Hydromet), Ministry of Agriculture	Hydromet is responsible for observing, archiving and understanding Guyana's weather and climate. It provides meteorological, hydrological, and oceanographic services in support of Guyana's national needs and international obligations.
Environmental Protection Agency (EPA) (within the Office of the President)	The EPA is the GoG agency responsible for overseeing the effective management, conservation, protection and improvement of the environment.
Civil Defence Commission (CDC)	The CDC has the responsibility for coordinating and monitoring disaster risk management and comprehensive disaster management in Guyana. It effectively responded to the impacts of climate change events including the major floods of 2005 and 2013, and droughts of 2010 and 2015 among others.

Other governmental as well as non-governmental organisations also have climate-related mandates.

Mainstreaming of climate change into national and sectoral policies, programmes and projects is guided by the Department of Environment and Climate Change and Guyana's Low Carbon Development Strategy.

Financial capacity

Economic resources, or finance, is a key determinant of adaptive capacity and an enabling factor for implementation of adaptation measures. Since the 2009 version of the LCDS Guyana identified a three phased approach to climate financing utilising ecosystem services. Phase 1 focused on bi-lateral partnerships, the main of which was Guyana's bi-lateral with the Kingdom of Norway where Guyana earned approximately US$226.5 million for its forest ecosystem services towards the implementation of projects identified in or aligned with Guyana's LCDS. All funds under the Guyana-Norway partnership have either been allocated to projects that have already been completed, are in progress or about to commence. Areas of project interventions include adaptation/resilience, renewable energy/mitigation, socio-economic development, forest governance, sustainable land management, and digital infrastructure. Phase 2 is the sale of ecosystem services on the voluntary market and Phase 3 the compliance market under the UNFCCC.

Guyana has continued to progress in its phased approach and is now the first country in the world to have carbon credits certified by the Architecture for REDD+ Transactions: The REDD+ Environmental Excellence Standards; the first to issue jurisdictional scale carbon credits on the voluntary carbon market under a initial deal worth US$ 750 million; and the first to issue carbon credits that are eligible for use by airlines in Phase 1 of CORSIA – the United Nations' International Civil Aviation Organisation (ICAO)'s global emissions reduction programme.

Guyana will continue to use its revenues to implement the programmes in its LCDS and align its developmental trajectory along a sustainable, low carbon, non-polluting pathway.

Policy/Regulatory Environment

Guyana's long-term vision for a sustainable and climate resilient economy is guided by the LCDS which is the country's national development strategy. All other sectoral policies and strategies are in turn aligned with the LCDS.

Institutional, Legal and Policy Frameworks and Regulations

The Department of Environment and Climate Change

The Department of Environment and Climate Change (DECC) supports Guyana's transition to a low carbon state and works closely with agencies such as the Guyana Forestry Commission, Environmental Protection Agency (EPA), Protected Areas Commission (PAC), National Parks Commission (NPC), and the Wildlife Conservation and Management Commission (WCMC). The DECC coordinates all reporting to the UNFCCC.

The Department of Environment and Climate Change, initiated a project funded by the Government of Guyana (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, UNCBD, and UNCCD. 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 (NCSA) to align with post-2015 sustainable development goals.

Following the project, the Guyana Forestry Commission (GFC) has successfully enhanced its capacity, achieving a detailed analysis of emissions through the REDD+ MRVS. The MRVS has significantly improved accuracy and specificity in the commitment to preserving forests. Notably, the MRVS has established a crucial link between indigenous communities and the national level, fostering community engagement. An important impact of the MRVS creation is the recognition by other sectors of the value in establishing similar systems for their respective work.

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 1.9).

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.

Table 3.1 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
United Nations Convention on Biological Diversity (UNCBD)	Signed on 5 June 1992, entered into force in 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
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (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
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 (CITES)	Opened for signature on 3 March 1973; entered into force on 1 July 1975	Acceded on 27 May 1977
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

Legislation

National Constitution of Guyana

The Constitution of the Co-operative Republic of Guyana of 1980 provides for the protection of the environment by the state and by the people; 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*."

Environmental Protection Act

The Environmental Protection Act of 1996 and its amendment in 2005 serve as the legislative framework for implementing environmental provisions outlined in the Constitution. Encompassing ten sections, these acts address the management, conservation, protection, and enhancement of the environment, pollution prevention and control, impact assessment of economic development on the environment, and sustainable use of natural resources. The Environmental Protection Agency (EPA) was subsequently established in 1996 under these acts, tasked with implementing effective measures for the management of the natural environment and its components. The EPA's jurisdiction spans various sectors, including waste, health, and the environment, with a legislative focus on mitigation efforts.

The EPA also ensures that developmental activities which have the potential to cause adverse effects on the natural environment are assessed before the activities are implemented. 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 greenhouse gas emissions, making a significant contribution to the fight against climate change.

Protected Areas Act

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 aims 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.

Wildlife Conservation and Management Act

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.

Other Key Legislation

There are some other natural resources legislation and those that ensure the country's environment is protected. Among these are:

- Fisheries Act, 2002[2];
- Amerindian Act, 2006[3];
- Forest Act, 2009[4]; and
- Mining Act, 1989[5] and its regulations, particularly, Mining Regulations, 2005.

Adaptation priorities, strategies, policies, plans, goals and actions to integrate adaptation into national policies and strategies

Guyana's commitment to sustainable development is evident through various strategic frameworks and plans.

The LCDS, launched in 2009, positions Guyana on a low carbon, green trajectory. The LCDS, updated in 2013 and subsequently in 2022 (after 7 months of stakeholder engagement, including Amerindian communities, satellites and villages), aims to transform the economy while providing a model for addressing climate change. Notably, the strategy addresses climate change mitigation, adaptation, and resilience-building priorities.

The National Biodiversity Strategy and Action Plan (NBSAP), aligned with the UNCBD, guides biodiversity conservation efforts until 2020. Additionally, the Aligned National Action Plan (ANAP) works against land degradation, aligning with the UNCCD Strategic Plan [103]. The National Land Use Plan (NLUP) strategically guides land development, promoting multiple land uses.

The Draft Climate Resilience Strategy and Action Plan (CRSAP), spanning 2016-2020, outlines key objectives and actions to enhance resilience to climate change across various sectors. This draft Plan informs the development of Guyana's National Adaptation Plan (NAP).

Several pre-existing strategies and plans contribute to Guyana's comprehensive approach, including the National Development Strategy (2001), Integrated Coastal Zone Management Action Plan (2000), National Mangrove Management Action Plan (2001), National Agricultural Sector Climate Change Adaptation Policy (2009), Guyana Climate Change Action Plan (2001), and the National Action Plan for Combating Land Degradation (2006). In 2018, the National Forest Policy Statement and National Forest Plan were revised. The overall objective goal of the National Forest Policy Statement and Plan is "*The conservation, protection and utilization of the state's forest, by ensuring its social, economic and environmental attributes and benefits are sustained and enhanced for the benefit of cur-rent and future generations of Guyanese, whilst fulfilling Guyana's commitments under international agreements and conventions"*.

These collectively reflect Guyana's dedication to sustainable development, conservation, and climate resilience.

Key Sector Strategies, Plans and Policies

The key policies, strategies and development plans that were being implemented after Guyana´s third national communication to the UNFCCC published in 2021 are summarized in the tables below by sector. This section provides a brief overview of some of the strategies, plans and policies of select key sectors. 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.

Agriculture Sector

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.
A 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. • Fibre 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: • 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.
Technology Actions Plan	2018	Objectives: • Mitigation and adaptation through prioritized technologies. Priorities (technologies for agriculture): • Freshwater Harvesting: Empoldering of Water Collection Areas. • Agrometeorology for Forecasting and Early Warning.
Agriculture Development Strategy 2021-2025 (Draft)	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. • 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.

Forestry Sector

Forest	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.
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.
National Mangrove Action Plan (NMAP) 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.

Climate Change

Title	Year	Description
National Determined Contributions (NDCs)	2015	Objectives: • Outline Guyana's conditional and unconditional contributions to the UNFCCC's Paris Climate 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 Program (CCAP) Climate Resilient Strategy and Action Plan (Draft)	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) 2009 and 2013	2009 and 2013	Objectives: • Advance low-carbon development. • Conservation of forest resources and enhance carbon sequestration. • Expand access to low-carbon and clean energy sources. • Engage in international cooperation. Priorities: • Implement sustainable land use practices. • Invest in green technologies. • Build climate resilience. • Promote stakeholder engagement.
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.
Guyana-Norway Agreement	*2009*	*Objectives:* • *Maintenance of deforestation rates against a set target.* • *Promote sustainable land use practices.* • *Performance based payments.* *Priorities:* • *Effective monitoring and reporting.* • *Multi-stakeholder 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.*

How best available science, gender perspectives and indigenous, traditional and local knowledge are integrated into adaptation

Climate and Gender in Guyana

Guyana has made several advancements in mainstreaming women and girls in climate action and disaster risk reduction. On the policy front, Guyana has launched its Low Carbon Development Strategy 2030 which builds on the successes for the first LCDS 2010, which saw significant benefits to women and girls through programmes funded by climate finances. Some of these programmes include the Micro and Small Enterprise project that build entrepreneurial capabilities for women and saw 2,201 Jobs Created, 224 Low Carbon Loans given – for small businesses in seventeen low carbon sectors, 591 Low Carbon Grants issued– 62% of beneficiaries were women, 38% men, and 4,482 people trained in basic management skills, record keeping, packaging and labelling, a female entrepreneur programme, climate smart agriculture, sustainable forestry, photography and other areas.

Climate financing earner by Guyana also went towards resourcing an Amerindian Development Fund which resulted in resources becoming available for Funded 180 communities and villages to strengthen entrepreneurship in Amerindian village economies, supported village initiatives in agriculture, tourism, manufacturing, village business enterprise, transportation and village infrastructure, provided 1,662 jobs created/Sustained with the majority being for women, and 1,253 Villagers Trained in Community Development Plans and Management Teams.

Bridging the ICT divide was also enabled for many hinterland women and girls with climate financing through the ICT Project. Through this project which is currently in progress, 200 ICT hubs to be established in Remote Communities, 4,000 laptops to be distributed (20 per community ICT Hub) along with 200 printers and televisions, Solar systems to be installed to power each hub and associated equipment, and over 200 e-Government public services to be offered remotely for convenience. This will transform the way in which women and girls access government services, social services, and business opportunities. It has been shown that the disproportionate impact of climate change on women is on account of the lack of connectivity and access to information and services. This project hits at the root cause of women and girls being affect by the climate crisis and presents a solution through the use of climate financing.

At the community level, there are also several success stories. The Guyana Marine Conservation Society, has led on a programme of capacity building of marine scientists to learn to properly pilot drones, and is planning to extend this initiative to schools in the Region One (Barima-Waini) of the north most regions of Guyana. The idea was sparked as a means of creating more opportunities for indigenous women. This initiative will open up innovative career advancement possibilities for young women in these far-flung hinterland villages of Guyana. In this region, the most intact ecosystem of mangroves in Guyana are found. Women and girls, now armed with the drone technology and with the ability to use it safely, doing flyovers of that resource are leading the way for monitoring the very resources that are key to climate action – nature.

Gender equality and social inclusion are central tenets for the effective implementation of the LCDS. The LCDS will promote gender and inclusion mainstreaming in climate change adaptation and mitigation strategies, including disaster risk management. Among the main implementation modalities of the LCDS will be the raising of awareness among the population about the effects of climate change, particularly on vulnerable groups. Participation in the different climate change and conservation programs with an inclusive approach is crucial since it has been shown that the participation of women in this type of project has been particularly successful. This will see the promotion of sustainable forest management, sustainable productive practices, forest conservation and recovery of degraded areas with small producers, especially women, especially to recover mining and forest areas.

Within the framework of the food security and climate change policy, an articulation will be elaborated for collaboration with women and vulnerable groups.   Agriculture is one of Guyana's main economic activities and the basis of its food security. Agricultural development is not possible without the participation of the private agro-exporter sector and small associated producers so that they can obtain a greater return on the sale of their products. Many of these sub sectors are dominated by women and their continued and strengthened participation in agricultural production chains is indispensable.

Mining is the main economic activity in Guyana, which accounts for an important segment of the skilled and unskilled labour force. In Guyana, it is necessary to generate skilled labour that can be integrated in this sector and facilitate the integration of vulnerable groups.

Tourism (Marine and Ecotourism) is a crucial low carbon sector that offers a wider range of opportunities for women to take an active part of the economy. The opportunity to diversify and expand the tourism offering creates the opportunity for women and rural/remote communities to engage in the economy.

The LCDS fosters an inclusion perspective in the development of the activities and the inclusion of women in decision-making in the mining industry through training and mentorship programs. A top priority of the LCDS is to support businesses owned by women and other vulnerable groups and facilitating the access to seed financing for entrepreneurship activities. The LCDS seeks to promote the inclusion of women and vulnerable groups in the key economic sectors especially trade, industry, commerce and tourism.

A move towards valuing ecosystem services and the economic contribution that ecosystems make in supporting the economy will help to highlight the value of the roles of women to the economy. The stewardship and management of ecosystem services and the creation of new small scale business opportunities can also provide additional opportunities for women and more rural or remote island communities, such as through small scale aquaculture.

In achieving all of the above priorities, the LCDS will promote access to accurate, timely, and accessible information that is sensitive to the needs of women and girls, boys, vulnerable groups including Hinterland communities, including language, literacy and disability.

Actions to Support Indigenous Peoples from Effects of Climate Change

Phase 1 – Low Carbon Development Strategy 2009 (2009 to 2020)

In the first phase of Guyana’s work on the Low Carbon Development Strategy, revenues earned from the Guyana Norway Bilateral Cooperation supported several actions on climate adaptation and mitigation at the village level. Investments were made in:

- Advancing the Amerindian land titling programme (fulfilling all requests for titling and extension over the project period for which this phase ends in 2026)
- Supporting ICT development at the village level (over 200 ICT hubs set up at village level)
- Supported two phases of the Amerindian Development Fund implementation which financed initiatives at the village level focused on building sustainable livelihood

In these areas, a total of US$38.5M was invested from climate finance sources through the Guyana Norway bilateral cooperation.

This was additional to government support through programmes such as the Presidential grant, and other community projects. Further, Government’s programme on infrastructure development, health care, education and social services have been expanded in Amerindian Villages, and financed from central government budget.

Phase 2 – Low Carbon Development Strategy 2030 (2021 to 2030)

Village-Led Investments: After the seven-month national consultation on LCDS 2030, it was agreed that 15 percent of all revenues received from the sale of carbon credits would be paid directly to indigenous and local communities across Guyana. For the year 2023, this totals US$22.5 million or G$4.7 billion. In line with the LCDS 2030 objectives, 15% of the revenues are being dedicated to bottom-up investments through community plans outlined in village sustainability plans. Villages follow local decisions making processes to participate in the benefit-sharing mechanism, and as of September 2023 all 242 villages submitted village plans. The strategic investment empowers villages across Guyana by providing the necessary resources and support to enhance their social, economic, and environmental well-being.

By involving villages in the planning and decision-making process, this allocation promotes community ownership and ensures effective utilization of funds to address their specific needs. Over January to February 2023, the National Toshaos Council, the national body of elected Village Leaders from across all ten regions of Guyana, led engagements which determined a structure for the allocation of these carbon credits payments. This structure centres on the determination of payments, based on population, and includes villages (both titled and untitled areas), communities, and satellites. Indigenous villages and local communities have defined for themselves their priorities of economic development initiatives of social upliftment, on climate adaptation and mitigation and food security that need to be advanced for village sustainability to be fostered.

As of end of 2023, over 800 project have been in implementation in areas of income generation, social upliftment, food security, and other related areas, all aimed at support villages in adapting and mitigating against the impact of climate change.

Village level governance structures are empowered through the Amerindian Act 2006, to deliver on village sustainability plans, outlining the short, medium and long-term priorities for each Village. These plans outline how villages, through a process of self-determination and autonomous management, will identify and implement actions to develop village livelihoods whilst addressing the impacts of climate change. It is intended that long-term carbon credits financing, will see flows of revenues to villages and communities from year 2023 and onwards into the future.

Impacts, Risk and Vulnerabilities

Observed temperature and precipitation trends

Temperatures in Guyana vary geographically with high altitude regions experiencing cooler temperatures than the coastal, lowland and savannah zones. Mean air temperatures in the upland regions and the interior (west) side of the country are between 20°C to 23°C. Mean air temperatures across the rest of the country are from 25°C to 27.5°C, reaching as high as 31°C, due to the stabilizing effect of the sea and the north-easterly trade winds.

Observed climate data shows mean annual temperatures have increased by 0.3°C since the 1960s, corresponding to an average rate of temperature increase of approximately 0.07°C per decade, with the highest changes occurring in the August-September months (~ 0.10°C per decade). This rate of increase is below the global average warming of ~ 0.08°C per decade. The average number of cold days per year has decreased by 37 (10% of days) and the frequency of cold nights has decreased at a similar rate.

With respect to precipitation, Guyana's coastal areas are dominated by a 'tropical wet' marine climate where mean annual precipitation is greater than 2000mm/year and which is distinguishable by two wet seasons (from April to July and from November to January) and two dry seasons (from February to April and from July to November). During the second wet season, northern coastal regions receive between

150mm and 300mm of rain per month. However, Guyana's savannah is dominated by a drier 'tropical wet-dry' climate where total precipitation is lower (with a mean of 1400-1800mm/ year) and less well distributed throughout the year. Savannah areas tend to have a shorter wet season and longer and drier dry season.

In addition to its tropical location, the principal factor influencing Guyana's precipitation patterns is the seasonal shift of the Inter-Tropical Convergence Zone (ITCZ), a cloud and rain-bearing belt of rising air where south-easterly and north-easterly trade winds converge, in turn affecting trade wind direction and rainfall patterns. On an inter-annual and decadal basis, Guyana is also influenced by the effects of the El-Niño Southern Oscillation (ENSO), which is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific. During El Niño years, there is a reported weakening of the trade winds and a move to drier conditions; during la Niña years there are stronger than average trade winds and significantly higher precipitation levels.

Since the 1960s, observed climate data shows increases in mean annual precipitation, with an average rate of increase across Guyana of 4.8mm per month, equal to 2.7% increase per decade. However, trends in seasonal precipitation are not statistically significant. Where data are available, there is also no evidence of any significant trends in maximum one- or five-day rainfall events.

Projected future climate trends

The climate scenarios for Guyana using the outputs from several General Circulation Models (GCMs) indicate that temperatures will increase and that sea level will continue to rise together with the height of storm surges. Ensemble median projections also indicate that average annual precipitation will decrease and that the proportion of heavy rainfall events will increase. There is uncertainty about these values as both positive and negative projections of change are generated when minimum and maximum values are considered. Table provides a summary of the direction and extent of change for the 2030s, 2040s-2070s and 2070s-2100.

Table3.2: Summary of climate change scenarios for Guyana.

(Source: McSweeney et al., 2010, Government of Guyana, 2012).

Climate variable	2030s	2040s – 2070s	2070s – 2100
Average annual temperature[7] (°C)	↑ 0.4°C to 2.0°C	↑ 0.9°C to 3.3°C	↑ 1.4°C to 5.0°C
Average annual precipitation[8] (% change)	Median: 0% to -4% Min-max: -29% to +14%+	Median: -4% to -8% Min-max: -41% to +13%+	Median: -4% to -5% Min-max: -63% to +20%+
Proportion of total rainfall that falls in heavy events[9]	No data	Median: ↑ 1-2% Min-max: -3% to +10%+	Median: ↑ 2-3% Min-max: -8% to +12%+
Sea level rise[10] (m)	↑0.14 m to 0.26 m	↑ 0.21 m to 0.43 m	↑ 0.25 m to 0.51 m
Sea level rise + storm surge[11] (m)	↑ 2.94 m to 5.94 m	No data	↑ 2.93 m to 6.19 m

[7] Results presented are minimum to maximum values across a range of General Circulation Models (GCMs) and scenarios (A2, A1B, B1). Source: McSweeney et al., 2010.
[8] Results presented are median values as well as minimum to maximum values across a range of General Circulation Models (GCMs) and scenarios (A2, A1B, B1). While the GCMs project a range of changes including increases as well as decreases when maximum and minimum values are considered, ensemble median values of change by the 2060s are consistently negative for all seasons and emissions scenarios. Source: McSweeney et al., 2010.

[9]A 'heavy' event is defined as a daily rainfall total which exceeds the threshold that is exceeded on 5% of rainy days in current climate of that region and season. This table refers to median annual change in %, as well as minimum and maximum values of change. While the proportion of total rainfall that falls in heavy events does not show a consistent direction of change when minimum and maximum values are considered, it does tend towards positive changes, particularly in the southern parts of the country in the seasons November, December, January and February, March, April. Source: McSweeney et al., 2010.

[10]Source: Government of Guyana, 2012.
[11]Source: Government of Guyana, 2012.

With respect to geographic variation, the projected rate of warming is similar in all seasons, but more rapid in the southern interior region of the country than in the northern, coastal areas. Reductions in precipitation conversely are projected as greater in the north in the 2030s and 2070s-2100.

Table 3.3 provides temperature and precipitation projections for Regions Five, Six and Ten for the period between 2040 and 2069 where a model with greater spatial resolution (10 - 50km), the Statistical DownScaling Model (SDSM), has been applied[12]. While results are largely consistent with annual average figures at the national level, it is also worth noting that the downscaled projections demonstrate a slight differentiation of impact in different regions. While reduction in average precipitation is projected as between 7% to 8% in Timehri from 2040-2069 for example, reductions in Ebini are projected to be greater from between 8.9% to 9.7%.

Table 3.3: Changes in mean monthly temperature and precipitation for Timehri, New Amsterdam and Ebini stations under future climate (2040- 2069). (Source: Government of Guyana, 2012)

Climate variable	Mean monthly minimum temperature (°C)	Mean monthly maximum temperature (°C)	Mean monthly change in precipitation (%)
Timehri (Region 4)	↑ 1.1°C	↑ 0.7°C to 1.1°C	-7.0% to -8.0%
	↑ 0.9°C to 1.1°C	↑ 0.5°C to 1.1°C	-7.4% to -8.3%
Ebini (Region 10)	↑ 1.0°C to 1.5°C	↑ 1.0°C to 1.1°C	-8.9% to -9.7%

Guyana's vulnerability to climate change

Vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity". This is represented diagrammatically in Figure 3.1.

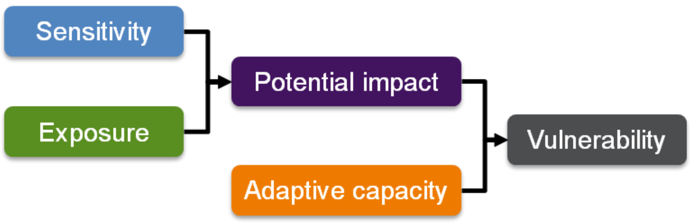

Figure 3.1: Vulnerability and its core components.

To understand Guyana's vulnerability to and the impacts of climate change, it is necessary to examine exposure to climate hazards; the sensitivity of assets, infrastructure and wider society to these hazards; and ability to adapt to the changes hazards may cause. It is important to acknowledge that, in many instances, climate drivers act in conjunction with other social, economic and environmental drivers. Indeed, climate change may not always be the primary driver of vulnerability but may act as an additional stressor on systems already affected.

[12] SDSM was applied to two GCMs (the CGCM1 and HadCM3 models).

Exposure to climate hazards

Guyana is currently exposed to extreme weather events which can be caused by a range of factors including heavy rainfall, sea state and tidal conditions, and inadequate or poorly maintained drainage and sea defence infrastructure. In terms of average annual loss to natural hazards, floods represent by far the greatest threat with United Nations International Strategy for Disaster Reduction (UNISDR) reporting that 99.9% of the expected loss per annum is associated with small, moderate and extreme flood events. Guyana is classified as a high flood risk country, with the greatest vulnerability experienced within the coastal zone. Indeed, 39% of Guyana's population and 43% of its GDP are located on the coastal zone in regions that are exposed to significant flooding risk by virtue of the concentration of the population, economic activities and critical infrastructure (e.g. transport) in these areas.

The IDB Disaster Exposure Index (DEI) had identified Guyana as the fourth most exposed country, 0.60 on a scale of 1.00, in the Latin American and Caribbean region to natural disasters. This is primarily the result of the country's high exposure to and experience of flooding as well as drought. Guyana's DEI score is particularly high given that the country is not significantly exposed to tropical storms, is not on the Caribbean hurricane belt and also has no significant earthquake or volcano risk.

As illustrated in Box 1, in January 2005, an unusual weather system produced the heaviest rainfall on record in Guyana resulting in the most devastating floods in Guyana's history. Box 1 demonstrates the impact on the agricultural sector. However, it is important to note that the social sectors, in particular the housing sector, suffered the largest economic losses and damage. Although a climate disaster of similar magnitude has not since occurred, the Government of Guyana (GoG) has noted with increasing concern that heavy precipitation events are occurring more frequently resulting in flooding and disruptions to the social, productive and infrastructural sectors. Indeed, since 2005 there have been seven extreme rainfall events which resulted in floods in 2006, 2008, 2010, 2011, 2013, 2014 and 2015. The UNISDR estimates that the floods of 2006 and 2008 affected approximately 135,000 people and those of 2006 and 2010 resulted in cumulative economic damage of US$ 183,700,000.

However, the hinterland region is also exposed to flood risk. In June 2011, continuous heavy rainfall in region 9 resulted in the worst flooding event since 1973. Two of the most populous areas were the most significantly affected and critical infrastructure such as roads, bridges and electricity plants were damaged and emergency supplies like food and water had to be flown in from Georgetown.

On the other extreme, in 2014-2015, some hinterland areas experienced a prolonged period of drought, which caused significant problems for local communities highly dependent on subsidence agriculture and reliable groundwater supplies.

Box 1: Impact of floods on the agriculture sector in Guyana

One of the most significant flood events Occurring in recent history was in early 2005. This event is reported to have affected close to 275,000 people (37% of the population) and caused economic damage estimated at US$ 465,000,000 (60% of GDP). It was caused by a combination of a wetter than average December (2004), which left the ground saturated, followed in January 2005 by some of the heaviest rainfall the country has experienced since records began in 1888. Some areas reported as much as 120-150cm of standing water, which remained for several days. The heavy rainfall also caused an increase in the water levels of the East Demerara Water Conservancy Dam (EDWC), which came close to a critical breaching level (59ft) and could have resulted in the failure of the dam wall.

A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts to the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica and Mahaica/West Berbice. Region 4 was most severely affected, experiencing close to 55% of the total damage, followed by

Regions 2 (23%) and 5 (19%). Considerable losses were recorded in the sugar, rice, livestock and other crop (fruits, vegetables, roots and tubers, and herbs and spices) subsectors.

Climate change will alter the characteristics of hazards to which Guyana is exposed (e.g. average annual rainfall) and the nature of variability (e.g. more intense storms, irregular seasonal rainfall), which will cause associated knock-on consequences for Guyana's socio-economic development objectives. It is estimated that by 2030 Guyana could be exposed to cumulative annual flood-related losses totalling US$150 million and that an extreme event similar to the serious flooding in 2005, which resulted in losses equivalent to 60% of GDP, could result in some US$0.8 billion in losses and harm to more than 320,000 people.

Sensitivity of assets, infrastructure and wider society

Guyana's vulnerability to weather- and climate-related impacts is partly a result of inherent characteristics of the country's geography and socio-economic development profile. These factors interact with the climate hazards to which Guyana is exposed and result in a range of climate impacts. Socio-economic factors include ageing and inadequately maintained critical infrastructure, limited access to the latest knowledge and technology, and wider poverty and development challenges. Unless addressed, these factors will increase Guyana's sensitivity, and in turn vulnerability, to future climate impacts.

Furthermore, maintenance regimes of the drainage and irrigation infrastructure over the past few decades, due to insufficient financial, technical and human resources, has resulted in much of the system not operating at full capacity, and some sections being inoperable. In early June 2015, several days of heavy rainfall resulted in extensive flooding in Georgetown and surrounding areas.

Box 2: Impact of droughts in Guyana's hinterland

Following an extended period of dry weather in late 2014 and early 2015, the hinterland was facing drought conditions by April 2015. Region Nine (Upper Takutu-Upper Essequibo) and parts of Region One (Barima-Waini) were particularly affected, resulting in reduction in the agricultural output in the Region, reduction in available water supply and increased dust pollution among other issues.

The lack of rainfall caused decreased water levels in the wells, lakes, ponds, rivers, creeks and other water sources, and frequent bush fires, which destroyed several farms at Aranaputa. Local communities experienced limited access to potable water for domestic and agriculture use. Residents were forced to go to local rivers, including the Rupununi River, for untreated water for domestic use, which at the time were flowing at low levels and with higher concentrations of particles. There were reports of an increase in the number of people suffering from vomiting and diarrhoea. The drought conditions were also linked to a resurgence of pests, including acushi ants and caterpillars, which attacked the few remaining crops. Dasheens, cassavas, eddoes and cash crops were observed to be particularly severely impacted by the drought.

In response, various ministries undertook actions to support local communities to cope with the effects of the dry weather conditions. For instance, the Ministry of Agriculture (MoA) deployed mist blowers and chemicals to various communities to fight the caterpillar and acushi ants' infestations, and provided veterinary assistance and vaccines to address disease outbreaks amongst cattle/livestock. The Ministry of Public Health (MoH) undertook awareness raising actions, including the distribution of health alert flyers and advisory on water purification, together with supporting efforts to identify and prevent water borne diseases.

Forecasters linked the drought to the El Niño weather phenomenon, when warmer than usual water stretches across the surface of eastern equatorial Pacific Ocean, about every three to seven years. The warmer water influences climate patterns in many places around the world. In response to the drought, the MoA set up a Special El Niño Working group to monitor and plan actions to reduce any adverse impact of a possible El Niño on agriculture production.

In 1998, Guyana experienced another major drought, when a state of emergency was declared because of widespread devastation to agriculture and mining.

In terms of access to the latest knowledge, sectoral best practice and technology, Guyana, like many developing countries, still has a far way to go. For example, in the agricultural sector small scale farmers generally have no or limited access to the finance, technology and technical knowledge on climate resilience practices thereby restricting their ability to manage the impacts of climate variability and change. This may include integrated pest management and disease control, crop rotation, crops tolerant to saltwater, water logging and drought, for instance. Indeed, amongst the resilience actions identified for the agricultural sector, it is acknowledged that the development and trial of the aforementioned agricultural techniques could be scaled-up.

Observed and Potential Impacts of Climate Change, Vulnerabilities, Risks and Opportunities and Priority Adaptation/Resilience Objectives/Actions Across Sectors

The following tables highlight the impacts, risks, vulnerabilities and adaptation and resilience priorities by sector in Guyana. Adaptation challenges, gaps and barriers are also alluded to. Each sectoral table is structured in two main parts:

Current situation, which contains:

- **Sector overview** – a short description of the sector's socio-economic profile based on literature review;
- **Climate vulnerability profile** – a synthesis of the detailed assessment of the sector's climate sensitivity, exposure and adaptive capacity. Sensitivity describes the characteristics of the sector that make it sensitive to climate and weather-related hazards and exposure focuses on the climate variables most relevant to that sector. The narrative on adaptive capacity describes stakeholders' assessments of the informational, human, institutional, financial and policy / regulatory capacity within that sector to support resilience building action.
- **Climate risks and opportunities** – a risk register and risk matrix containing the risks and opportunities the sector faces. The risks cover the period up to the 2030s and assume that only existing risk management actions are in place (i.e. no additional resilience building measures).

Future vision, which contains:

- **Sectoral objectives** – a summary of the objectives for the sector considering climate change and associated challenges to the sector's functioning and contribution to Guyana's socio-economic development. This is based on stakeholder discussions and feedback.
- **Climate resilience actions** – an inventory of actions identified for the sector based on literature review and stakeholder consultation. The actions are grouped against the "five pillars", or types of action, consistent with Guyana's Second National Communication. Pillars Four and Five

do not contain actions for a small number of sectors; this is a reflection of the state of the evidence base and the need for early actions to focus on building adaptive capacity in these instances. Details of whether the action is an existing one that could be scaled-up or replicated are included, together with information on the action's relevance at the national, sub-national or local scale, and proposed implementing agencies. Lead implementing agencies have been identified wherever possible.

Agriculture

A: Current situation
Socio-economic importance
• Agriculture is essential to Guyana in terms of its significance to food security, poverty reduction, employment generation and foreign exchange earnings. • It is Guyana's largest economic sector. Between 2009 and 2013, the agriculture sector contributed on average approximately 20% to GDP and accounted for on average 40% of the county's total export earnings per annum. Sugar and rice have accounted for over 50% of this contribution since 2000. The agricultural sector is the largest employer, providing over 33% direct employment. • Main agricultural products include sugarcane, rice, edible oils, beef, pork and poultry. • Sugar is an important agricultural and agro-industry in Guyana, representing 3.8% of GDP and 19% of agricultural GDP in 2013. A significant share of Guyana's sugar is exported, primarily to the Caribbean and the EU. • Rice is an important sector of the economy, growing year by year, contributing approximately 5% of GDP and 13.8% of agricultural GDP. It is exported primarily to the EU and the Caribbean; for instance, Guyana holds 50% of the Jamaican rice market. The rice sub-sector directly supports approximately 20% of the population and is the country's main staple. • Agriculture is also a critical livelihood activity, both for subsistence and commercial purposes and provides revenue generating income for about 25,000 farming households with approximately 90% concentrated in coastal areas and 10% in the hinterlands. With the exception of sugarcane, farms are predominantly small using less than 15 hectares of land. • The new administration will place greater emphasis on large-scale private investment in farming, especially in the Intermediate Savannahs and Region 9. Some of the crops identified for diversification in the hinterland areas are corn, soybean, cassava and legumes.
Climate vulnerability profile
• The agriculture sector is inherently extremely vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions, plant development and animal health. This vulnerability is exacerbated in Guyana by a number of factors (outlined below), which increase the exposure and sensitivity of the sector to climate impacts. • The concentration of agricultural activity in The Low Coastal Plain, a narrow strip of land the majority of which is below mean high tide level, increases the exposure of the sector to sea level- and storm surge-related flood damage. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. • The agriculture sector is highly dependent on the availability of water, a critical input for plant and animal growth. Surface water resources are currently abundant across the country. However, changes in precipitation patterns, coupled with rising temperatures, may result in an increase in the number of droughts. Temperatures are projected to increase across all seasons, with the warming most pronounced in the dry season of August, September and October. In these months, temperature is projected to increase by

a minimum of 0.9°C and a maximum of 2.5°C by the 2030s; 1.5°C and 5.1°C by the 2060s; and 2.6°C and 6.6°C by the 2090s. Drought conditions and changing rainfall patterns will exacerbate existing stress on Guyana's internal water resources, aquifers and rivers. According to the World Bank, in 2013 Guyana withdrew approximately 60% of its 241 cubic meters of renewable internal fresh water resources, 94.3% of which was used for agricultural purposes. Furthermore, livestock depend on the availability of grazing land, which is sensitive to drought (as well as flooding near the coast).

- The current state of drainage and irrigation systems further increase the sensitivity of the sector to climate impacts. Particularly in rice-growing areas, where drainage and irrigation systems are poorly maintained, droughts and heavy rains already have a negative impact on rice crops. These impacts are likely to become worse given projections across a range of future climate change scenarios, which indicate decreases in seasonal precipitation (up to 6mm for the 2030s, 17mm for the 2060s and 20mm for the 2090s) and increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated.
- Stakeholder consultations highlighted that the capacity of the sector to deal with climate impacts is affected by a number of informational, technological, institutional and regulatory barriers. These include the fact that the majority of agriculture is undertaken by small farmers who lack the technical knowledge, finance and technology to respond to and manage the impacts of climate variability and change. At the institutional level, there is a lack of cooperation and coordination among agencies, creating overlapping responsibilities and gaps. Stakeholders also commented that policy and regulation are poorly enforced, which potentially increases the exposure of agricultural activities to climate impacts (e.g. land-use planning policies and exposure to flooding; water abstraction regulations and exposure to droughts).

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the agriculture sector, as detailed below and presented on the accompanying risk matrix.

The highest magnitude risks identified for the sector are associated with sea level rise and saline water intrusion causing damage to crops (risk ref A1), flooding causing a reduction in the discharge window available for coastal drainage, which could affect sugar cane crop production (risk ref A4) and changes in water levels in the East Demerara Water Conservancy (EDWC), which would have impacts for irrigation (risk ref A6). Drought also appeared as an important risk driver, but given the uncertainty in future precipitation projections, the likelihood of the risk to agriculture yields was scored lower than the risks detailed above. Because the agriculture sector is a major contributor to GDP, any change in production will have significant consequences for the nation's economy and the livelihoods of those working in the sector (risk ref A2 and A3). Furthermore, any changes in yield of staple crops, for example rice, would have detrimental impacts for food security and human health (risk ref A5).

Risk register for the agriculture sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk

A1	Sea level rise causes salt water intrusion with the consequence that agricultural land is damaged (e.g. rice production) and rural livelihoods and commercial enterprises are threatened	Yes	Almost certain	Catastrophic impact	Serious
A2	Incremental climate change and extreme events cause a decrease in agricultural production (e.g. sugar and rice crops) with the consequence that employment, both direct and indirect, is lost	Yes	Likely	Catastrophic impact	Serious
A3	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that revenue is lost at the enterprise, community and smallholder level and rural livelihoods and commercial enterprises are threatened.	Yes	Likely	Major impact	Serious
A4	Increase in extreme rainfall events and sea level rise cause flooding which reduces the discharge window available for coastal drainage with the consequence that the quality and quantity of sugar cane crop production is threatened and rural livelihoods and commercial enterprises are negatively impacted	Yes	Moderate	Catastrophic impact	Serious
A5	Incremental climate change and extreme events causes a decrease in rice paddy production with the consequence that food security is threatened	No	Moderate	Catastrophic impact	Serious
A6	Incremental climate change and extreme events cause water levels in the East Demerara Water Conservancy (EDWC) to fall below feasible levels for irrigation with the consequence that agricultural production declines and rural livelihoods are threatened	Yes	Likely	Major impact	Serious
A7	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that communities face food insecurity and associated human health impacts	Yes	Moderate	Moderate impact	High
A8	Incremental climate change and extreme event particularly increased frequency of droughts, causes water	Yes	Moderate	Major impact	High

	shortages for agricultural purposes (especially rice production) and a decrease in agricultural production with the consequence that rural livelihoods and commercial enterprises are threatened				
A9	Sea level rise causes coastal flooding and erosion with the consequence that agricultural land is damaged or destroyed and coastal livelihoods and food security are threatened	Yes	Almost certain	Minor impact	High
A10	Increase in extreme rainfall events causes flooding with the consequence that agricultural crops are damaged and revenue is lost	Yes	Moderate	Major impact	High
A11	Incremental climate change and extreme events particularly increased frequency of droughts, cause water shortages for agricultural purposes (especially rice production) with the consequence that more water is pumped and energy use (operational expenditure) increases and rural livelihoods and commercial enterprises are threatened	Yes	Likely	Minor impact	High
A12	Incremental climate change and extreme events, particularly increased frequency of droughts, cause water deficits and reduced sugar cane yields with the consequence that rural livelihoods and commercial enterprises are threatened	Yes	Likely	Moderate impact	High
A13	Incremental climate change and extreme events, particularly increased frequency of droughts, cause water deficits and a reduction in livestock productivity with the consequence that rural livelihoods and commercial enterprises are threatened	Yes	Likely	Moderate impact	High
A14	Increase in extreme rainfall events causes water levels in the East Demerara Water Conservancy (EDWC) to rise above safe operating levels with the consequence that flood mitigation systems are breached and extensive flooding of agricultural land.	Yes	Moderate	Moderate impact	High
A15	Increase in extreme rainfall events causes a reduction in the "opportunity	Yes	Moderate	Major impact	High

	days" for planting and reaping sugar cane with the consequence that the quality and quantity of sugar cane crop production is threatened and rural livelihoods and commercial enterprises are negatively impacted				
A16	Increase in extreme rainfall events causes flooding due to stress and failure of drainage infrastructure and water management systems with the consequence that agricultural yields are lost (e.g. rice) and rural livelihoods are threatened	Yes	Moderate	Major impact	High
A17	Incremental climate change and extreme events causes a decrease in agricultural production with the consequence that economic growth and poverty reduction efforts are threatened	Yes	Moderate	Moderate impact	High
A18	Increase in extreme rainfall events causes flooding with the consequence that livestock are lost and rural livelihoods are threatened	Yes	Moderate	Moderate impact	High
A19	Decrease in mean annual rainfall causes drought and water shortages for agricultural purposes (especially rice production) with the consequence that irrigation is ineffective and agricultural yields (e.g. rice) are threatened and rural livelihoods are negatively impacted.	Yes	Moderate	Major impact	High
A20	Increase in extreme rainfall events causes flooding of dam roads, which makes agricultural land inaccessible to mechanical combine harvesters with the consequence that harvesting is delayed (e.g. rice), crops are damaged and yields are threatened, negatively impacting rural livelihoods	Yes	Moderate	Major impact	High
A21	Extreme events cause disruption in agricultural production with the consequence that commodity prices increase and food shortages occur, resulting in socioeconomic losses	Yes	Moderate	Moderate impact	High
A22	Increase in extreme rainfall events causes difficulty in accessing (e.g. sugarcane and rice) fields (which is already difficult during the rainy season) due to the poor state of some farm-to-	Yes	Moderate	Moderate impact	High

	market roads with the consequence that agricultural yields decrease and rural livelihoods are negatively impacted				
A23	Increase in extreme rainfall events causes flooding with the consequence that agricultural assets (e.g. land, livestock) in interior communities are destroyed	Yes	Moderate	Minor impact	Medium
A24	Incremental climate change and extreme events cause outbreaks of pests and diseases (e.g. paddy bug, red rice and blast infestation for rice crops) and lost agricultural production with the consequence that revenue is lost at the enterprise, community and smallholder level and rural livelihoods and commercial enterprises are threatened	Yes	Moderate	Minor impact	Medium
A25	Incremental climate change and extreme events cause proliferation of weeds and pest infestation with the consequence that agricultural yields (e.g. rice and sugar) decrease and livelihoods are threatened	Yes	Moderate	Minor impact	Medium
A26	Incremental climate change causes increased humidity and moisture, leading to increased incidences of diseases (e.g. rice blast infestation) with the consequence that agricultural yields (e.g. rice) decrease and rural livelihoods are negatively impacted	Yes	Moderate	Minor impact	Medium
A27	Incremental climate change and extreme events cause wildfire with the consequence that agricultural land (particularly for smallholders in the hinterland) is damaged or destroyed and food security is threatened	Yes	Moderate	Minor impact	Medium

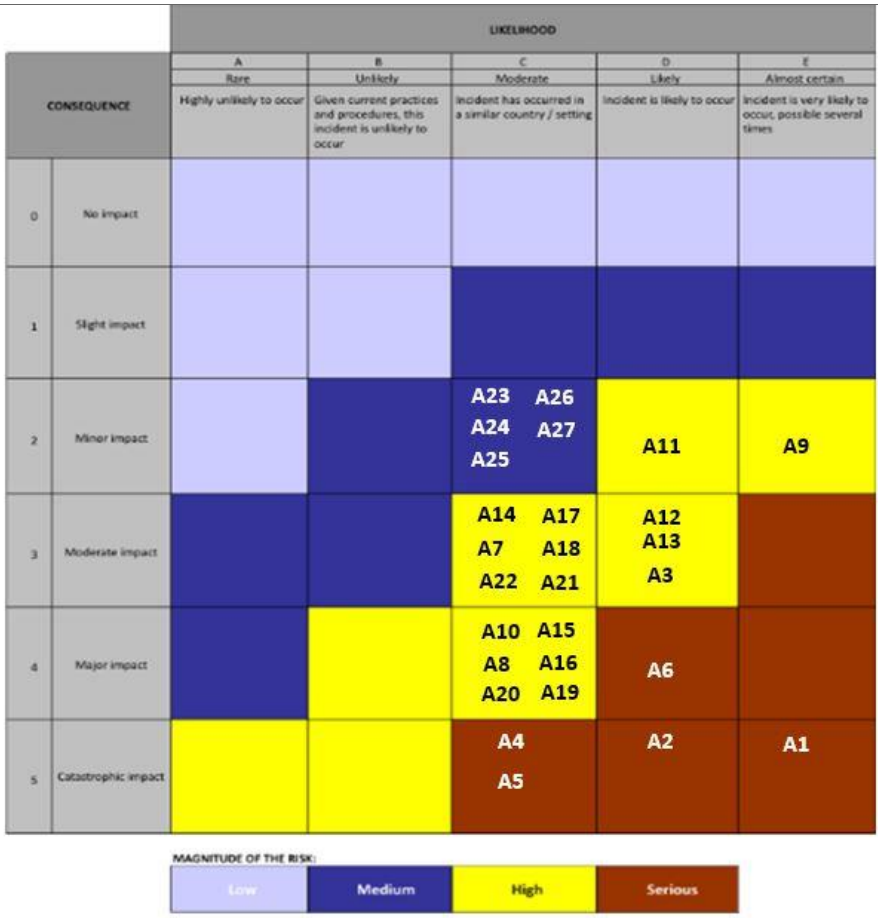

Figure 3.2: Risk matrix for the agriculture sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the agriculture sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Slight losses (less than 10%) of annual production and/or livestock	Minor losses of between 11% and 25% of annual production and/or livestock	Moderate losses of between 25% and 35% of annual production and/or livestock	Major losses of between 35% and 50% of annual production and/or livestock	Catastrophic losses of more than 50% of annual production and/or livestock

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge on climate vulnerability of the sector, particularly the impact of climate change on water resources;** • **Improve climate modelling and weather forecasting / research, climate data storage and access for a range of user groups (Hydromet services);** • **Promote adaptation good practice and develop innovative solutions (e.g. new germplasm, crops and water management best practice, including drip irrigation and protected agriculture);** • **Provide farmers with skills, training, knowledge and tools to understand and manage climate change risks;** • **Upgrade and maintain drainage and irrigation supporting systems;** • **Embed climate change adaptation responses into agricultural policies and develop appropriate climate change regulations for the sector (e.g. water abstraction quotas and land use planning);** • **Enhance monitoring and evaluation of climate impacts on agriculture and on measures to mainstream adaptation.**

Climate Adaptation and Resilience Priorities for Agriculture					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (∇), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-A	Conduct climate hazard and vulnerability mapping nationally to identify and prioritize agricultural regions/areas that are most vulnerable to the impacts of climate change	**A1 – A15, A17, A18, A20, A22**	∇	N	GL&SC, Hydromet Service <u>MoA</u>
2-A	Conduct investigations on the impacts of climate change on the most notable and prevalent pests and diseases affecting the crops and livestock sector, establish linkages with public health	**A1 – A22**	∇ *	N	MoA, <u>NAREI, GLDA, MoH VPHU)</u>
3-A	Facilitate access to, upgrade and/or develop decision support tools and seasonal forecasts for farmers to improve their ability to manage the impacts of climate variability at scales relevant to farmers and agricultural managers	**A1 – A22**	∇	L	<u>Hydromet Service, MoA</u>

4-A	Establish routine data collection and storage procedure for the conservancies and reservoirs	**A6, A8, A10, A11, A12, A13, A14, A15, A16, A18, A19, A20, A21, A22**	∇	S	NDIA, Hydromet Service
5-A	Improve calibration of hydrological model to synthesize conservancy flows	**A5, A6, A7, A8, A9, A11, A12, A14, A15, A16, A17, A18, A19, A20, A21, A22**	∇ …	S	NDIA, Hydromet Service
6-A	Undertake studies to analyse groundwater levels (building on a US Army Corps study from 1998) and the potential for groundwater to be used more widely to boost productivity	**A1 – A13, A17, A19, A21**	∇	S	Hydromet Service
7-A	Develop and test agricultural techniques that build resilience to a variable and changing climate. This includes integrated pest management and disease control; crop rotation; use of appropriate greenhouse systems; crop-specific measures. The latter includes developing different crop varieties resilient to diseases, drought, floods and salinization. Increase use of climate-responsive fertilizers and more productive use of pesticides,	**A2, A3, A21, A22**	∇	N	MoA, NAREI, GRDB, GUYSUCO
8-A	Identify and scale up appropriate climate change coping mechanisms used for agriculture over the years by indigenous people	**A1 – A12, A15, A16, A17,**	∇ …	N	MoA, NAREI, MOAA, MoLG

		A19, A21			
9-A	Conduct feasibility study, including demand study, for introducing crop insurance across Guyana, building on World Bank pre-feasibility study conducted in 2010	**A1, A2, A3, A4, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A18, A19, A20, A22**	*	N	MoA, MoF, Bureau of Statistics, insurance companies
10-A	Review, update and implement early warning and information management systems for farmers	**A1 – A7, A9, A10, A12, A14, A17, A18, A21, A22**	∇	N	CDC, GL&SC, NAREI, GUYSUCO, Hydromet, MoA
11-A	Conduct a study to determine the feasibility of completing Phases II and III of the Mahaica/Mahaicony/Abary Agricultural Development Authority (MMA/ADA) Scheme	**A2, A3, A5, A16, A19, A20, A22**	*	S	MoF, MoA, NDIA, MMA/ADA Scheme
12-A	Undertake localized vulnerability and risk assessments of agricultural lands, coastal aquifers, and drainage and irrigation systems to address impacts of sea level rise and storm surge	**A1 – A7, A9, A10, A11, A12, A14, A17, A19, A20, A22**	∇	S	NAREI, GL&SC, NDIA, GWI
13-A	Undertake detailed topographic, land-use and hydrological mapping of coastal lowlands; assessment of East Demerara Water Conservancy system integrity and hydraulic modelling; and pre-feasibility studies for coastal lowland interventions	**A1, A2, A6, A10, A14, A16, A20, A21, A22**	∇ …	N	GL&SC, GFC,NDIA, MOA
14-A	Develop climate change scenarios and projections at the national and local/sub-national levels, scales which are more relevant to end-users	**A1, A2, A3, A4, A6, A8, A9, A10, A12, A14,**	∇	N, S, L	Hydromet Service, GL&SC, MoA, DECC

		A16, A17, A18, A19, A21, A22			
15-A	Encourage organisations to use local and short-term weather forecasting, regional CIHM 3 month forecasts and drought predictor tool from the CCCCC (a Guyana-specific drought predictor tool is needed)	**A2 – A8, A10 – A22**	*	N, S, L	Hydromet Service, MoA, CCCCC
16-A	Use higher resolution climate models and impact assessments to inform coastal planning and management	**A1 – A8, A10- A15, A17 – A21**	∇	N	MoA (outsourced to specialists as required), EPA
17-A	Develop a comprehensive national hydrometeorological monitoring network (overcoming the current focus on the north and the east)	**A2, A3, A4, A6, A7, A10, A13, A15, A16, A18 – A22**	∇	N	Hydromet Service
18-A	Secure the appointment of a Hydromet instrument technician to with the use of radar data	**A2 – A10, A12, A13, A14, A17, A19 - A22**	*	N	Hydromet Service, CCCCC
19-A	Establish a centralised repository for climate-related data	**A2 – A8, A10 – A22**	*	N	Hydromet Service, MoA
20-A	Facilitate research based on spatial variations within sectors	**A1, A2, A3, A4, A7, A8, A9, A10, A13, A15, A17, A19, A20, A22**	∇	S	MoF, UG, DECC, sectoral ministries, GL&SC,
21-A	Promote and facilitate the participation of the Bureau of Statistics and non-state actors in conducting research on climate impacts e.g. IICC, WWF, CIG	**N/A**	∇	N	MoF, BoS, IIC, WWF, CIG

Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
22-A	Showcase best management practices through the establishment of demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, agrochemicals and fertilizer application, plant husbandry, livestock breed evaluation, forage conservation, husbandry and water conservation and management,	**A1, A2, A4, A5, A6, A9, A10, A11, A12, A13, A16, A18, A20, A22**	∇	N, L	NAREI, GRDB, GUYSUCO, , Pesticides Board, GLDA
23-A	Develop and implement an awareness raising programme on the impacts and risks of climate change on water and soil resources to support sustainable agricultural practices to manage these impacts	**A9 – A12, A19, A21, A23, A27**	∇	N	DECC, GWI, NDIA, UG, GSA, MOA
24-A	Conduct research to develop capacity in Guyana with respect to finding solutions to water-related climate impacts	**A1 – A22**	∇	N	MoA, NAREI, GUYSUCO, UG, EPA – Water Quality Unit, Hydromet, FAO, GWI
25-A	Include climate resilience as a focus for Guyana's participation in the Global Initiative on Plant Breeding Capacity Building (GIPB)	**A1 – A22**	∇	N	NAREI, GUYSUCO, GRDB, IAST, Crops and Livestock
26-A	Conduct training and capacity development programmes for indigenous communities in climate-smart agricultural practices	**A1 – A7, A9, A10, A12, A15, A17, A19, A22**	∇ …	S	NAREI, MOAA, MoA
27-A	Develop the necessary capacity within the Ministry of Agriculture and natural resource agencies to respond to climate change	**A1, A2, A4, A6, A7, A8, A9, A11, A13, A14, A16, A18, A19, A21, A22**	∇	S	MoA, MNR
28-A	Conduct awareness raising campaign among farmers about	**A1 – A13,**	*	N, L	MoA, IPED, DECC

	crop and livestock insurance, if such a scheme is put in place (see action 9-A)	**A15, A16, A17, A19**			
29-A	Expand current extension services to farmers to include provision of e-training (where Internet access permits) in agronomic farming practices; and continued improvement and implementation of the ‘Six-Point Programme’	**A1, A2, A3, A5, A8, A20, A22**	∇ …	N	NAREI, GUYSUCO, GRDB, GLDA, GSA
30-A	Strengthen institutional capacity of Government to manage water levels in the East Demerara Water Conservancy and to guide interventions aimed at reducing vulnerability to flooding	**A1, A2, A4, A5, A6, A8, A9, A11, A13 – A17, A19, A21, A22**	∇	S	MoA, NDIA, GWI
31-A	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation and train local community members in skills required for monitoring of climate impact	**A1, A2, A4, A5, A7-A10, A12, A14, A16, A18-A22, A26, A27**	*	N	MoF, MoA, NAREI, GCF, IICC, GSA
32-A	Provide training and education to develop technical expertise for improved climatological monitoring and forecasting and downscaling global and regional climate models to specific regions and sectors in Guyana	**A1 – A22**	*	N	MoA, UG, Hydromet Services
33-A	Develop and introduce a course on water conservation as part of tertiary education	**A2, A3, A5, A6, A8, A11, A12, A13, A17, A21**	*	N	Guyana School of Agriculture, UoG
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
34-A	Review, and revise if necessary relevant legislation, such as the Water Commission Act, to integrate climate change considerations	**A1, A2, A4, A5, A6, A8, A9, A10, A11, A13, A14,**	*	N	MoLA, MoLG, GWI

		A15, A16, A18, A19, A22			
35-A	Review and implement the 2013-2018 Agriculture Disaster Risk Management Plan, so that opportunities for strengthening climate resilience are identified	**A1 – A22**	∇	N	CDC, MoA
36-A	Implement 2013-2020 National Agriculture Strategy, which takes into account climate change as a risk and opportunity for the agricultural sector	**A1 – A22**	∇	N	MoA
37-A	Finalise the Draft National Land-Use Policy and the National Land-Use Plan, for Cabinet approval	**A1, A4, A9**	∇	N	GL&SC, MNR, MOA
38-A	Develop a regional agriculture strategy for the Rupununi region (a region of high ecological value), which will strengthen the region's resilience and work toward sustainable and climate-smart agriculture. This may serve as a model for Ebini (Region10) Intermediate Savannah. The Ministry of Agriculture has already begun the planning process	**A3, A7, A8, A10, A11, A13, A15, A17, A18, A19, A21**	∇ …	S	MoA, GL&SC, CH&PA, MOAA, NAREI
39-A	Conduct a comprehensive review of human resource policies within the agricultural sector and include provisions for (i) skills development through training on climate change and climate risk reduction to staff who are at the forefront of the supply chain, (ii) job recruitment and introduction of compensation packages for key positions that remain vacant.	**A1 – A22**	*	N	MoA, DECC
40-A	Develop and implement policies to promote investment in the processing of agricultural products, to add value and variety to output for food and other uses, improving nutrition and food security	**A7, A8, A9, A11, A12, A3, A15, A17, A21, A22**	∇	N	MoA, GMC, GSA, MITC,
41-A	Ensure gender issues are integrated into sectoral projects/ programmes relevant to resilience building	**A7, A8, A13, A15, A17, A19,**	*	N	MoF, Ministry of Human Services, Ministry of

		A20, A21, A22, A25, A26, A27			Social Cohesion
42-A	Develop a more robust framework for monitoring and evaluation, covering climate impacts and changes observed, as well as adaptation responses	**A1, A2, A3, A4, A5, A8, A9, A10, A13, A14, A16, A18, A19**	*	N	MoLA, MOA
43-A	Develop a climate research strategy and action plan for the agriculture sector in Guyana, which will inform policy development and review	**A1 – A18, A21 – A25**	*	N	DECC, MOA
44-A	Enhance collaboration and coordination between the MoA and Ministry of Public Infrastructure (MOPW) to promote an integrated approach to Coastal Zone Management, including drainage and irrigation and management of sea and river defence infrastructure	**A2, A7, A8, A9, A10, A12, A13, A17, A19, A21**	∇	N	MoA, MOPW
45-A	Research and develop GoG position on GMOs	**A24 – A26**	*	N	MoA
Pillar 4 Actions: Generation and application of technologies					
46-A	Re-assess and build on Agriculture Market Information Service (AMIS), implemented through the MoA and mobile phone service providers, which provides weather information and market information to farmers via mobile phone Short Message Service (SMS)	**A1 – A11, A13, A15, A16, A18 – A23, A25**	∇	N	GMC, MoA, Digicel
47-A	Upgrade drainage and irrigation system to deal with the expected greater intensity in rainfall; increased drought conditions; and increased flooding and salinity	**A1 – A22**	∇	S	NDIA, GUYSUCO, MMA, other conservancy authorities
48-A	Conduct studies and pilot projects on rainwater harvesting and conservation of water for irrigation, e.g. in the Rupununi	**A2, A7, A8, A9, A10, A12, A13,**	*	S	MoA

		A17, A19, A21			
49-A	Develop and implement environmental management systems for agriculture	**A1, A2, A4, A6, A7, A8, A9, A11, A14, A15, A16, A24, A25, A26, A27**	*	N	MoA, MNR
50-A	Develop dynamic farm and agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation	**A1, A2, A5, A7, A9, A10, A11, A13, A16, A17, A19, A21**	*	N	MoA, NAREI
51-A	Assessment to examine the reallocation of agriculture as a flood risk management response	**A4, A6, A9,A14, A15, A16, A17, A18, A20, A22, A23**	∇ …	N	CDC, MoA, NAREI
52-A	Infrastructure, machinery and equipment: existing stock of machines should be modified and replaced with new, specialized machines which can operate under very wet conditions	**A1, A2, A3, A4, A5, A15, A16, A20, A22**	∇	N	GUYSUCO, GRDB, MoA
53-A	Improve existing roads and develop new infrastructure to improve access to market and reduce post-harvest losses	**A1, A4, A9, A16, A18, A19, A20, A21, A22**	∇	N	MoA, NAREI, New GMC, MOPW
54-A	Upgrade and maintain drainage and irrigation system for flood risk management in Georgetown	**A1, A14**	∇	L	Municipality of Georgetown, MoLG
55-A	Maintain the East Demerara Water Conservancy which protects Georgetown and most of the East Coast from overflow water	**A6, A8, A10, A11, A12,**	∇	S	MoA, NDIA

		A13, A14, A18, A19			
56-A	Upgrade the East Demerara Water Conservancy which protects Georgetown and most of the East Coast from overflow water	**A6, A8, A10, A11, A12, A13, A14, A18, A19**	∇	S	MoA, NDIA
57-A	Implement packaging and processing systems for agriculture products, such as vacuum packaging to prolong shelf life of food supplies	**A7, A8, A9, A11, A12, A3, A15, A17, A21, A22**	∇	N, S, L	MoA
Pillar 5 Actions: Financing instruments					
58-A	Source financing for research and development programmes, including through use of financial incentives for private sector companies	**A1 – A22**	∇	N	MoA, Fair Trade
59-A	Develop and provide financial incentives scheme for farmers, appropriate to each region, to implement climate resilient farming techniques/actions	**A11, A16, A21, A26**			NAREI, GLDA
60-A	Identify sources of financing for the development and trial of climate resilient agricultural techniques	**A1 – A27**	∇	N	MoF, MoA, NAREI, GLDA
61-A	Identify sources of financing for demonstration farms and educational programmes	**A1, A2, A3, A5,A6, A7, A8, A11, A13, A15, A16, A20, A21, A22**	∇ …	N	NAREI, MoA, GLDA, MoF, IICA
62-A	Identify sources of funding for updated, climate-resilient infrastructure and equipment	**A1, A4, A6, A8, A9, A10, A11, A12, A14, A16, A18,**	∇	N	Sea & River Defence Division of MOPW, MoLG, MOA, NDIA, MoF

		A19, A20, A21, A22			
63-A	Strengthen primary insurance market, which helps to strengthen resilience within the economy to catastrophic events	**A1 – A22**	∇	N	MoA, insurance companies, IPED
64-A	Source financing for the development and dissemination of an appropriate crop insurance product, should it be deemed feasible (see actions 9-A, 28-A)	**A1, A2, A3, A4, A5, A7, A8, A9, A10, A11, A12, A13, A16, A18, A20, A21**	*	N	MoF, MoA
65-A	Secure funds for upgrading coastal irrigation and drainage system and improving sea defences	**A1, A4, A6, A8, A9, A10, A11, A12, A14, A18, A19, A20**	∇	S	MoF, MoA, MOPW, MLG
66-A	Source funding for automated weather stations and field staff	**A4, A5, A6, A8, A10, A11, A12, A13, A14, A15, A16, A18, A19, A20, A22, A23, A24, A25, A26, A27**	∇	N	MoF, MoA

Community and Regional Development

A: Current situation
Socio-economic importance
• All countries need competitive dynamic regions to achieve their economic, social and environmental objectives. Community and regional development is viewed as the general effort to reduce regional disparities by supporting (employment and wealth-generating) economic activities in regions. The vision in Guyana, as stated by the Ministry of Local Government (MoLG) is for sustainable, cohesive and empowered communities across the country. • Guyana is divided into 10 Administrative Regions and each Region is administered by a Regional Democratic Council (RDC) which is headed by a Chairman. The Regions are divided into neighbourhood councils, known as Neighbourhood Democratic Councils (NDCs). Georgetown and Guyana's other major cities are important generators of wealth, employment and productivity growth and play a leading role in the national economy. • Guyana's rural hinterland accounts for 95% of the land area and 10% of the population and is home to a number of important economic activities, including agriculture, forestry and mining. However, transport, energy and ICT connections to the hinterland are limited, which will be a constraint to socio-economic development in these regions. • The communities sector, in both rural and urban locations, is especially important for job creation and provision of services like water, waste management and housing that are essential to a productive and sustainable future. • The challenge for Guyana is to strike a balance between the interests, capacities and objectives of national and sub-national levels, to ensure that all places contribute to and benefit from economic growth.
Climate vulnerability profile
• Regions and communities in Guyana are vulnerable to climate change. Vulnerabilities differ depending on location (rural vs. urban, coastal vs. hinterland) and physical and socio-economic characteristics of each community/region, for example division of labour between men and women, main sources of livelihood, and access to critical infrastructure such as transport, energy, health facilities and communications. • Georgetown, where most of the population is concentrated, is highly sensitive to the impacts of flooding due to the city's strained and inadequate drainage infrastructure, leading to various negative impacts such as property damage, loss of life, and deterioration of health due to water-borne illnesses. The city's drainage system depends primarily on 13 sluices. Pumps are used to drain water off the land when the sluice gates are closed, but not all are currently functional. Flooding is linked to heavy rainfall as well as sea level rise. Management of the EDWC and other conservancies is also critical, especially when there is prolonged heavy rainfall. Climate projections show increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated. • The concentration of the population along the coast also exposes communities and economic activities to flooding and erosion associated with sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the

maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. These climate hazards have the potential to exacerbate flooding, particularly in Georgetown and coastal communities. The floods of early June 2015 illustrate the vulnerability of Guyana's urban areas to flooding.

- **Wastewater management, especially the management of septic effluent along coastal communities, and solid waste management also faces challenges and programmes are being designed to address this.**
- **Health is therefore a key issue for communities and regions in Guyana, and is the responsibility of the RDCs. Climate factors influence the incidence of water-, vector-, and food-borne diseases. For example, warmer temperatures, higher humidity and more places where water can collect favour malaria transmission. Other diseases, such as dengue, gastroenteritis and diarrhoea are also sensitive to changes in climatic conditions.**
- **Many communities in Guyana are dependent on agriculture for their livelihoods. Agriculture itself is very vulnerable to climate change, which increases the sensitivity of the communities which depend upon it. A decrease in agricultural production, as a source of livelihoods and food security, is of particular concern, as Guyana has a high rate of population at risk. In terms of food security, the following risk groups have been identified in Guyana: low-income families, the indigent and homeless population, children 0–5 years of age, adults over age 65, and those infected with communicable diseases or affected by one or more non-communicable chronic diseases.**
- **Gender roles also create vulnerabilities in communities. The division of labour in some communities may lead to different vulnerabilities for men and women.**
- **The capacity of communities and local governments to adapt to the impacts of climate change was assessed by stakeholders as moderate; Stakeholders commented that policies related to climate resilience exist, and these need to be supported at regional and national level; there is also a particular need to strengthen land use planning.**

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for community and regional development.

The majority of risks identified for this sector were deemed high magnitude. These risks identified are are largely linked to risks in other sectors, for example, the impacts of sea level rise on agricultural land is identified as having cascading consequences for regional development and socio-economic growth (risk ref CRD2). Similarly, the impacts of floods and droughts on mining operations could lead to detrimental consequences for the livelihoods and health of rural communities in these areas (risk ref CRD3). These climate risks have the potential to exacerbate regional socio-economic inequalities. The final, more direct, high magnitude risk relates to flood damage to infrastructure, including housing, roads, telecommunications and utilities, and the risk of human injury and death (risk ref CRD1).

Risk register for Community and Regional Development. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk	Likelihood (2030s)	Consequence	Magnitude of risk
CRD1	Increase in extreme rainfall events cause flooding with the consequence that infrastructure, including housing, roads, telecommunications and utilities,	Yes	Likely	Catastrophic impact	Serious

	are damaged or destroyed and there is increased risk of human injury and death				
CRD2	Sea level rise cause coastal flooding and erosion with the consequence that agricultural land is damaged or destroyed and regional development and socioeconomic growth are threatened in coastal areas	Yes	Likely	Catastrophic impact	Serious
CRD3	Extreme events combined with the concentration of population in exposed coastal zones, causes an increased chance of climate-related disasters with the consequence that physical and socio-economic damage and loss of life occur	Yes	Likely	Catastrophic impact	Serious
CRD4	Extreme events particularly floods and droughts, cause detrimental impacts to mining operations and riverine landforms with the consequence that livelihoods and health of rural communities in the hinterland is detrimentally impacted	Yes	Likely	Major impact	Serious
CRD5	Extreme events cause unsuitable living and working conditions with the consequence that gender inequality increases, with the disempowerment of women	Not yet	Moderate	At the	High
CRD6	Incremental climate change and extreme events cause a greater number of natural hazard-related disasters with the consequence that lives are threatened (men, women and children)	Yes	Moderate	Major impact	High
CRD7	Extreme events particularly heatwaves, droughts and floods, cause problems with solid waste management and drainage and irrigation with the consequence that waste management systems and practices will need amending and implemented/ enforced	Yes	Moderate	Major impact	High
CRD8	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that rural livelihoods and commercial enterprises are threatened, employment is lost and social problems develop	Yes	Moderate	Major impact	High

CRD9	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that regional development and socioeconomic growth are threatened	Yes	Moderate	Major impact	High
CRD10	Incremental climate change and extreme events causes a decrease in agricultural production and revenue at the enterprise, community and smallholder level with the consequence that community services (e.g. health, education, infrastructure and transport) are detrimentally affected	Yes	Moderate	Major impact	High
CRD11	Incremental climate change and extreme events causes migration with the consequence that human resources are loss from Guyana	Yes	Moderate	Moderate impact	High
CRD12	Increase in extreme rainfall events causes flooding with the consequence that resources are required for disaster response efforts	Yes	Almost certain	Minor impact	High
CRD13	Increase in extreme rainfall events causes a result in loss of instructional time at schools with the consequence that educational development is impeded	Yes	Almost Certain	Minor impact	High
CRD14	Increase in number of extreme 'hot days' and increase in mean annual temperature causes heat stress amongst school pupils with the consequence that the learning process is affected	Yes	Likely	Slight impact	Medium

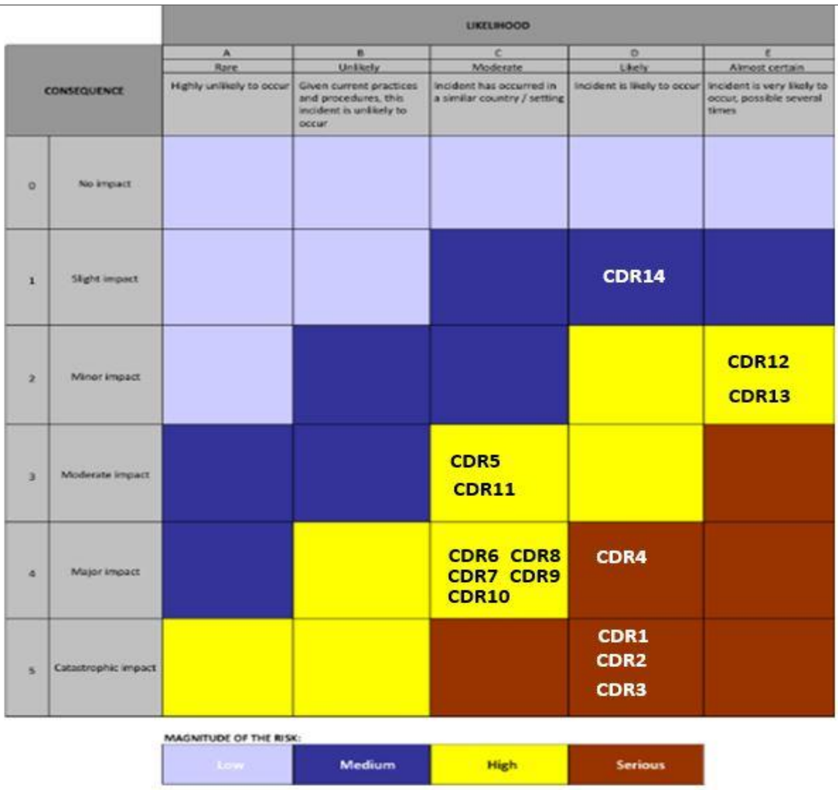

Figure 3.3: Risk matrix for community and regional development.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for Community and Regional Development have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Easily reversed Few households /people affected	Can be fixed, reversible Several households affected	Can be fixed, reversible with effort/input Many households affected	Impacts are hard to reverse Livelihoods directly affected Human lives and biodiversity (flora & fauna) are threatened	Irreversible Human lives and biodiversity (flora & fauna) are lost Whole community is affected

B: Future vision
Recommended Sectoral Objectives
• **Tailor and generate climate change knowledge products to meet the educational needs of targeted communities** • **Promote coordination and networking among the councils and all relevant agencies and stakeholders** • **Engage Hinterland locations and promote synergies between outreach programmes (DECC, REDD+ Secretariat, MSSC)** • **Help local government agencies access skills, training, knowledge and tools to understand and manage climate change risks** • **Build climate resilience of communities through effective and climate resilient water, waste management, health care, education, energy, transport and ICT programmes** • **Restore and develop mangrove forests to increase the resilience of coastal protection systems** • **Strengthen disaster risk management and response efforts at community, regional and national levels**

Climate resilience actions proposed in Guyana

Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-C	Conduct research and studies on climate change in regions not targeted to date, e.g. Region 7. For example, CDC has generated hazard, vulnerability and risk maps for Regions 5 and 6, and they intend to scale this up to other regions.	**CRD1**	… ▽	S	WWF, CI, UG, CDC, MoA, RDCs, MOAA, NTC, NRDDB
2-C	Review and replicate the risk reduction management centre in Region 9 (which is modelled on the Cuban system) to cover other regions	**CRD1-11**	…	S	CDC, MOAA, MOLG, NRDDB, RDC, VC, CBOs
3-C	Conduct situational analysis, identify needs and justify expansion of outreach activities and climate change capacity building	**CRD4**	…	N	CI, DECC, GFC, EPA, Ministry of Human Services

4-C	Conduct feasibility studies on waste management options from a regional perspective	**CRD7**	*	N, S	MoLG, RD, NDCs, MNR, EPA, RDCs
5-C	Undertake reconnaissance surveys of mangrove degradation and vulnerability and identify needs for restoration	**CRD2**	…	N	GFC, EPA, MoA, MOPW
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
6-C	Tailor climate change educational material/product to suit target audiences	**CRD3**	∇	N, S, L	DECC, MNR, MoE, WWF, CI, EPA
7-C	Include climate change on the agenda of indigenous peoples' representative groups, such as the National Toshaos Council, GOIP, APA, TAAMOG, NADF, CBOs	**CRD1**	*	N	MOAA, NTC
8-C	Train and strengthen climate change technical capacity at regional level, including Amerindian villages	**CRD2**	*	N, S	MoLG, RD, MoA, MOAA, RDC, MoE, NTC, CBOs, NDC
9-C	Support the Civil Defence Commission (CDC) with early warning/ disaster response systems for communities, using the approach developed in Region 9 as a model and to assess lessons learned	**CRD2**	…	N, S	MoLG, CDC
10-C	Provide training on technical expertise required to develop an early warning system and maintain it	**CRD1**	∇	N, L	CDC, EPA, UG
11-C	Extend the volunteer corps[13] used by the CDC in Regions 4, 6 and 9 to cover all regions	**CRD3**	∇	S	CDC, MOAA, CBOs, NTC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
12-C	Review and enforce laws and policies in relation to the environment, to include climate change, inclusive of mining and forestry.	**CRD4**	*	N, S, L	MoLG, Guyana Police Force, EPA, MoLA, National Task Force, DNRTE
13-C	Update the draft Disaster Management Policy to integrate climate change	**CRD1, CRD8, CRD12**	*	N	CDC, MoLG, MoH, GWI, MOAA, NTC, DECC

[13] The volunteer corps is split into (1) members with specialized skills, e.g. medical, engineering, GIS, and (2) general members. The skilled volunteer's role is to deliver community-based DRM – lead the process of identifying hazards, risks, actions and delivering actions at the community level. The general volunteers are involved in emergency response.

14-C	Enact & implement national disaster management legislation	**CRD2**	*	N	CDC, National Platform for Disaster Risk Management
15-C	Finalise and implement the Integrated Disaster Risk Management Plan, which is being developed with the Inter-American Development Bank and integrates climate risk	**CRD2**	…	S, L	CDC, MoLG
16-C	Provide institutional strengthening support to local democratic organisations, including assessment and recommendations on how to improve their financial sustainability. The current shift towards decentralisation and devolution, and the development of regional development action plans (Region 10 is the pilot) provides a window of opportunity for the integration of climate resilience.	**CRD5, CRD6**	*	N, S	MoLG
17-C	Explore the option of resettlement of exposed communities, as demonstrated in October 2015 when several farmers in the Mahaica Creek area were relocated to the Hope Estate on the east coast of Demerara, due to persistent flooding following unseasonal heavy rainfall and outflow from the conservancy.	**CRD3**	*	N, S	MOLG
Pillar 4 Actions: Generation and application of technologies					
18-C	Replant mangroves in critical areas	**CRD2**	▽	N, S	GFC, EPA, NDIA, MOPW,MoA
19-C	Develop and upgrade warning systems and evacuation procedures	**CRD1, CRD6**	▽	N	CDC, National Platform for Disaster Risk Management
20-C	To advance an Integrated Waste Management Strategy, including exploration of waste to revenue	**CRD7**	*	N	MoLG, National Task Force
Pillar 5 Actions: Financing instruments					
21-C	Identify and access funding for development and upgrade of early warning systems	**CRD3, CRD8**	▽	N	MoF, CDC

22-C	Conduct feasibility study on contingent capital and cash reserves to provide immediate liquidity in case of a disaster and to create awareness of risk	**CRD7**	*	N	MoF, CDC, MoLG
23-C	Identify and access funding for the implementation of the Integrated Disaster Risk Management Plan	**CRD 1, CRD8**	*	N	CDC (Ministry of the Presidency)
24-C	Allocate budget to Ministry of Communities to design and implement projects and initiatives to support building climate resilience	**CRD10**	∇ *	N, S, L	MoLG
25-C	Improve access to grants and loans to assist businesses (including but not restricted to small scale farmers and fisher folk) in times of disasters and extreme weather	**CRD9**	...	S	MoLG, RDC, MOAA

Ecosystems and Biodiversity

A: Current situation
Socio-economic importance
• **Biodiversity refers to the degree of variation of life on Earth and includes all animals, plants, fungi, micro-organisms and the genetic variation among these. Biodiversity varies from location to location, with the greatest biodiversity in the tropics.** • **Guyana's location contributes to its high levels of biodiversity; it is situated in the neo-tropical bio-geographical territory of north-eastern South America and within the Guiana Shield region which forms part of the Amazon Biome. The Amazon Biome, spanning 6.7 million km2, is the largest remaining tropical rainforest in the world, home to at least 10% of the world's known biodiversity. From coastal mangroves to old growth rainforests, wetlands and savannahs, Guyana's ecosystems support a diverse range of species. Inclusive of other groups such as Arthropods, Fungi, Nematodes and Algae. The total estimated numbers of species found in Guyana is 13,229 species. Despite its modest size, Guyana boasts globally extraordinary levels of biodiversity. The country is home to more than 900 species of birds, 625 strictly freshwater fishes, 250 mammals, 250 amphibians, and 210 reptiles, for a grand total of at least 2,285 vertebrates. In maps of global species diversity, Guyana occupies global hotspots for birds, mammals, and amphibians, as well as for freshwater organisms (mammals, amphibians, reptiles, fishes, crabs, and crayfish. Marine vertebrate diversity is typical of the Caribbean region, and scores modestly at the global scale. Guyana is home to more than 7,000 vascular plant species, the great majority of them native to the country. The Guyanese flora accounts for more than 85% of all vascular plant species known from the three countries of the Guiana Shield. More than 100,000 invertebrate species are expected to occur in Guyana (insects, arachnids, crustaceans, myriapods, mollusks, annelids, sponges, cnidarians, and others). A more precise accounting of these groups, and of Guyana's significant fungal and non-vascular plant diversity (lichens, liverworts, algae, etc.), is not possible at present due to incomplete**

sampling and incomplete species description. All of the numbers in this section are fluid since exploration of Guyana's rich biodiversity is ongoing and new species of plants and animals are described from Guyana every year. In 2021 alone, newly described species for Guyana include multiple fishes, plants, beetles, butterflies, and a bat. Nearly 100 of the vertebrate species known from Guyana occur nowhere else on Earth.
These include:

- **75 endemic fish species, such as the armored catfish - Ancistrus Kellerae – known only from the Kuribrong River below Kaieteur Falls;**
- **19 endemic amphibian species, such as the globally-endangered Kaei Rock Frog, known only from the Maringma Tepui; and**
- **Four endemic reptile species, such as the lizard Pantepuisaurus Rodriguesi, likewise known only from the Maringma Tepui.**

- **Guyana's biodiversity provides a basis for climate regulation, poverty reduction, provisioning of freshwater, economic growth and development in areas such as agriculture, forestry and fisheries, payment for forest climate services, and community-based economies. Loss of biodiversity, habitats and ecosystems and any disruption in the provision of ecosystem services would have a negative impact on the economy and the quality of life of all communities.**
- **Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognized. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities.**

Climate vulnerability profile

- **From a global perspective, the Millennium Ecosystem Assessment estimated that approximately 60% of the ecosystem services are already being degraded or used unsustainably (including freshwater, fisheries, air and water purification). Climate change is expected to be the dominant direct driver of biodiversity loss by the end of the century. Ecosystems and biodiversity are vulnerable to a range of climate parameters and hazards, including incremental changes in temperature and rainfall, sea level rise, increases in ocean temperature and pH, water availability, flooding, soil erosion and ground instability, wildfire and pests and diseases. Anticipated impacts of climate change on biodiversity include shifting of ecosystem boundaries, change in natural habitats and sharp increases in extinction rates for some species. For example, warmer springs have led to earlier nesting for 28 migratory bird species on the East Coast of the United States. Furthermore, impacts on one particular species can have a ripple effect on others, for example disrupting food production.**
- **Terrestrial ecosystems and biodiversity, including vegetation, wetlands, forests, insects, birds and animals, are sensitive to the slow creeping change in temperature and precipitation patterns over the longer-term. In Guyana, mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s. The largest increases in temperature are projected for the southern portion of the country. Trends in annual rainfall are more uncertain, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, ensemble median values of change by the 2060s are consistently negative for all seasons and emissions scenarios. Projections vary between -34% to +20% by the 2090s, with ensemble median values of -18% to -4%. Changes in temperature and water resources, through shifting rainfall amounts and timing, are likely to impact the tolerance thresholds of many species and ecosystems.**

- **Terrestrial systems are also vulnerable to extreme events. Droughts in particular cause poorer habitat suitability in terms of food, water, cover and useable space, leading to wildlife migration, mortality through starvation, predation, reduced production and recruitment (survival of young ones) and broader environmental degradation. In Guyana, stakeholders commented that El Niño results in conditions similar to heatwaves and prolonged El Niño events may mimic desertification conditions. This puts biodiversity under pressure, with animals experiencing heat stress, for example.**
- **Forests are also vulnerable to wildfires, which may increase in frequency and intensity in a warmer and potentially drier climate. The projected rise in temperatures and long periods of drought are predicted to lead to more frequent and more intense fires. Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes. Fire damaged areas are subsequently vulnerable to erosion from wind and water, leading to sedimentation of waterways.**
- **Terrestrial ecosystems and biodiversity is also vulnerable to pests and diseases. Many important pest (e.g. mosquitoes, rodents) and diseases (e.g. malaria and leptospirosis) are affected directly or indirectly by weather and climate. Future climate change has the potential to affect the distribution, timing and intensity of pest and disease outbreaks.**
- **Guyana's freshwater and groundwater resources are vulnerable to saline intrusion from storm surge and sea level rise and contamination from flood events, leading to reduced water quality for species living in or close these environments. In the interior regions where indiscriminate mining practices have changed and/or inhibited water flows, surface water pollution and salinization is currently a critical issue, which may be further exacerbated in a changing climate.**
- **Guyana's coastline is home to a diverse and important range of ecosystems, including mangrove forests, which offer important natural coastal protection benefits. Coastal ecosystems and biodiversity are vulnerable to sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. Coastal flooding and erosion has the potential to damage and destroy coastal ecosystems, including beaches, estuaries and biodiversity. This may in turn lead to problems with water systems, agriculture, infrastructure, fisheries, tourism and other related sectors dependent on the coast. The vulnerability of mangroves to coastal erosion and flooding is a particular concern, given their importance providing land stability in the coastal zone. Stakeholders commenting that young mangroves are susceptible to being uprooted or damaged, which hinders their growth, and man-made infrastructure (such as seawalls) hinders the ability of mangroves to naturally adapt to sea level rise by moving inland.**
- **Marine ecosystems and biodiversity are sensitive to ocean temperature and pH. Climate change-induced changes in water temperature, ocean currents and coastal upwelling may cause changes in the distribution of marine species, which are already experiencing pressures from other non-climate drivers, including over-fishing, pollution, human settlement and development, mining and shipping industry. As such, the impact of climate change on marine ecosystems is incredibly complex, with both positive and negative changes likely. The importance of the fisheries industry in Guyana means that impacts on marine ecosystems and biodiversity will have a significant effect on the productivity and profitability of the industry. The capacity of key actors in the sector to deal with climate impacts is affected by several key challenges including a number of informational, institutional, financial and regulatory barriers and issues. In terms of information, stakeholders noted that resources exist but they are frequently not coordinated or integrated into decision-making. Specifically, there is a lack of information on the**

economic value of ecosystems and biodiversity (though it should be noted that the 2013 LCDS Update details the economic value of ecosystem services provided by forests, at around US$5.8 billion).

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for ecosystems and biodiversity.

In this sector, no risks were identified with catastrophic impacts (level 5 consequence); the majority of the risks were clustered around major – moderate impacts (level 4 – 3 consequence). However, the "almost certain" likelihood assigned to several risks creates a number of "serious" risks for the sector. The highest magnitude risks for ecosystems and biodiversity are linked to environmental degradation caused by changes in freshwater and groundwater systems (e.g. flows and salinization) (risk ref E1), flooding, landslides and soil erosion (risk ref E3), sea level rise and increase in storm surges causing coastal erosion or sediment deposition (risk ref E2) and changes in sea surface temperatures impacting ocean ecosystems (risk ref E5). Given the value of ecosystems and biodiversity to a range of interested groups (e.g. indigenous communities, tourism operators, forestry agencies), climate-induced pressure or changes in ecosystems and habitats has the potential create conflicts between different user groups (risk ref E4).

Risk register for ecosystems and biodiversity. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
E1	Incremental climate change and extreme events causes changes in freshwater and groundwater systems (e.g. flows and salinization) with the consequence that environmental degradation occurs and biodiversity is threatened and human health, the economy and livelihoods are compromised	Yes	Almost certain	Major impact	Serious
E2	Sea level rise and increase in storm surge causes coastal flooding and erosion / deposition with the consequence that coastal ecosystems (e.g. mangroves) are damaged or destroyed and environmental degradation occurs	Yes	Almost certain	Major impact	Serious
E3	Extreme events causes flooding, landslide, soil erosion and water contamination with the consequence that environmental degradation occurs with consequences for rural livelihoods	Yes	Almost certain	Major impact	Serious

E4	Increased pressure or changes in ecosystems and habitats may cause increased tension between different interested stakeholder groups	Potentia l risk	Almost certain	Major impact	Serious
E5	Increase in sea surface temperatures causes detrimental impacts on ocean ecosystems and functioning with the consequence that environmental degradation occurs	Potentia l risk	Likely	Major impact	Serious
E6	Incremental climate change and extreme events causes negative impacts on forests and wetlands with the consequence that environmental degradation occurs	Yes	Likely	Moderate impact	High
E7	Incremental climate change causes emergence of pests with the consequence that environmental degradation occurs	No	Moderate	Moderate impact	High
E8	Extreme events cause detrimental consequences for ecosystems and biodiversity with the consequence that the national cultural identity is affected (e.g. land of many waters, coat of arms, animal extinction)	Potentia l risk	Moderate	Moderate impact	High
E9	Incremental climate change and extreme events particularly increased heatwave duration, causes increase in fire frequency and intensity with the consequence that irreversible environmental degradation and change occur including agricultural productivity, livelihoods	Yes	Moderate	Minor impact	Medium

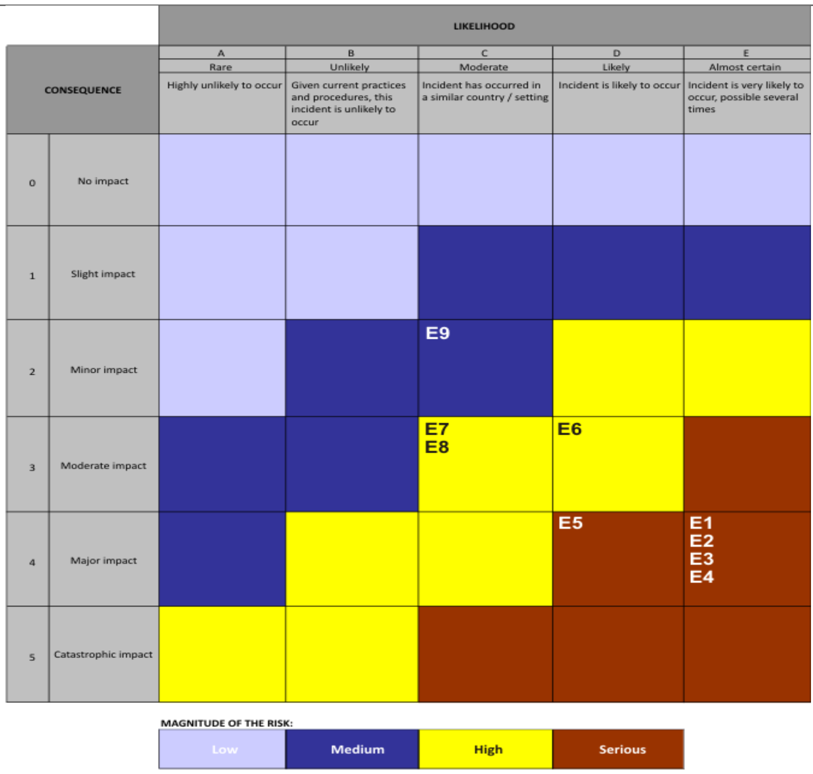

Figure 3.4: Risk matrix for ecosystems and biodiversity.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for ecosystems and biodiversity have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Original biodiversity and ecosystem services interrupted over a short period (0-12 months)	Original biodiversity and ecosystem services negatively impacted and recoverable over a period of 1 to 3 years and impact on productivity negligible (less than 5%)	Original biodiversity and ecosystem services damaged and only recoverable over a period of 3 to 10 years and resulting in a decrease greater than or equal to in 25% in productivity in relevant sectors	Original biodiversity and ecosystem services significantly damaged and only recoverable over a period of 10 to 25 years and resulting in a decrease greater than or equal to 50% in productivity in relevant sectors	Original biodiversity and ecosystem services destroyed beyond and only later replaceable by secondary systems resulting in a decrease greater than or equal 80% in productivity in relevant sectors

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge on climate vulnerability of ecosystems and biodiversity, particularly the associated impacts on livelihood, economy and society** • **Create a central repository of all research on biodiversity and ecosystem services (BES) that is freely accessible** • **Disseminate information through targeted outreach and awareness sessions for various groups of society (e.g. teachers, youth, media, indigenous peoples, farmers, all law enforcement bodies, etc.)** • **Promote conservation good practice to adapt to the impacts of climate change** • **Develop, implement and enforce law, policy and regulation for climate resilient ecosystems and biodiversity and mainstream in current laws, policies and regulations, national development strategies, plans, etc. through an inclusive evidence-based process** • **Enhance and diversify funding for the sector especially in the areas of research and development** • **Restore and develop mangrove forests to increase the resilience of coastal protection systems** • **Restore degraded interior ecosystems caused by mining activities**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (∇), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-Ec	Conduct research and analysis of past and present climate impacts on the natural environment	**E1, E2, E3, E5, E6, E7, E8**	∇	N, S, L	DECC, UG, EPA, Iwokrama, CI-Guyana,

					WWF-Guianas, MoA, MNR, Hydromet, NAREI, GFC, GGMC, MOAA, MoLG, RDCs, NTC, PAC
2-Ec	Research into natural ecosystems and the natural protection they provide from extreme weather events (e.g. watershed management), and how these will be impacted by climate change	**E1, E2, E6, E7, E8**	∇	N, S, L (phased approach, from L to N)	DECC, UG, EPA, Iwokrama, CI-Guyana, WWF-Guianas, MoA, MNR, Hydromet, NAREI, GFC, GGMC
3-Ec	Undertake mapping of key areas (threatened, key stone and hotspot areas and species) using GIS and other available technology	**E1, E2, E3, E5, E6, E7, E8**	*	N	PAC, GFC, UG
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-Ec	Develop a widespread awareness program on the importance of ecosystems and biodiversity and how climate change impacts these systems. Incorporate the importance of evaluating the effectiveness of adaptation action	**E1, E2, E3, E6, E8**	∇	N, S, L	EPA (EIT DEPT.),MoE, MNR, MoA, Media, CI, WWF, Iwokrama, DECC, GFC, PAC, MOAA
5-Ec	Train local community members in skills required for design and implementation of adaptation measures as well as monitoring and evaluation	**E1, E2, E3, E6, E7, E8**	∇	N, S, L	Iwokrama, CI, WWF, RDCs, NTC, EPA, EIT, MoA, MoE, GFC, GGMC, PAC, MOAA
6-Ec	Strategic packaging and dissemination of knowledge and best practices around climate resilience and the natural environment	**E1, E2, E3, E6, E7, E8**	∇	N, S, L	MNR, CI, WWF, MoA, NDC, RDC, NTC, MoE, UG, DECC, GFC, NAREI, Media
7-Ec	Develop and implement a public awareness raising programme about mangrove conservation and restoration	**E2, E5, E7**	∇	N, S, L	MNR, MoA – Mangrove Restoration Secretariat, UG, sector

					agencies, GFC, MOPW
8-Ec	Create a central repository for research. The location should consider the results of a feasibility study that was recently completed to establish a Centre for Biodiversity Studies at UG	**E2, E3, E5, E6, E7, E8**	*	N, S, L	UG, , EPA, MNR, MoA, CI, WWF, DECC, Iwokrama, Biodiversity Centre proposed under LCDS
9-Ec	Institutional strengthening of relevant agencies to enforce laws, policies and regulations	**E1, E2, E3, E5, E6, E7, E8**	*	N, S, L	MoLG, MNR, EPA
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
10-Ec	Ensure gender issues are integrated into sectoral projects/ programmes relevant to climate resilience	**E1, E2, E3, E4, E5, E6, E7, E8**	∇	N, S, L	Human Rights Association, MOAA, Women's Associations, CI, WWF-Guianas, EPA, Ministry of Human Services
11-Ec	Develop a more robust framework for monitoring and evaluation	**E1, E2, E3, E5, E6, E7, E8**	∇	N, S, L	MNR, MoLG, Sector agencies
12-Ec	Adopt an Ecosystem-based Adaptation (EbA) approach to environmental management policies and strategies, to build resilience and reduce the vulnerability of ecosystems and people in the face climate change impacts, especially given Guyana's abundance of natural capital	**E1, E3, E5, E6, E7, E8**	∇	N, S, L	MNR, CI, MOAA, WWF, MoA, UG, Iwokrama, Sectors agencies
13-Ec	Development and implementation of policies and legislation to conserve mangroves, building on National Mangrove Management Action Plan 2010-2012.	**E2, E5**	∇	N, S, L	MNR, MoA, Mangrove Restoration Project, UG, Legal Affairs, GFC
14-Ec	Monitor compliance with environmental impact assessment requirements for coastal mangrove alterations	**E2, E5**	*	N, S, L	MNR, MoA, EPA, GFC
Pillar 4 Actions: Generation and application of technologies					

15-Ec	Implement climate resilient conservation programmes to protect key ecosystems and biodiversity	**E1, E2, E3, E5, E6**	∇	N, S, L	MNR, UG, CI, Iwokrama, sector agencies, DECC, WWF, MoA, NTC
16-Ec	Develop mangrove monitoring system	**E2, E5**	∇	N, S, L	MoA-NAREI, Mangrove Restoration Project, UG, MNR, EPA, GFC
17-Ec	Implement mangrove development and restoration programmes, including ecological mangrove restoration methods	**E2, E5**	∇	N, S, L	MoA-NAREI, Mangrove Restoration Project, UG, MNR, EPA, GFC
Pillar 5 Actions: Financing instruments					
18-Ec	Source financing for research and development, monitoring and conservation/replanting programmes		∇	N, S, L	MoF, Parliament, CI, WWF, MNR, UG, MoA-NAREI, DECC, PMO, EPA, Iwokrama sector agencies
19-Ec	Conduct gap analysis to compare required finance with finance accessed/available	**E1, E2, E3, E4, E5, E6, E7, E8, E9**	∇	N, S, L	All relevant agencies

Fisheries

A: Current situation
Socio-economic importance
• **Agriculture is essential to Guyana due to its contribution to food security, poverty reduction, employment generation and foreign exchange earnings.** • **It is Guyana's largest economic sector. Between 2009 and 2020, the agriculture sector contributed on average approximately 20% to GDP and accounted for on average 40% of the county's total export earnings per annum. The agricultural sector is the largest employer, providing direct employment of over 33%. The fisheries sector is one of the five principal sub-sectors of agriculture.** • **Between 2009 and 2020, the fisheries sub-sector contributed an average 2.1% to total GDP.**

- Approximately 6,500 people are employed in fisheries harvesting and an additional 6,000 persons in processing. In addition, there are indirect livelihood opportunities from fishing related industries, such as boat building.
- The fisheries industry consists of three types of activities: (i) marine fisheries, which includes industrial trawler fishery, deep-slope fishery and small-scale artisanal fishery; (ii) inland fisheries, which consists of subsistence activities and an ornamental fish industry and are conducted in rivers, lakes, swamps and flooded plains; and (iii) capture fishery, including aquaculture, which is practiced on the small-scale on the coast in polder areas and in ponds.
- While the production and employment in inland fisheries and aquaculture are small compared to those in marine fisheries, there is the potential for significant development. Commercial aquaculture is identified as one of the most promising economic activities with high potential for rapid export and job creation growth. The industry has been experiencing average annual growth of 14% since 1995.
- The main exports from the marine fisheries are Shrimp (Penaeus spp), Seabob (Xiphopenaeus kroyeri) and Whitebelly (Nematopalaemon schmitti).
- In Guyana, fish is a major source of animal protein (estimated at 35.6 kg per capita), which is more than twice the world average of 14 kg per capita, and thus points to the importance of fish to the Guyanese diet.

Climate vulnerability profile

- The fisheries sector is vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions and the aquatic environment. The artisanal subsector, the inland fisheries and aquaculture are likely to be particularly vulnerable due to the sensitivity of these environments and livelihoods to even minor environmental changes.
- With the projected increase of temperature and change of rainfall, the main threats to the fisheries sector are the decrease in water quality and disruption of ecosystem dynamics, which cause changes in species distribution, species abundances and the productivity of the marine ecosystems.
- Furthermore, while the increased intensity of rainfall could probably lead to an increased rate of spawning, it would also cause recurrent flooding that could adversely affect aquaculture activities.
- Saltwater intrusion can also adversity affect aquaculture production, since certain species would not be able to tolerate saline conditions.
- The resultant economic impacts on the fisheries subsector will be a cause of concern given the high level of dependence on the resource (particularly at the subsistence level) and the contribution of the industry to the national GDP and employment.
- Stakeholder consultations examined the informational, technological, institutional and regulatory barriers that would affect the capacity of the sector to deal with climate impacts.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the fisheries sector.
Only one risks was identified as serious magnitude; the disruption of critical fisheries habitats due to sea level rise (risk ref Fi1). Most of the risks (7) were assigned high magnitude. These risks are associated with changing marine species distribution and abundance (risk ref Fi4), disruption to critical fisheries habitats due to extreme events (risk ref Fi5), and flooding causing destruction of ponds and other fishing infrastructure and pathogen transmission (risk ref Fi2, Fi3 and Fi7). The reduction in fisheries production due to outbreaks of aquatic pests and diseases was rated as low risk, as stakeholders viewed this as an issue that would primarily affect the aquaculture subsector (risk ref Fi12). The potential for inland flooding to produce

higher productivity in newly flooded area was identified as an opportunity (risk ref Fi13). In light of the fact that fish is a major protein source for Guyanese, any change in production will have adverse consequences for the livelihoods of those working in the sector (risk ref Fi4), and further, have detrimental impacts for food security (risk ref Fi6).

Risk register for the fisheries sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref:	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of Risk
Fi1	Sea level rise causes changes in the nature and distribution of nursery habitats, with the consequence that fisheries production decreases and revenue is lost	Yes	Likely	Major impact	Serious
Fi2	Increase in extreme rainfall events causes flooding and the transportation of pathogens, with the consequence that fish are killed in the aquaculture subsector and revenue is lost	Yes	Moderate	Major impact	High
Fi3	Increase in storm surge height causes coastal flooding with the consequence that lives, households and assets, such as ponds and other fishing infrastructure (e.g. landing sites and cooperative buildings) are threatened	Yes	Likely	Moderate impact	High
Fi4	Incremental climate change and extreme events cause decreased water quality and disruption of ecosystem dynamics, changing marine species distribution and abundance with the consequence that revenue is lost at the enterprise, community and individual level and coastal livelihoods and commercial enterprises are threatened	No	Moderate	Moderate impact	High
Fi5	Incremental climate change and extreme events cause disruption to critical fisheries habitats, such as seagrass and mangroves, with the consequence that fisheries production decreases and revenue is lost	Yes	Moderate	Moderate impact	High
Fi6	Incremental climate change and extreme events cause a decrease in fish production with the consequence that food supplies decrease and food security is threatened	Yes	Moderate	Moderate impact	High
Fi7	Increase in extreme rainfall events causes flooding with the consequence such that lives, households and assets, such as ponds and other fishing facilities (e.g. feed storage rooms) are threatened	Yes	Moderate	Moderate impact	High

Fi8	High temperatures and drought causes exceedance of species tolerances, with the consequence that marine fisheries production decreases and revenue is lost	Yes	Moderate	Moderate impact	High
Fi9	Sea level rise causes saline intrusion into freshwater bodies, with the consequence that freshwater aquaculture is negatively impacted and livelihoods and commercial enterprises are threatened	No	Moderate	Minor impact	Medium
Fi10	High temperatures and drought causes exceedance of species tolerances, with the consequence that inland fisheries production decreases and revenue is lost	Yes	Moderate	Minor impact	Medium
Fi11	High temperatures and drought cause a reduction in the size and distribution of inland areas that are fishable, with the consequence that conflicts arise between fisher folk	Yes	Moderate	Minor impact	Medium
Fi12	Incremental climate change causes outbreaks of aquatic pests and diseases with the consequence that fisheries production decreases and revenue is lost	Yes	Unlikely	Slight impact	Low
Fi13	Increase in extreme rainfall events causes flooding with the consequence that some spawning areas increase in size, with the consequence that productivity is higher in the newly flooded areas	Yes			Opportunity

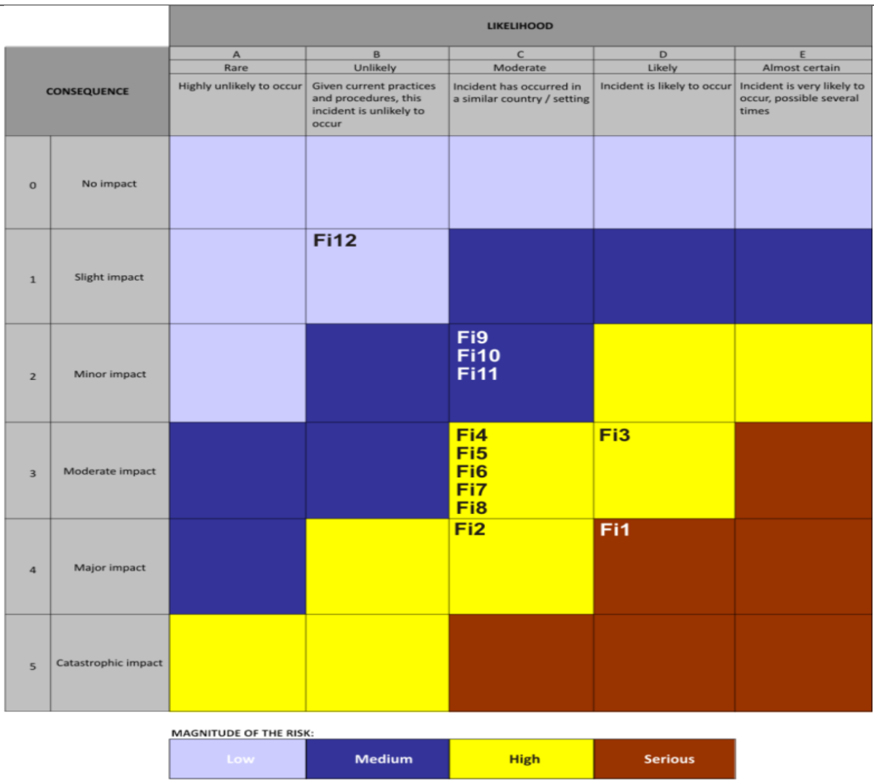

Figure 3.6: Risk matrix for the fisheries sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the fisheries sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Slight losses of less than 2% of annual production and covered by normal contingency allocations	Minor losses of between 2% and 10% of annual production	Moderate losses of between 10% and 25% of annual production	Major losses of between 25% and 50% of annual production	Catastrophic losses of more than 50% of annual production

NB: The Fisheries Department does not monitor production in the inland fisheries sector

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge on climate vulnerability of the sector** • **Promote adaptation good practice and develop innovative solutions** • **Provide coastal communities with skills, training, knowledge and tools to understand and manage climate change risks** • **Adopt an integrated financial risk transfer package that fosters efficient restoration of livelihoods of fisher-folk**

Climate resilience actions proposed for Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-Fi	Conduct detailed assessment and model the impacts of climate change on fisheries	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, DECC, CRFM
2-Fi	Conduct hazard and vulnerability mapping nationally to identify and prioritise regions/areas that are most vulnerable to the impacts of climate change.	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, DECC, CRFM
3-Fi	Promote research and development capacity in Guyana with respect to sustainable fisheries management, taking into account the impacts of climate change	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	UG, FD, CRFM, FD, GATOSP
4-Fi	Develop and pilot fisheries techniques that build resilience to a variable and changing climate	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi8**	*	L	FD
5-Fi	Monitor fish catch and effort data	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	…	N	FD
6-Fi	Monitor socio-economic status of fishers in coastal communities	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, UG

7-Fi	In coordination with vulnerability assessments, conduct capacity assessment to determine the suitability of current fisheries institutions to adapt to climate change	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, DECC, CRFM
8-Fi	Map and evaluate coastal ecosystems and habitats, including sea-grass beds, mangrove systems, to document location, state of health and contribution to economic development	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, DECC, CRFM
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
9-Fi	Enhance public awareness of climate change impacts on fisheries and facilitate greater fisher safety at sea	**Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, MARAD, DECC
10-Fi	Develop and implement a sustainable public information & dissemination programme on the impacts of climate change on fishing communities and alternative livelihood programmes (linked to 9-Fi)	**Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, DECC, EPA
11-Fi	Promote livelihoods in non-fisheries (i.e. tourism)	**Fi2, Fi3, Fi4, Fi5, Fi6**	…	N, S, L	FD, MOA
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
12-Fi	Develop and implement policies to increase fisheries sustainability, focusing on efforts to reduce fishing effort and fleet capacity	**Fi1, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	∇ …	All levels	FD, GATOSP, CRFM
13-Fi	Develop Fisheries Management Plan on the basis of the best available information, including climate change, to achieve optimum sustainable use and long-term conservation of fisheries resources	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	∇ …	National	FD, DECC
14-Fi	Establish Fisheries Reserve	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6**	…	Sub national	FD, MNR, PAC, EPA
15-Fi	Implement an ecosystem approach to fisheries	**Fi1, Fi2, Fi4, Fi5, Fi6, Fi7, Fi8**	*	National	FD, FAO
16-Fi	Encourage diversification in targeted fish species	**Fi1, Fi2, Fi4, Fi5, Fi6, Fi7, Fi8**	∇ …	National	FD

17-Fi	Revise and upgrade national fisheries and marine resource management policies, legislation and regulations to incorporate and address ecosystem approach to fisheries, climate change and DRM considerations	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	∇ …	National	AG, FD, Cabinet
Pillar 4 Actions: Generation and application of technologies					
18-Fi	Identify and implement technological innovations, such as increased capture efficiency, storage, transportation and handling	**Fi1, Fi3, Fi4, Fi5, Fi6**	∇ …	N, S	FD
19-Fi	Construct climate-resilient fishing infrastructure	**Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N	FD, CRFM
Pillar 5 Actions: Financing instruments					
20-Fi	Identify and access sources of financing for research and development programmes, including through use of financial incentives for private sector companies	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N	MOA, MOF
21-Fi	Identify and access sources of financing for the development and trial of climate resilient fisheries techniques	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N	MOA, FD, MOF
22-Fi	Identify and access sources of financing for awareness raising programmes	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6**	*	N	MOA, FD, MOF
23-Fi	Identify and access sources of funding for updated, climate-resilient infrastructure and equipment	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6**	*	N	MOA, FD, MOF
24-Fi	Identify and access sources of financing for research and development; monitoring and information programmes	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N	MOA, FD, MOF
25-Fi	Partner with financial institutions to provide competitive loans for the fishing communities to promote risk reduction practices	**Fi1, Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, MOF, International donor agencies
26-Fi	Set up contingency/DRM funds to be owned and managed by fisher-folk groups and cooperatives	**Fi2, Fi3, Fi4, Fi5, Fi6, Fi7, Fi8**	*	N, S, L	FD, MOF, International donor agencies

Forestry

A: Current situation
Socio-economic importance
• Forests occupy approximately 85% of the land mass of Guyana. Forests provide a habitat for a large range of animal and plant species, and a number of important ecosystem services, such as soil erosion protection, purification of water supplies and maintenance of environmental stability. Mangrove forest ecosystems are also important, providing a variety of similar functions. • Forest resources are used for agriculture, harvesting of forest produce, ecotourism, research, conservation and Amerindian reservations. • The forestry sector's contribution to GDP was 3% in 2022. • The sector also provides a significant source of employment for Guyanese people. In 2020, 20,000 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. • Guyana is implementing a Reduced Emissions from Deforestation and Degradation (REDD+) mechanism through which results based payments are earned for reducing deforestation and forest degradation, sustainable forest management and enhancement of carbon stocks. • Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognised. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities. Similarly, there is a desire that the negotiations regarding logging concessions should place equal, if not greater emphasis on environmental impact rather than economic gain.
Climate vulnerability profile
• Forest ecosystems are vulnerable to a range of climate parameters and hazards, including incremental changes in temperature and rainfall, sea level rise, flooding, soil erosion and ground instability, wildfire and pests and diseases. Anticipated impacts of climate change on biodiversity include shifting of ecosystem boundaries, change in natural habitats and sharp increases in extinction rates for some species. • Forests, and the insects, birds and animals they support, are sensitive to the slow creeping change in temperature and precipitation patterns over the longer-term. In Guyana, mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s. The largest increases in temperature are projected for the southern portion of the country. Trends in annual rainfall are more uncertain, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, ensemble median values of change by the 2060s are consistently negative for all seasons and emissions scenarios. Projections vary between -34% to +20% by the 2090s, with ensemble median values of -18% to -4%. Changes in temperature and water resources, through shifting rainfall amounts and timing, are likely to impact the tolerance thresholds of many tree species and associated ecosystems. This may result in some species thriving in a changing climate, whereas others will be unable to cope and may decline in number. • Forests are vulnerable to wildfires, which may increase in frequency and intensity in a warmer and potentially drier climate. The projected rise in temperatures and long periods of drought are predicted to lead to more frequent and more intense fires. In 1997/1998, El

Niño events produced widespread drought with accompanying forest fires. Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes. Fire damaged areas are subsequently vulnerable to erosion from wind and water, leading to sedimentation of waterways.

- **Forest ecosystems are also vulnerable to pests and diseases. Warmer temperatures may result in changes in the geographical range of pests, alterations in population growth rates, extension of the development season, and increased risk of invasion by migrant pests.**
- **Guyana's mangrove forests along the coast and river estuaries offer important natural coastal protection benefits. However, there are extremely vulnerable to sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. The vulnerability of mangroves to coastal erosion and flooding is a particular concern, given their importance providing land stability in the coastal zone. Stakeholders commenting that young mangroves are susceptible to being uprooted or damaged, which hinders their growth, and man-made infrastructure (such as seawalls) hinders the ability of mangroves to naturally adapt to sea level rise by moving inland.**
- **The forestry sector's dependence on transport systems to deliver forest-related products (including furniture, crafts, utensils, charcoal and firewood) to market makes it vulnerable to weather-related disruption. Transport systems are susceptible to a number of climate parameters, including extreme precipitation change, flooding and landslides. Road connections to the hinterland are poor and there are insufficient all weather access roads connecting forestry areas, in the hinterland, to Georgetown. These roads are vulnerable to flooding and land instability associated with heavy rainfall events. Climate projections suggest that the proportion of rainfall occurring in heavy events may increase (although the trend is weak), particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. Stakeholders commented that although the majority of transport of forest products utilises road infrastructure, one large concessioner and a few small operators use the Corentyne River for transport and are currently affected by seasonal flow.**
- **The capacity of key actors in the sector to deal with the impacts of climate change was assessed as being moderately high by stakeholders. There is strong institutional capacity, particularly within MNR, NGOs, and inter-agency committees/projects, for example Land Reclamation, National Toshaos Council, the Multistakeholder Steering Committee (MSSC) under the DECC and the GFC. In terms of information, climate change projections are available regionally and locally, and selected types of information exist, including vulnerability studies for mangroves, adaptation option appraisals for forest communities and monitoring and evaluation systems through GFC's routine monitoring and MRVS. Stakeholders noted that forestry issues are integrated into the education system, stakeholder consultation, and the Forestry Training Centre Incorporated (FTCI) conducts training and awareness raising activities. The policy and regulatory environment was assessed by stakeholders as strong, with many relevant policies and acts, including the National Forest Plan (2018), National Forest Policy Statement (2018), Revised Forest Act (2009), Environmental Protection Act (1996), Code of Practice for Timber Harvesting, Non-Timber Forest Products (NTFP), Iwokrama Act (1996), Protected Areas Act (2011) and Wildlife Management Authority. Finally, the availability of finance is assessed as moderately high, with stakeholders noting that a variety of sources of funding exist and are used, including government funds and those available through bilateral/multilateral environmental agreements and international donors, such as WWF and CI.**

Climate risks and opportunities
The vulnerability profile described above creates a number of climate change risks for the forestry sector. **The forestry sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix. Five high risks were identified, with the highest magnitude risks related to the climate-driven loss of critical ecosystem services provided by the forest, such as soil erosion protection and water catchment management, which will result in broad-scale environmental degradation (risk ref FO1), and forest degradation, which will negatively impact forest resources, resulting in a decrease in related earnings (risk ref FO2).**

Risk register for the forestry sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
FO 1	Incremental climate change and extreme events cause a loss of critical ecosystem services provided by the forest, such as soil erosion protection and water purification with the consequence that environmental degradation	No	Moderate	Catastrophic impact	High
FO 2	Incremental climate change and extreme events cause forest degradation, negatively impacting forest resources (e.g. wood and minerals) with the consequence that export earnings from forest resources decrease	No	Moderate	Major impact	High
FO 3	Sea level rise causes coastal flooding with the consequence that mangrove vegetation is destroyed	Yes	Likely	Moderate impact	High
FO 4	Incremental climate change and extreme events can cause changes in the understory species composition of forests	No	Moderate	Moderate impact	High
FO 5	Incremental climate change and extreme events, particularly increased frequency of droughts, causes rivers to dry up with the consequence that rivers are no longer navigable (for transport of forest products and equipment) and forestry production decreases and livelihoods(forest concessionaires) are threatened	Yes	Likely	Major impact	High

FO 6	Incremental climate change and extreme events will affect accessibility, livelihood options and non-traditional forest products (NTFP) extraction of forest dependent communities/entities	Yes	Moderate	Minor impact	Medium
FO 7	Incremental climate change and extreme events, such as drought cause forest fires in dry areas, predominantly where land has been cleared for other land use purposes with the consequence that forests and agricultural land are destroyed	Yes	Likely	Slight impact	Low

Figure 3.7: Risk matrix for the forestry sector.

Likelihood scoring criteria. Based on feedback from the DECC, qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for forestry have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Slight losses which are temporary in nature	Short term with recovery in less than five (5) years	Medium term with recovery between 5 to 10 years	Long term with recovery in more than 10 years	Irreversible, permanent loss

B: Future vision

Recommended Sectoral Objectives

- **Improve knowledge on climate vulnerability of the sector**
- **Enhance monitoring and evaluation of climate impacts on forestry and integrate findings into action plans**
- **Develop, strengthen, implement and enforce laws, policies and regulations for climate resilient forestry**
- **Strengthen and retain human and institutional capacity within the forestry sector**
- **Restore degraded forest ecosystems**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-For	Continue research and data collection of vegetation cover and other resources, using remote sensing among other technologies and methodologies, to build up an evidence base of changing trends over time. This could involve, for example, accessing US satellite data for vegetation cover (free of charge).	**FO1, FO3, DO4, FO5**	…	N	GFC, REDD Secretariat
2-For	Undertake research and monitoring of the impacts of climate change on forests to inform decision-making. This includes promoting research to develop technologies and improve data collection.	**FO1, FO2, FO3, FO4, FO5**	▽	N, S, L	UG, GFC, Iwokrama, DECC, CI-Guyana, WWF, NRDDB, FAO
3-For	Conduct economic valuation of forest resources (timber and non-timber products and services)	**FO1, FO2, FO3, FO4**	▽ …	N	GFC, FPDMC, DECC, FTCI, Iwokrama

Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-For	Develop and implement capacity building programmes to promote education and awareness, both at local levels (e.g. with indigenous and other communities that depend on the forests, people that live near mangroves, people related to logging industries, conservationists, park rangers, local authorities, etc.) and national levels (policy-makers, industries, decision-makers, etc.)	**FO1, FO2, FO3, FO4, FO5**	∇ …	N, S, L	GFC, DECC, CI-Guyana, Iwokrama, WWF, NAREI, PAC, NRDDB, KMCRG, FPA
5-For	Integrate climate resilient practices into REDD+ training and extension services provided to forest communities, especially Amerindian communities	**FO1, FO2, FO3, FO4, FO5**	∇ …	L	GFC, REDD Secretariat, DECC, Iwokrama, EPA, MOAA
6-For	Conduct capacity building programmes for communities to develop and maintain alternative income-generating activities, to incentivise conserving forests	**FO1, FO2, FO3, FO4, FO5**	∇ …	S, L	NAREI, DECC, GFC, CI-Guyana, Iwokrama, FAO, PAC, MOAA
7-For	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation	**FO1, FO2, FO3, FO4**	∇ …	N, S, L	DECC, GFC, MNR, MoE, conservation NGOs, CI
8-For	Train local community members in skills required for monitoring and evaluation	**FO1, FO2, FO3, FO4, FO5**	∇ …	S, L	GFC, MRNE, Iwokrama, CI-Guyana, WWF, FTCI, NTC, MNR
9-For	Strengthen coordination among forestry stakeholders, natural resource agencies and dissemination of information (studies, reports, GIS shape files, research findings)	**FO1, FO2, FO3, FO4, FO5**	∇ …	N, S, L	All forestry stakeholders
10-For	Promote and enhance awareness of the importance of freshwater resources to enable and support a climate resilient forest	**FO1, FO2, FO4, FO5**	*	N, S, L	All forestry stakeholders
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
11-For	Implement relevant law, policy and regulation to place to support efforts to build resilience in protected areas	**FO1, FO2, FO3,FO4, FO5**	* ∇	N, S, L	GFC, EPA, PAC, MNR, NTC

12-For	Identify and integrate adaptation needs within REDD+ readiness activities, leveraging the synergies between adaptation and mitigation (e.g. sustainable forest management)	**FO1, FO2, FO3, FO4**	∇ …	N, S	GFC, REDD Secretariat, DECC, MNR
13-For	Develop and utilize management plans to guide protection, conservation, harvesting, processing and marketing of goods and services produced by forests and protected areas, taking into account climate change, in line with the GFC's Codes of Practice	**FO1, FO2, FO3, FO4, FO5**	∇ …	S, L	GFC, PAC, MNR, Iwokrama, EPA, FTCI, FPDMC
14-For	Enact and enforce existing legislation supporting the implementation of sustainable forest management plans	**FO1, FO2, FO3, FO4, FO5**	∇	S, L	GFC, EPA, MoLA
15-For	Ensure gender issues are integrated into sectoral projects/ programmes	**FO1, FO2, FO3, FO4**	∇ …	N, S, L	Women and gender equity Commission, Women's Affairs Bureau, Men's Affairs Bureau, Ministry of Human Services, UNICEF
16-For	Building on existing MRVS, continue to develop a robust framework for monitoring and evaluation of climate change impacts on forest resources	**FO1, FO2, FO3, FO4, FO5**	∇ …	N, S, L	GFC, EPA, PAC, DECC, GGMC
17-For	Use the results produced from the MRVS Interim Measures reports to inform risk management	**FO1-FO7**	∇ …	N, S, L	GFC
Pillar 4 Actions: Generation and application of technologies					
18-For	Continued and improved mapping and demarcation of forested areas, with boundaries gazetted and made permanent, through GPS aided surveys and technologies such as remote sensing using LIDAR, ARC GIS, LANDSTAT	**FO1, FO2, FO3, FO4, FO5**	∇ …	N	GFC, PAC, Iwokrama, GL&SC, REDD Secretariat,
19-For	Increased reforestation and restoration activities as a result of deforestation	**FO1, FO2, FO3, FO4, FO5**	∇	N, S, L	All relevant agencies

20-For	Continue to monitor mangroves in Region 1, and strengthen involvement of communities in this process	**FO3**	∇ …	N, S, L	MoA, EPA, PAC, GFC, NDC, RDCs
21-For	Continue the development of the MRVS so that it can better monitor deforestation and degradation	**FO1-FO7**	∇	N, S, L	GFC
Pillar 5 Actions: Financing instruments					
22-For	Increase financial allocation for research and capacity building programmes	**FO1, FO2, FO3, FO4**	∇ …	N, S, L	GoG, international donor/finance community
23-For	Provide economic incentives to protect the forest	**FO1, FO3, FO5**	∇ …	N, S, L	GoG, international donor/finance community
24-For	Use of payments received for the forests' climate services to develop Guyana's green economy	**FO1, FO2**	∇ …	N	GoG, GFC, DECC
25-For	Improve access to financial resources available through bilateral and multilateral agreements	**FO1, FO2, FO3**	*	N	GoG, DECC

Health

A: Current situation
Socio-economic importance
• **Guyana's Health Vision identifies national objectives and targets related to health, in particular the delivery of quality, effective and responsive health services and prevention measures as well as improvement of the physical, mental and social wellbeing of all people. It also covers environmental health, food security and nutrition and health promotion. The health sector thus makes a significant contribution to the welfare of Guyanese people by providing effective medicines and health care, contributing to the productivity of the population, as well as offering employment opportunities.** • **The sector also provides essential services in times of weather and climate-related disasters, such as flooding. A strong health sector is necessary to prevent and reduce the prevalence of climate-related diseases, including vector- and waterborne diseases such as malaria, dengue and chikungunya, which affect the population, particularly vulnerable groups such as women, children, the elderly and disabled.** • **Overall, a strong and effective health sector contributes to quality of life, helps prevent loss of productivity of the country's workforce, loss of life and reduces health care costs.**
Climate vulnerability profile
• **The health sector is very vulnerable to climate change, as climatic conditions can exacerbate the severity and occurrence of existing health problems, such as heat stress,**

respiratory illnesses, vector- and water-borne diseases including malaria, dengue and chikungunya. Furthermore, Guyana's health sector faces a number of challenges (outlined below) that increase its sensitivity and exposure to climate impacts.

- The primarily coastal location of Guyana's health care facilities (e.g., hospitals, health centres), which are vital to responding to risks in vulnerable communities, increases the exposure of the facilities to climate impacts, particularly flooding. The 2005 floods illustrated the vulnerability of Guyana's health sector, in terms of direct damage and losses to healthcare infrastructure and indirect operational and treatment costs. Total costs were estimated at US$0.9 million or 11% of GDP (2004 prices). Over 25 health centres in Georgetown, the East Coast and the West Bank Demerara areas were flooded. These types of impacts are likely to worsen, given future climate change projections across a range of scenarios. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s.
- Guyana has a shortage of health care professionals, which means limited resources to deal with existing health problems. This shortage has been exacerbated by aggressive recruiting of medical personnel by developed countries.
- Good health is highly dependent on clean water supply and sanitation, which are sensitive to changes in climatic factors such as temperature and rainfall. While access to basic sanitation has greatly improved in Guyana, with about 84% of the population using improved sanitation facilities, challenges remain. Guyana Water Inc. (GWI), the water and sewerage services public utility, faces operational, financial, and institutional challenges, including deteriorating distribution systems and high levels of non-revenue water, unreliable delivery of water at low pressures and often low quality. Changes in water quality, which will have significant impacts on health, may be caused by drought due to higher temperatures or flooding due to increases in extreme rainfall. Projections across a range of future climate change scenarios indicate increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution.
- The capacity of the health sector to deal with climate impacts is affected by a number of informational, technological, institutional, financial and regulatory barriers.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the health sector.

The risks the health sector faces are spread across the range of likelihood and consequence scales. The highest magnitude risks are linked to potential water scarcity and the impacts on health (e.g. access to clean drinking water and good sanitation) and inequalities (e.g. gender, education, poverty) (risk ref H2) and the potential for internal and external migration to occur, due to climate-induced changes in living and working conditions (risk ref H3). Both these risks assessed as being moderately likely; however, if they did occur they would have catastrophic consequences for development objectives, including human health. The other high magnitude risk is a cascading consequence from potential declines in agricultural production and revenue, which may cause detrimental consequence from community services, including health and education (risk ref H1). This is because in many geographical locations, agricultural enterprises (such as GUYSUCO) provide a range of community services including health, education, infrastructure and transport facilities. Other risks identified included changes in vector-borne

diseases (such as malaria, dengue) driven by potential increases in rainfall (risk ref H7 and H11) and water-borne and food-borne diseases (such as diarrheal diseases) driven by flood impacts on sanitation (risk ref H4 and H5).

Risk register for the health sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
H1	Incremental climate change and extreme events causes a decrease in agricultural production and revenue at the stakeholder and community (e.g. enterprise, community and smallholder) level with the consequence that community services (e.g. health, education) are detrimentally affected	Yes	Likely	Major impact	Serious
H2	Decrease in mean annual rainfall, particularly increase in drought frequency, causes water scarcity with the consequence that human health is negatively impacted (e.g. access to clean drinking water and good sanitation) and inequalities are exacerbated (e.g. gender, educational, poverty)	Yes	Moderate	Catastrophic impact	Serious
H3	Incremental climate change and extreme events causes deteriorating / unsuitable living and working conditions with the consequence that internal and external migration Occ, with associated detrimental human health impacts	Yes	Moderate	Catastrophic impact	Serious
H4	Increase in extreme rainfall events causes breach of river embankments, leading to flooding with the consequence that water sources are contaminated, with detrimental effects on health	Yes	Moderate	Major impact	High
H5	Increase in extreme rainfall events causes overtopping of the East Demerara Water Conservancy, leading to flooding with the consequence that housing and latrines are damaged, with detrimental effects on health (e.g. water-borne diseases and infections)	Yes	Moderate	Major impact	High

H6	Increase in extreme rainfall events causes the overtopping of the East Demerara Water Conservancy, leading to catastrophic flooding with the consequence that lives are lost and public health emergency Occ	No	Unlikely	Catastrophic impact	High
H7	Incremental climate change especially increases in rainfall, cause increases in the incidence of infectious diseases (e.g. malaria, dengue and gastroenteritis) with the consequence that human health is negatively affected	Yes	Moderate	Moderate impact	High
H8	Increase in mean annual temperature particularly increased humidity and heatwave duration, causes heat stress, particularly in urban areas and for outdoor workers with the consequence that human health is negatively impacted	Yes	Likely	Minor impact	High
H9	Extreme events, particularly heatwaves, droughts and floods, cause problems with waste management with the consequence that human health is negatively impacted	Yes	Moderate	Major impact	High
H10	Increase in extreme rainfall events causes flooding with the consequence that resources are directed to disaster response efforts	Yes	Moderate	Moderate impact	High
H11	Incremental climate change, particularly an increase in average annual and seasonal precipitation, causes increased geographic exposure to malaria with the consequence that human health is negatively impacted	Yes	Unlikely	Minor impact	Medium
H12	Increase in storm surge height causes coastal flooding and erosion with the consequence that there is increased risk of human injury and death and communities are displaced	Yes	Unlikely	Slight impact	Low

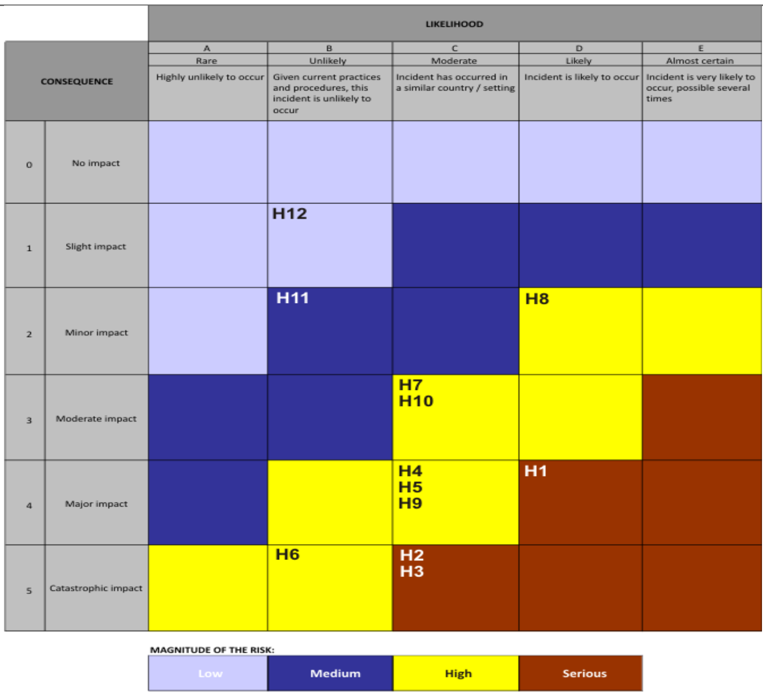

Figure 3.8: Risk matrix for the health sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the health sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
In a defined area: affecting 5% of the total national population – revenue, health, related issue, social life (education, religion, etc.)	Few reported cases in about 2/3 regions Affecting 10-15% of the total national population	Spread to about 3-5 regions Affecting 15-25% of the total national population	Spread to 5-6 regions Affecting 25-44% of the national population	Spread to 8 or more regions Affecting 45-65% of the national population

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge on climate vulnerability of the 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 – 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, that incorporate design features (e.g. renewable energy sources, 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**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-H	Undertake research into the impact of climate change on public health (especially relating to the threat of malaria)	**H1 - H9**	▽	N, L	<u>MoH</u>: vector control unit (VCU) and environmental health unit (EHU), surveillance unit, centre for disease control
2-H	Strengthen data gathering, processing and reporting procedures to increase the availability of data for analysis and climate resilient planning	**H1 – H 10**	▽	N, S, L	<u>MoH</u>: vector control, EHU, Stats unit. EPA
3-H	Develop and implement early warning monitoring system which pre-empt increases in illness associated with climate factors, such as heat-related illnesses or illnesses associated with flooding	**H1 – H10**	▽	N, S, L	MoH, MOLG
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-H	Develop and implement capacity building programme for public health sector on climate resilient	**H1 – H10**	▽ …	N, S, L	<u>EHU of MoH</u>

	health care practices, such as integrating climate change into risk assessments, considering climate change when developing plans and activities, implementing communication strategies to raise awareness about climate impacts on health,				
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
5-H	Integrate climate change considerations into all national policies and plans that relate to public health	**H1 – H10**	∇	N, S, L	MoH, MOLG
Pillar 4 Actions: Generation and application of technologies					
6-H	Create and maintain basic public health infrastructure, in terms of training, surveillance, immunisation, vector control, and emergency preparedness in response to climate risks	**H1, H4, H5, H6, H7, H10**	∇ …	N, S, L	MCH of CDC, VCU of MoH, Hydromet
7-H	Implement programmes to prevent vector borne diseases such as malaria, dengue and chikungunya (e.g. spraying and treated bed nets)	**H1 - H7, H9, H10**	∇ …	N, S, L	VCU of MoH MOLG, health centres, MOAA
8-H	Improve water quality and sanitation to prevent gastroenteritis and leptospirosis	**H2, H4, H5, H7, H9**	∇	N, S, L	GWI, MoLG
9-H	Implement flood proofing measures for health clinics, especially the low lying areas	**H1, H4, H5, H6, H10**	∇	N, S, L	MoH
10-H	Improve sanitation and water for flood risk management along low lying areas	**ALL**	∇	N, S, L	GWI, MoH, M&CC, food and drug dept.
11-H	Develop emergency response system for epidemic/ widespread illnesses	**ALL**	∇	N, S, L	MoH, CDC, sister agencies
12-H	Extend medical care to mobile and remote populations vulnerable to climate change	**H3, H7**	*	N, S, L	MoH and sister agencies
Pillar 5 Actions: Financing instruments					
13-H	None defined yet.				

Housing

A: Current situation
Socio-economic importance
• **Improving the housing sector in Guyana has the potential to achieve pro-poor growth, creating new wealth for the emerging working class and small entrepreneurs. It would**

improve productivity, provide access to financial markets, and fosters asset accumulation in general. • However, Guyana's housing sector faces a number of challenges, resulting from under-population and the spatial configuration of the population. Of the total population, the vast majority (90%) are concentrated on the narrow coastal belt, where population density is more than 115 persons per square kilometre. • Guyana's CH&PA faces the need to meet a housing deficit totalling 20,000 units for low-income families and an additional 52,000 houses are over 30 years old and require improvement. • Finally, the construction sector, of which housing is a key component, is an important economic sector in Guyana. Housing contributes to GDP in two ways: through private residential investment and through personal consumption expenditure. Over the past decade, about 12% of the total annual investment was directed into this sector which generated over 8% of GDP. Additionally, for low income individuals, the government has provided core homes and provided materials for eligible people to improve their houses.
Climate vulnerability profile
• The housing sector is vulnerable to a range of climate-related hazards, including sea level rise, storm surge, flooding from extreme rainfall events and heatwaves. These hazards have the potential to directly impact housing infrastructure or the services on which communities rely (e.g. water and sanitation). • The concentration of the population along the coast exposes communities, houses and supporting infrastructure to flooding and erosion associated with sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. • Coastal communities also have a high level of dependence on coastal aquifers for domestic water supply. This renders the population extremely vulnerable to the effects of salt water intrusion as a result of sea level rise. • Exposure to flooding is also linked to heavy rainfall events and overtopping of drainage and irrigation systems. The 2005 flood caused much damage to the housing sector, approximately 275.6 million USD, with stakeholders noting that 61 shelters had been established to house the worst hit victims of the flood. Region 9 stakeholders also commented that the Linden/Lethem Road infrastructure was washed away. In addition, residents in informal settlements along the Lamaha Railway Embankment in Georgetown had to be relocated to a planned residential area (La Parfaite Harmonie Housing Scheme). Water supply, sanitation and drainage infrastructure is sensitive to floods and any compromise of these systems has the potential to create health risks for local communities (e.g. leptospirosis and cholera). • The housing sector is also vulnerable to high temperatures. The frequency of days and nights that are considered 'hot' in current climate are projected to increase substantial in all climate scenarios. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s. Overheating in houses has the potential to create health risks for residents, including heat exhaustion or heat strokes, which in severe cases, can be fatal. Vulnerability to these risks depends on the style and condition of the housing stock (e.g. use of air-conditioning), and the demographics of residents (e.g. elderly, young and sick are more vulnerable to heat-related health conditions).

- **The capacity of the housing sector to deal with climate impacts is affected by a number of institutional, informational, financial and policy and regulatory barriers.**

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the housing sector.

The housing sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix. The highest magnitude risks are related to housing infrastructure damage, personal injury and community displacement resulting from flooding of rivers and drainage canals, specifically in Georgetown, (risk ref HO1 and HO2) and sea level rise and storm surge (risk ref Ho3).

Risk register for the housing sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
HO1	Increase in extreme rainfall events causes flooding with the consequence that housing infrastructure is damaged or destroyed and communities are displaced	Yes	Almost certain	Catastrophic impact	Serious
HO2	Increase in extreme rainfall events causes flooding of Georgetown due to overflowing drainage canals with the consequence that houses and other infrastructure are damaged or destroyed and communities are displaced	Yes	Almost certain	Major impact	Serious
HO3	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that households and lives are threatened	Yes	Almost certain	Moderate impact	Serious
HO4	Sea level rise causes coastal flooding with the consequence that mangrove vegetation is destroyed reducing its ability to protect the coast	Yes	Likely	Moderate impact	High
HO5	Sea level rise causes saline intrusion with the consequence that materials used for building houses will degrade at an accelerated rate	Yes	Moderate	Minor impact	Medium
HO6	Increase in extreme rainfall events causes waterlogging of coastal areas with the consequence that houses in coastal areas are damaged and	Yes	Moderate	Minor impact	Medium

	existing poor waste disposal practices are compounded, with detrimental impacts on human health				
HO7	Sea level rise causes erosion with the consequence that housing foundations are weakened	Yes	Unlikely	Minor impact	Medium

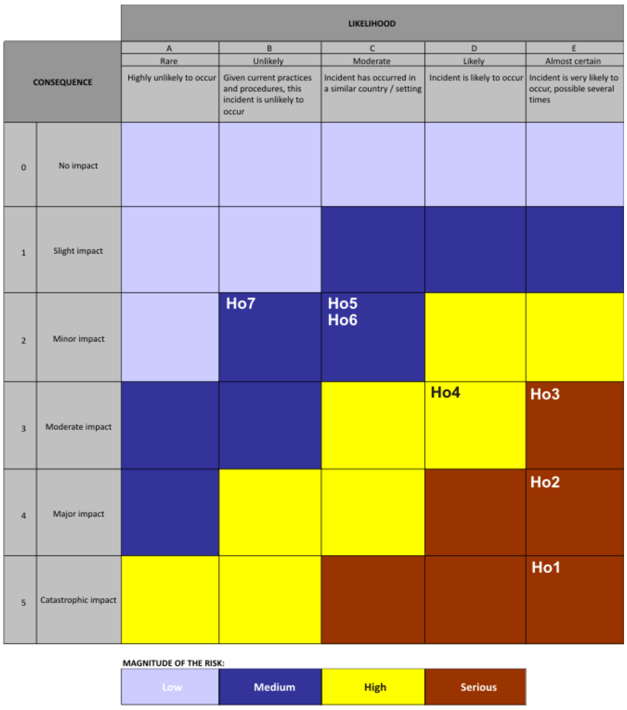

Figure 3.9: Risk matrix for the housing sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the housing sector have been defined in collaboration with in-country stakeholders. (E) relates to economic consequences, (S) relates to social consequences.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Temporary inundation Swelling of ceilings/doors Loss of aesthetic quality at household and community levels	Damage to building materials (E) e.g. sand and cement Damage to buildings/weakening of foundation Cost of repairs (E) Health impacts	Destruction of ecosystems e.g. Mangroves for provision of building materials	Inundation of bottom stories, flat houses (S) (E) Cost of relocation, retrofitting	Displacement of households/communities (S)

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge on social vulnerability to climate change** • **Promote land use planning and housing developments to consider the impacts of climate change** • **Promote adaptation good practice and developing innovative solutions** • **Improve drainage within housing areas** • **Improve waste management systems at a household and community level** • **Develop, implement and enforce housing-related laws, policies, regulations and national strategies for climate resilience** • **Promote institutional synergies in the housing sector** • **Increase access to funding/financial resources for ‘climate smart’ buildings**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-Ho	Conduct vulnerability assessment/ surveys and hazard mapping to assess physical, social and economic impacts of recent events on housing, and to identify flood risk areas, particularly in Georgetown.[14]	**HO1, HO2, HO3**	▽ …	S	<u>CH&PA</u>, <u>GL&SC</u>, EPA, NDIA, OP, GFC, MNR, CDC, M&CC

[14] SIDS and other countries prepare hazard maps for risk analysis but Guyana does not currently, along the low elevation coastal zone. (Food and Agriculture Organization of the United Nations (FAO) (February 2013). Status of Disaster Risk Management, Plans For Floods, Hurricanes and Drought In The Agriculture Sector: A Caribbean Perspective. Rome: FAO)

2-Ho	Research on best practice land use policy, housing development and building technology to support climate resilient housing	**HO1, HO2, HO3, HO4**	*	N, S, L	CH&PA, GLSC, MNR, NDC, CDC, DECC, GEA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
3-Ho	Conduct an awareness raising programme for the public on potential climate change impacts on housing and management of impacts	**ALL**	*	N, S, L	CH&PA. Media, DECC, CDC, MNR, private sector
4-Ho	Promote social and economic research, environmental education and public awareness, and community involvement programmes that address the complex issues of settlements, with the aim of improving the surroundings and quality of life	**ALL**	∇ *	N, S, L	MOAA, CH&PA, EPA, MNR, (RDCs) Local, Government, National Task Force
5-Ho	Develop and implement awareness raising programme on climate resilient housing development and land use policies	**ALL**	*	N, S, L	CH&PA, Media, MNR, GEA, CDC, GLSC
6-Ho	Develop and implement capacity building and training programmes on climate resilient building design for architects, engineers, other private sector actors etc.	**ALL**	*	N, S, L	UG, GTI, Other educational institutions
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
7-Ho	Promote the integration of gender issues into housing projects/ programmes relevant to climate resilience	**ALL**	*	N, S, L	Ministry of Communities, Ministry of Social Cohesion
8-Ho	Develop a more robust framework for the effectiveness of adaptation actions	**ALL**	∇	N, S, L	CH&PA, Legal Affairs, CDC, NDC, DECC
9-Ho	Integrate climate change into (Draft) National/Regional Land Use Policy and Plan to provide guidelines on appropriate areas for new developments	**ALL**	*	N, S	CH&PA, DECC, GLSC
10-Ho	Design housing development processes to control/phase out development in flood risk areas, using information from climate change impact studies	**ALL**	*	N, S, L	CH&PA, GLSC, private housing developers
11-Ho	Develop lands, climate resilient infrastructure and urban areas in the interior	**HO1**	∇	S	GLSC, CH&PA, Ministry of Public Infrastructure, GPL, GWI

12-Ho	Develop building codes to integrate climate resilience and encourage the design of a robustly built environment, for example, encouraging people to not to completely concrete their yards to ensure sufficient infiltration of water to reduce flood risk. Some building codes are already in existence; for example, a building code for the construction of 3 and 4 storey buildings incorporates climate resilience by ensuring that the building's foundation can withstand inundation.	**HO1, HO2, HO3**	∇	N	Guyana Bureau of Standards, CH&PA, NDCs, (Local Government)
13-Ho	Develop guidance for retrofitting existing housing developments to integrate climate resilience	**HO1, HO2, HO3**	*	N, S, L	GEA, CH&PA, GPL, CDC, National Task Force
Pillar 4 Actions: Generation and application of technologies					
14-Ho	Build shelters on higher ground either or inland, to house people in the event of inundation due to storm surges	**HO1, HO2, HO3**	∇	N, S, L	CH&PA, CDC, RDC, NDC
15-Ho	Ensure that emergency shelters (e.g. churches, schools) are climate resilient and self-sufficient in water and energy	**HO3**	*	N	CDC
16-Ho	Plan clearly defined evacuation routes and implement stimulation exercises, supported by a robust educational campaign	**HO1-HO3**	*	N	CH&PA, CDC, RDC, NDC, DECC
Pillar 5 Actions: Financing instruments					
17-Ho	Source financing for research and development and awareness raising programmes	**ALL**	*	N	MoF, CH&PA, MoFA
18-Ho	Provide appropriate economic incentives to encourage compliance with new building codes, in collaboration with insurance and financial sectors	**ALL**	*	N	MoF (GRA), Insurance companies, CH&PA, lending institutions
19-Ho	Increase access to funding/financial resources for 'climate smart' buildings and to support building resilience in the housing sector (e.g. CCRIF insurance)	**HO1HO1, HO2, HO3**	*	N	MOF, CH&PA, Insurance companies

Indigenous Peoples

A: Current situation
Socio-economic importance
• There are nine indigenous tribes settled across the ten administrative Regions of Guyana, which are part of the many ethnic groups that make up the people of Guyana. • Indigenous populations constitute about 9% of Guyana's total population, or approximately 69,000 people. Each tribe has its own cultural identity, language, heritage and traditional economic activities, often integrated with the natural environment. • Combined, indigenous tribes have ownership of about 13.9% of Guyana's lands. • These communities are at various stages of integration with the national economy. Their access to the natural environment and ownership of forestland make indigenous peoples well suited to the conservation and sustainable management of forests, as recognised in the LCDS.
Climate vulnerability profile
• The livelihoods of many indigenous peoples are inherently vulnerable to climate change, due to a number of factors that increase sensitivity and exposure, including dependence on ecosystem services and agriculture, and isolation from main infrastructure and transportation networks. • Many indigenous peoples' communities are found in the forested interior of Guyana, and are highly dependent on the provisioning ecosystem services provided by the forest, which are sensitive to climate change. Many indigenous peoples' communities use forest resources as a source of food, medicine, building materials, fibres, tannins and dyes. Forests are sensitive to climate variability and change, for example higher temperatures leading to higher incidences of drought, which may cause wildfires, in turn damaging or destroying forests, savannah and indigenous peoples' farms. Projections across a range of future climate change scenarios indicate that the frequency of days and nights that are considered 'hot' in current climate will increase substantially. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s. Nights that are considered 'hot' for the annual climate of 1970-99 are projected to occur on 33-90% of nights by the 2060s and 46-99% of nights by the 2090s. • Many indigenous peoples' communities are also found along waterways (e.g. Santa Mission, Orealla, Siparuta, Moraikabai, St. Cuthbert's Mission) and on the low coastal plain. Riverine communities are sensitive to increased rainfall, as they are already vulnerable to flooding during rainy seasons. Climate projections show increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution. Communities located close to the coast may be exposed to sea level- and storm surge-related flood damage. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. • Many indigenous peoples' communities are heavily dependent on small-scale agriculture, particularly for the provision of their main staple, cassava. Agriculture itself is sensitive to climate change due to the close connections between climatic conditions, plant

development and animal health, which in turn increases the sensitivity of indigenous peoples' communities.

- **Capacity to deal with climate impacts to indigenous peoples is affected by a number of barriers - informational, technological, institutional and regulatory, among others.**

Climate risks and opportunities

- **The vulnerability profile described above creates a number of climate change risks for indigenous peoples.**
- **The risks identified for indigenous people are clustered towards the higher magnitude end of the scale; over half the risks identified were deemed serious, with the remainder viewed as high magnitude. The highest magnitude risks for indigenous peoples' communities are linked to decreases in agricultural production due to changes in water resource availability, with consequences for livelihoods (risk ref AA1), food and health (risk ref AA2 and risk ref AA6). Other high magnitude risks were linked to sea level rise and flooding impacting livelihoods (risk ref AA3), and potentially resulting in relocation of coastal and riverine communities (risk ref AA4). Riverine communities, such as Chenapou, are already vulnerable to flooding during the rainy season. Furthermore, many of the villages in the North Pakaraimas are at risk when it rains because mountainous roads become dangerous in the wet. Finally, the potential impacts associated with wildfires were deemed serious, namely destruction of forests, savannah and indigenous peoples' farms, and health risks associated with the increased dust (risk ref AA5). Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes.**
- **It should be noted that 15% of the revenue for all carbon credit sales go directly to the accounts of the 243 Amerindian communities, satellites and villages in Guyana for implementation of projects identified in their Village Sustainability Plans (VSPs). These VSPs are prepared by the villages and are voted into acceptance by the members of the village at their village meetings. There are currently over 800 projects in implementation under the VSPs utilising carbon credit revenues. These projects are in addition to all of the projects funded by Government in the national budget or through other sources for the development of Amerindian communities, satellites and villages.**

Risk register for indigenous peoples' communities.The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
IP1	Incremental climate change and extreme events particularly increased frequency of droughts, causes water shortages for agricultural purposes, with implications for traditional agricultural methods (e.g. slash and burn) and a decrease in agricultural production with the consequence that indigenous peoples' livelihoods, reliant on agriculture, are threatened	Yes	Almost certain	Catastrophic impact	Serious

IP2	Increase in extreme rainfall events causes flooding with the consequence that agricultural yields are lost (e.g. cassava crops rot), leading to a food deficit and detrimental impacts on health (e.g. mosquito invasion and malaria; contamination of drinking water)	Yes	Almost certain	Catastrophic impact	Serious
IP3	Sea level rise and extreme events causes flooding in the Low-lying areas of the coastal region of Guyana with the consequence that the livelihoods of indigenous communities, which live along the waterways, are threatened	Yes	Likely	Major impact	Serious
IP4	Sea level rise causes flooding with the consequence that coastal indigenous peoples' village livelihoods are threatened and relocation may be necessary, with recognition of ancestral land rights	Yes	Likely	Major impact	Serious
IP5	Incremental climate change and extreme events (droughts) causes wildfire with the consequence that forests, savannah and farms are destroyed, wildlife die or migrate, health is threatened (e.g. through increased dust, restricted access to potable water), and productive time is lost in search of water	Yes	Likely	Major impact	Serious
IP6	Incremental climate change and extreme events causes decline in farm productivity, traditional hunting and fishing with the consequence that people are more reliant on store bought food, with associated socio-economic and health implications (e.g. weight, diabetes, caries, etc.)	Yes	Likely	Major impact	Serious
IP7	Increase in number of extreme 'hot days' causes water shortages and heat stress with the consequence that health and sanitation in general communities is detrimentally affected, with the occurrence of heat stress, skin rashes and psychological stress	Yes	Likely	Moderate impact	High
IP8	Increase in extreme rainfall events causes flooding with the	Yes	Moderate	Moderate impact	High

	consequence that rural homes and other buildings are destroyed and communities are displaced				
IP9	Incremental climate change and extreme events cause disruption in the regular season of wild forest fruits that wild animals and birds feed upon, impacting their food chain with the consequence that wild animals and birds now search for food on farms, compounding stress on already struggling farms	Yes	Moderate	Major impact	High
IP10	Extreme events causes disruption to communication and transport infrastructure with the consequence that remote indigenous peoples' communities are disconnected and operating costs in these areas increase.	Yes	Likely	Moderate impact	High
IP11	Incremental climate change causes detrimental impacts on indigenous peoples' land and resources with the consequence that their livelihood, identity and culture are affected	Yes	Likely	Moderate impact	High
IP12	Incremental climate change and extreme events particularly increased frequency of droughts, causes lower water levels in freshwater lakes, ponds and rivers with the consequence that fish are more easily caught, with a positive impact on livelihoods	Yes			Opportunity

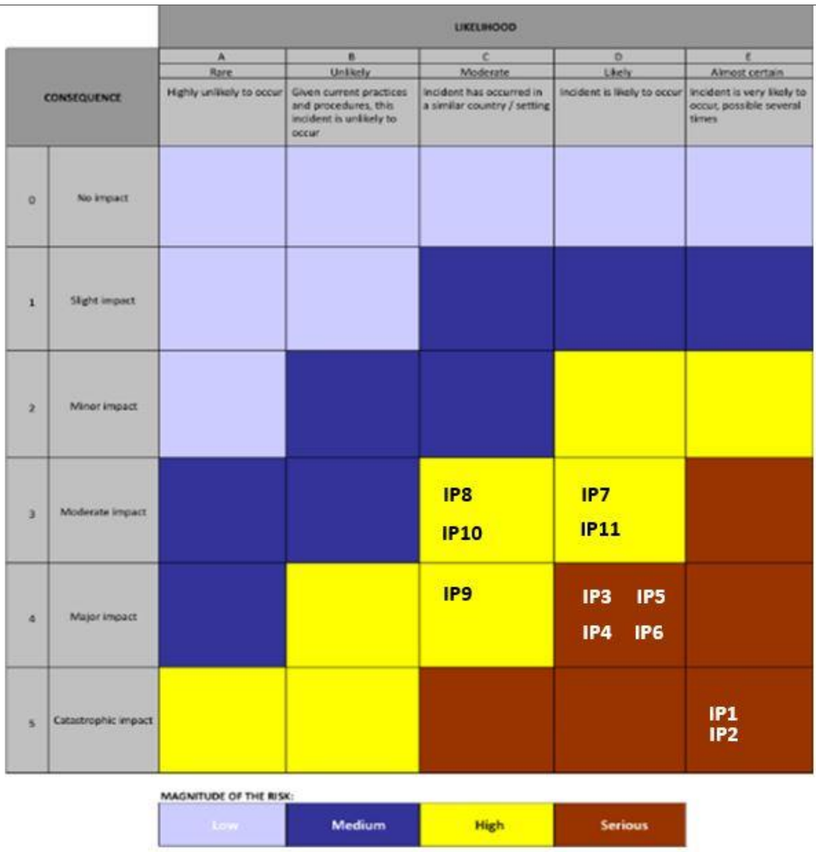

Figure 3.10: Risk matrix for indigenous peoples.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for Indigenous Peoples have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Impacts are easily reversed Few households/ people affected	Impacts can be fixed/ reversible Several households affected	Impacts can be fixed/ reversible, but would take effort/ input Many households affected	Impacts are hard to reverse Livelihoods directly affected Human lives and biodiversity (flora & fauna) are threatened	Irreversible impacts Human lives and biodiversity (flora & fauna) are lost Whole community is affected

B: Future vision

Recommended Sectoral Objectives

- **Improve food security and health, expanding the use of renewable energy, adding value to agricultural goods and developing ecotourism**
- **Increase and improve potable water security and access, particularly for remote satellite communities**
- **Improve early warning systems for extreme events, particularly for remote satellite communities**
- **Use traditional and scientific knowledge to inform decision makers, stakeholders and the younger generation in developing resilience and adaptation plans**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (∇), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined, where known)**
Pillar 1 Actions: Information, research and systematic observation					
1-Ip	Examine how traditional knowledge can be further researched and documented, with FPIC from the relevant indigenous peoples' groups and individuals (and must be used to guide policy decisions nationally)	**IP6, IP11**	∇	N, S, L	NTC, <u>MOAA, IP, NGOs, CBOs</u>
2-Ip	Implement mechanisms to ensure that traditional knowledge is captured in the adaptation planning stage, particularly via the National Toshaos Council (NTC) and other indigenous peoples' representative groups	**IP11**	∇	N, S, L	NTC, <u>MOAA, other groups, indigenous CBOs</u>
3-Ip	Promote the wider use of 3 month weather forecasts,		∇	S, L	MOAA, NTC, <u>Hydromet</u>

	including consideration of traditional knowledge				
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-Ip	Conduct awareness raising and capacity building programmes within indigenous peoples' communities about how to adapt to climate change impacts in these communities	**IP1, IP2, IP4**	▽	N, S, L	MOAA, DECC, GFC, RDCs & extension officers , IP groups
5-Ip	Support indigenous communities to add value to agricultural goods, for example through processing. This will involve building capacity in quality control, packaging and marketing		*	N, S, L	MOAA, MoA, Village Council, NTC
6-Ip	Provide institutional and capacity training to the NTC and support to the MOAA and NTC to help them integrate climate resilience into all development projects. This could be through the use of the Caribbean Climate Online Risk and Adaptation TooL (CCORAL)		*	N	CCCCC
7-Ip	Provide training and support to NTC on how to develop funding proposals for climate resilience projects	**IP3**	*	N	CCCCC and other external organisations
8-Ip	Promote wider dissemination and of the Community Guidance Manual on Climate Change		*	S, L	MOAA, NTC, Village council
9-Ip	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation, using simple language	**IP1**	▽	N, S, L	MOAA, GFC, DECC, GGMC, EPA
10-Ip	Train local community members in skills required for monitoring and evaluation and reporting	**IP4**	▽	N, S, L	Village council, WWF & other environmental organisations, CBOs, GFC, RDCs, MOAA, Extension officers
11-Ip	Simplify and translate relevant climate change documents to enable easy understanding for indigenous and hinterland communities		*	S, L	MOAA
12-Ip	Explore opportunities for the new Youth Development		*	N	MOAA, CCCCC

	Programme to include elements of climate resilience as part of the vocational training provided to youth and young adults. CCCCC have offered support to help develop this programme.				
13-Ip	Conduct regular consultation with indigenous communities and include their contributions on matters related to CRSAP	**IP11**	▽		APA, MOAA, NTC, DECC
14-Ip	Establish effective and efficient communication systems in communities in relation to climate change	**IP10**	▽		EPA, DECC, MOAA
15-Ip	Include climate change on the agenda of indigenous peoples' representative groups, such as the National Toshaos Council, GOIP, APA, TAAMOG, NADF, CBOs	**IP1-12**	*	N	MOAA, NTC
16-Ip	Extend the volunteer corps[15] used by the CDC in Regions 4, 6 and 9 to cover all regions	**IP8**	▽	S	CDC, MOAA, CBOs, NTC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
17-Ip	Integrate climate change into Village Resource Development Plans (VRDPs)[16]. VRDPs follow a participatory process to draw up a community sustainable development plan that can be used to communicate development aspirations both within the village and outside, e.g. with government or development partners. The plans allow local communities to maintain natural capital, increase social wellbeing and grow their economies along a healthy sustainable path	**IP6**	▽	L	Village councils, MOAA, NTC
18-Ip	Review land use planning policies, particularly in the context of a potential move inland to avoid flood risk and respecting indigenous people's rights		*	N	CH&PA, MOAA, NTC, Amerindian groups

[15] The volunteer corps is split into (1) members with specialized skills, e.g. medical, engineering, GIS, and (2) general members. The skilled volunteer's role is to deliver community-based DRM – lead the process of identifying hazards, risks, actions and delivering actions at the community level. The general volunteers are involved in emergency response.
[16] For example, see: http://www.conservation.org.gy/publications/Village_Resource_Development_Planning_Toolkit_For_Communities.pdf

19-Ip	Improve local health care facilities, including the provision of training and resources to deal with the anticipated impacts of a changing climate	**IP7**	∇	S, L	Ministry of Health, MOAA
20-Ip	Establish community safety net programmes		∇	N, S, L	Village councils, Ministry of Health, NRC
21-Ip	Ensure gender issues are integrated into sectoral projects/ programmes		∇	N, S, L	Village councils, Ministry of Human Services, MOAA, Amerindian groups
22-Ip	Ensure there is access and integration of indigenous knowledge in the process of adaptation. This could build on knowledge sharing initiatives like Project Cobra (a EU-funded programme, with full name 'Local Solutions for Future Challenges: Community Owned Best Practice for Sustainable Resource Adaptive Management in the Guiana Shield')	**IP9**	∇	N, S, L	MOAA, NTC, NRDDB
23-Ip	Develop a more robust framework for monitoring and evaluation	**IP1, IP2**	∇	N, S, L	MNR, GFC,GGMC, MOAA, MoLA
24-Ip	Enhance institutional capacity to implement policies and regulations related to climate change and the environment	**IP11**	**...**	N, S, L	MNR
25-Ip	Ensure the resilience actions proposed and implemented are aligned with the UN Declaration on the Rights of Indigenous Peoples	**IP11**	*****	N	MOAA
26-Ip	Encourage the preservation of pristine lands and forest under the management of indigenous people				
Pillar 4 Actions: Generation and application of technologies					
29-Ip	Support the development of small-scale renewable energy projects to improve energy security for isolated indigenous communities		*	S, L	MOAA

30-Ip	Improve existing roads and develop new infrastructure to improve access to markets	**IP10**	∇	N	MOPW,MOAA
31-Ip	Review and replicate community participatory resource monitoring and mapping projects in South and North Rupununi at the national level e.g. SCPDA's mapping and land-use planning work ("Thinking together for those coming behind us") NRDDP's Community Reporting, Monitoring and Verification (CMRV) and KMCRG's natural resource management work	**IP6**	**...** ∇		MOAA, DECC, APA, IP NGOs, CBOs, NTC
Pillar 5 Actions: Financing instruments					
32-Ip	Improve access to soft loans to construct more climate resilient homes, through demonstration or pilot projects	**IP8**	∇	N, S, L	MOAA, MOPW
33-Ip	Allocate national budget to MOAA, and maximize on opportunities through projects and initiatives to support building climate resilience for addressing current climate impacts, preparations and recovery	**IP10**	∇ *****	N, S, L	MOAA, GoG
34-Ip	Establish a climate resilience adaptation fund for indigenous communities	**IP10**	*	N	MoF, MOAA, NTC

Mining

A: Current situation
Socio-economic importance
• **Guyana is home to deposits of gold, diamonds, bauxite, manganese and other precious metals. Mining, one of the country's most important economic activities, primarily takes place in the hinterland.** • **In 2009, the sector contributed 10.6% of GDP.** • **On average, gold represented 78% of the total value of the mining sector's output and is an important export for Guyana; in 2012, 51% of the country's total export revenues were attributed to gold production.** • **The sector also contributes significantly to employment; in 2010 it employed 11,189 people (direct employment), or about 13,900 (direct and indirect employment).** • **Three scales of operation are recognised in Guyana: (1) Small-scale (1500 feet x 800 feet whilst a river claim consists of 1 mile of a navigable river); (2) Medium-scale prospecting and mining (between 150 and 1200 acres); and (3) Large-scale prospecting, mining and quarrying (between 500 and 12,800 acres).** • **Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognized. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities.**
Climate vulnerability profile
• **The characteristics of Guyana's mining sector make it vulnerable to climate and weather-related hazards, largely due to its dependence on large fixed assets, transport, energy, water and people.** • **Medium- and large-scale mining and quarrying activities use a range of large fixed assets, such as recovery and haulage equipment (e.g. dredges, excavators, bulldozers, crushers), which are sensitive to a range of climate-related hazards, including extreme temperatures, flooding and land instability.** • **The landform features in hard rock mining, including pit walls and waste rock piles, are also vulnerable to flooding and land instability associated with extreme rainfall events. In May 2015, an open-pit gold mine in remote southern Guyana collapsed and buried up to 10 miners in debris. The collapse occurred in the densely forested Potaro-Siparuni Region near the border with Brazil following recent heavy rains.** • **The mining sector depends on transport systems to deliver supplies, workforce and products to and from the mine. As most mining takes place in remote hinterland locations, the transport network is particular vulnerable to weather-related disruption. Road are vulnerable to flooding and landslides, and river transportation is sensitive to both high- and low-flow conditions. If the river levels are too high, following heavy rainfall, river transport will be disrupted. Conversely, if river levels are too low, the rivers will no longer be navigable and infrastructure along the banks (e.g. landings) will be left inaccessible.** • **Energy is also a key system that enables production in the mining sector. Energy systems in Guyana are sensitive to climate change. The country's dependence on imported petroleum fuel for energy generation makes the energy sector sensitive to weather-related disruption and associated price volatility in the supply chain, which in turn increases the vulnerability of the mining sector. However, a number of the larger mining operators have invested in technology to generate most of their own energy, reducing their vulnerability to weather-related disruption.**

- **Water is also critical to the mining sector, serving many uses (e.g. mineral extraction techniques, cooling equipment and controlling dust) and is sensitive to various climatic variables, particularly increases in temperature and changes in rainfall.**
- **Mining processes produce large volumes of wastewater, often contaminated with harmful chemicals. Tailing ponds and dams, due to their long life spans, pose risks to the surrounding environment and populations long after they have stopped being used. Tailing ponds are vulnerable to flooding and land instability associated with extreme rainfall events, which have the potential to cause the release of harmful chemicals into local ecosystems and water sources. This would cause damage to protected species and natural habitats, or contaminate surface waters, ground waters or land that leads to a risk to human health.**
- **As discussed in the Health sector briefing note, climate change is likely to significantly affect the health of the human capital that is essential for the operation of the mining sector. The mining workforce is particularly vulnerable to temperature extremes and flood-related hazards. The frequency of days and nights that are considered 'hot' in current climate are projected to increase substantial in all climate scenarios. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s. Warmer working conditions are a concern for health, safety and levels of performance. They can lead to diminished mental task ability, increased accident risk and, if prolonged, heat exhaustion or heat strokes. These can significantly affect the productivity of outdoor, production line and factory workers.**
- **The capacity of the mining sector to adapt to climate change was viewed as low to moderate by stakeholders. In terms of informational resources, stakeholders commented that some information exists, primarily in the form of Environmental Impact Assessments (EIA) The largest barrier identified by stakeholder was the lack of availability of finance to respond and manage the impacts of climate change.**

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the mining sector.

The sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix, ranging from low magnitude right through to "serious". The highest magnitude risks are linked to flooding, erosion and land instability impacting the transport of mining material from the mine (risk ref M1) and the supply chain into mining communities (risk ref M4), drainage, tailings and landform management (risk ref M3 and M6) and workforce health and safety (risk ref M5). Conversely, water scarcity may disrupt hydraulic mining, the main mining method in Guyana, resulting in stoppages in operations and loss of revenue (risk ref M2).

Risk register for the mining sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
M1	Increase in extreme rainfall events causes flooding, erosion and land instability with the consequence that roads are damaged and transport of	Yes	Almost certain	Major impact	Serious

	mining materials by truck is disrupted, resulting in loss of revenue for commercial enterprises				
M2	Extreme events particularly droughts, cause water scarcity with the consequence that hydraulic mining, the main mining method in Guyana, is disrupted, resulting in stoppages in operations.	No	Likely	Catastrophic impact	Serious
M3	Increase in extreme rainfall events causes flooding with the consequence that drainage and tailings management are compromised, resulting in overflows into waterways, an increase in turbidity levels and subsequent pollution of interior waterways.	Yes	Almost certain	Major impact	Serious
M4	Increase in extreme rainfall events causes flooding with the consequence that roads are damaged and transport of food and other vital resources for workforces is disrupted, resulting in cessation of work and loss of revenue for commercial enterprises.	Yes	Moderate	Catastrophic impact	Serious
M5	Increase in extreme rainfall events causes flooding with the consequence that mine workings are flooded, disrupting operations, jeopardising workforce health and safety and resulting in loss of revenue for commercial enterprises	Yes	Likely	Major impact	Serious
M6	Increase in extreme rainfall events causes erosion and land instability with the consequence that mine workings (active and closed) are washed out and landforms (e.g. pit walls) fail, resulting in environmental degradation	Yes	Likely	Major impact	Serious
M7	Incremental climate change and extreme events particularly increased frequency of droughts, causes rivers (where gold is mined) to dry up with the consequence that rivers are no longer navigable (for transport of equipment) and mining operations cease, leaving miners seeking employment elsewhere	No	Unlikely	Catastrophic impact	High
M8	Increase in extreme rainfall events causes flooding of tailing dams with	No	Moderate	Major impact	High

	the consequence that the dam walls fail, resulting in flooding and the uncontrolled release of contaminants				
M9	Incremental climate change especially increases in rainfall, cause increases in the incidence of infectious diseases (e.g. malaria, dengue and gastroenteritis) with the consequence that health of the mining workforce is negatively affected	Yes	Moderate	Moderate impact	High
M10	Incremental climate change causes drying of open stockpiles or waste storage areas with the consequence that dust is mobilised affecting the health of the mining workforce and nearby communities	Yes	Likely	Minor impact	High
M11	Increase in extreme rainfall events causes riverine flooding with the consequence that loading and transportation of mining materials (e.g. bauxite) along rivers is disrupted, resulting in loss of revenue for commercial enterprises and decrease in export earnings	No	Likely	Moderate impact	High
M12	Increase in extreme rainfall events causes erosion and land instability with the consequence that acid-forming materials are exposed leading to acid rock drainage (ARD)/acid mine drainage and environmental degradation if it is not contained	No	Moderate	Slight impact	Medium
M13	Increase in number of extreme 'hot days' causes electrical equipment (e.g. mechanical, power, IT systems) to underperform or fail with the consequence that commercial mining operations are disrupted, or maintenance costs increase	No	Unlikely	Slight impact	Low
M14	Increase in number of extreme 'hot days' causes heat stress and dehydration with the consequence that mining workforce health and safety is jeopardised	No	Rare	Slight impact	Low

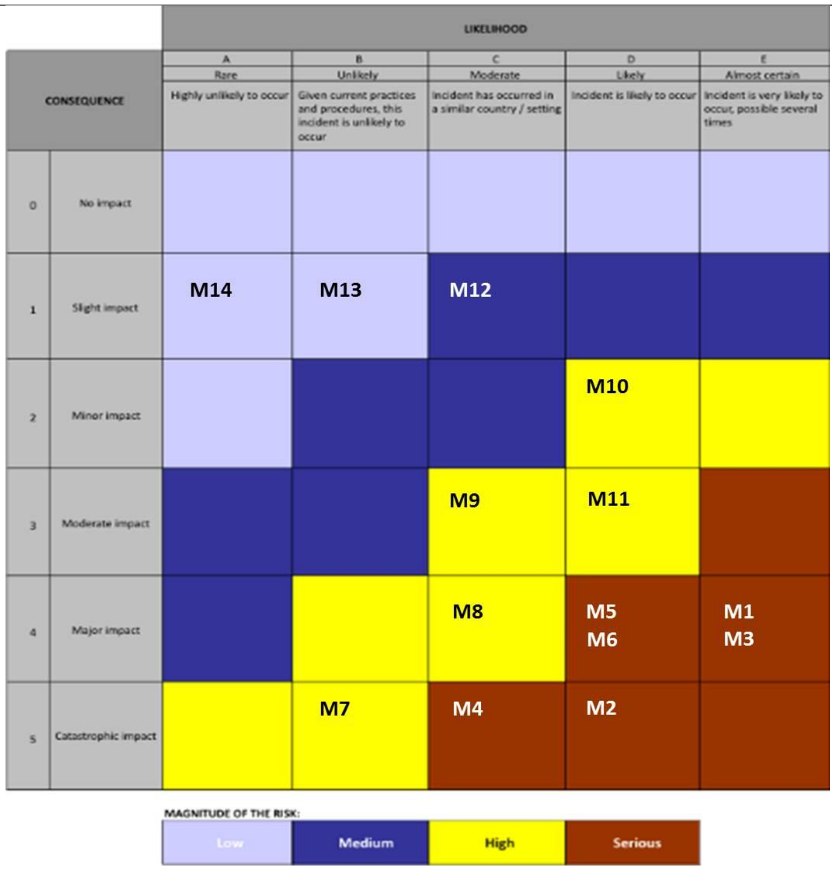

Figure3.11: Risk matrix for the mining sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for Mining have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Loss of production below 5% Very low level of pollution	Loss of production between 6 – 19% Low level of pollution	Loss of production between 20 – 39% High level of pollution	Loss of production between 40 – 64% Very high level of pollution	Loss of production 65% or more Extremely high level of pollution (water and soil)

B: Future vision
Recommended Sectoral Objectives
• **Increase awareness through targeted training of miners to understand better and manage climate change risks** • **Reduce the exposure of the mining workforce to health-related risks associated with vector-borne diseases (e.g. use of insecticide treated nets, keeping the immediate environment free of possible breeding sites)** • **Promote the adoption of climate resilient methodologies through robust R&D interventions** • **Provide financial assistance to miners to implement climate smart recovery methods (e.g. mercury free extraction), reduce the impact of mining and improve prospecting methods** • **Review and update mining policies, regulations and relevant codes of practices to ensure effective consideration of climate change adaptation, conservation and reclamation** • **Strengthen monitoring and enforcement capacities of relevant regulatory agencies (GGMC & GGDMA) to oversee compliance with climate change adaptation measures** • **Restore degraded interior ecosystems caused by mining activities**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-M	Design national research and development programme on climate impacts on the mining sector and climate resilient, sustainable mining practices (e.g. research on climate impacts, alternative sources of freshwater, appropriate reforestation systems and closed circuit mining)	**M1, M2, M3, M6, M7, M13**	**…**	S	MNR, GGMC
2-M	Conduct high level analysis on past climate impacts on Guyana's mining sector (small, medium and large scale) and modelling of future risks (e.g. impacts on infrastructure, operations, labour, etc.)	**M1, M2, M3, M4, M6, M7, M9, M10, M11, M12, M13, M14**	**…**	S	MNR, GGMC, Ministry of Public Infrastructure
3-M	Establish digital inventory of EIA findings (when they can be shared) and necessary data sharing mechanisms/platforms (e.g. MOU)	**M2, M12, M13**	*****	N	MNR, EPA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					

4-M	Develop and implement education and awareness raising programmes to promote climate resilient and sustainable mining practices once understood	**M2, M3, M6, M7, M11, M14**	∇	S	GGMC, GWMA, GGDMA, GMSTC, EPA
5-M	Train relevant regulatory agencies in satellite imagery interpretation of mining operations to enable better monitoring and enforcement	**M14**	*	N	GGMC, GGDMA, EPA
6-M	Build institutional capacity among mining organisations to deal with environmental pollution and climate change impacts	**M3, M5**			GGMC, EPA, MOH
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
7-M	Amend and implement mining regulations to ensure implementation of labour laws and allow for the sustainable use of forest resources and prevent forest degradation	**M12, M14**	*	N	MNR, GGMC
8-M	Develop guidance to integrate climate resilience considerations into Environmental Impact Assessments or environmental plans when building new mining infrastructure (e.g. tail-end dam)	**M1, M3, M5, M6, M8, M13**	*	N	MNR, EPA
9-M	Review and update Mining School curriculum to include climate change considerations in relevant modules for miners to understand and better manage risks	**M2, M3, M6, M7, M9, M10, M12, M14**	… *	S	GMSTC, GGMC,
10-M	Review and amend labour laws to adequately address mining sector employers' and employees' health risks associated with climate related vector and water borne diseases	**M10**	*	N	Ministry of Human Services and Labour
11-M	Review and amend mining legislation to address risk associated with climate change (e.g. increasing reclamation bond/fee)	**M5**	*	N	GGMC, MNR, MOLA
Pillar 4 Actions: Generation and application of technologies					
12-M	Design and implement land reclamation programmes for small, medium and large scale miners, integrating climate resilience	**M2**	∇ …	S	GGMC, GGDMA
13-M	Utilise connection with international governing bodies (e.g. International Council on	**M2, M3, M6, M7, M11,**	*	N	GGMC

	Mining and Metals, ICMM) and regional organisations (e.g. Instituto Latinamericano del Fierro y del Acero, ILAFA) to share best practice on the most appropriate climate-resilient technologies for the Guyana mining context	**M12, M13**			
14-M	Encourage mining operators to invest and adopt best practice (e.g. water efficient processing equipment, wastewater management processing equipment, geotechnical / engineering solutions), based on research of appropriate climate-resilient technologies	**M2, M3, M6, M7, M11**	*	N	GGMC
15-M	Implement healthcare measures to protect the mining workforce from infectious and vector-borne diseases (e.g. treated bed nets to prevent malaria and spraying programmes to prevent malaria, dengue and chikungunya as well as other health hazards such as pit failure, mercury poisoning and water borne diseases.	**M5, M6, M8, M9, M10, M14**	∇ …	N, S, L	VCU of MoH MOLG, health centres, MOIA
Pillar 5 Actions: Financing instruments					
16-M	Identify and access sources of sustainable financing for research and capacity building programmes (e.g. Mercury Free Mining Fund) along with training in sustainable mining practices for small and medium scale miners	**M2, M3, M4, M5, M6, M7, M8, M9, M10, M12, M14**	… *	N	MNR, GGDMA, GGMC

Sea and River Defence Infrastructure

A: Current situation
Socio-economic importance
• **Guyana has a low-lying coastline of approximately 459 km. The majority of Guyana's coastal zone is below sea level and relies largely on engineered (seawalls and rip raps) and natural (mangroves) sea defence structures to protect the coast from the Atlantic Ocean.** • **The system of sea defences measures approximately 340 km and covers about 80% of Guyana's coastline. Guyana's sea defence system consists of hard (e.g. concrete sea walls) and soft engineering structures (also called managed realignment, e.g. mangroves). Mangroves function as natural breakwaters along the coast and represent a very important natural sea defence for Guyana.** • **About 90% of the population and important economic activities, as well as major infrastructure, are located within the coastal zone. Major economic sectors primarily located in the coastal zone include agriculture, fisheries, health, energy, forestry and tourism; any impact to the coast land would significantly impact Guyana's GDP.** • **The country's population is concentrated in Georgetown, located on a 14 –20 km estuary of the Demerara River. As the coastal area is vulnerable to sea level rise and flooding, sea and river defence infrastructure is critical for the protection of both the economy and society.**
Climate vulnerability profile
• **Guyana's sea and river defence infrastructure systems are highly vulnerable to climate change; about 45% of the coastline is currently subject to erosion. A number of characteristics increase the sensitivity and exposure of these systems, including a dependence on large fixed assets and the ecosystem services provided by mangroves, concentration of infrastructure along the coast, and inadequate existing infrastructure.** • **The sector is dependent on, and composed of, large fixed assets in the form of sea walls, dams and drainage infrastructure, which are sensitive to the impacts of climate change due to their long life times. As much of this infrastructure is, naturally, concentrated along the coast, exposure to sea level rise is heightened. There is also a high dependence on the ecosystem services provided by mangroves, which offer natural protection from rising sea levels and flooding. Mangroves are highly vulnerable to climate change, in particular sea level rise, which could destroy or damage them. This further increases the sensitivity of sea defence systems. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s.** • **Exposure to flooding is also linked to heavy rainfall events and overtopping of drainage and irrigation systems. Neglect of essential maintenance to the drainage and irrigation infrastructure over the past few decades has resulted in much of the system not operating at full capacity, and some sections being completely inoperable. For example, the 2005 floods, a result of heavy rainfall, were exacerbated by overtopping of the EDWC. Also, in early June 2015, several days of heavy rainfall resulted in extensive flooding in Georgetown and surrounding areas. The city's drainage system depends mainly on 13 sluices, of which 10 were fully functional in early June, 2015. Pumps are used to drain water off the land when the sluice gates are closed. Future rainfall projections are likely to create further challenges for Guyana's coastal drainage systems. Trends in annual rainfall are uncertain**

across a range of climate models, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, there is a higher level of agreement that the proportion of heavy rainfall events may increase, particularly during the wet season of November, December and January and in the dry season of February, March and April.

- **Much of the country's sea defence structures are currently inadequate, which increase their vulnerability to climate change. Despite the significant investments to rehabilitate sections of Guyana's sea defence system, a 2014 survey17 showed that 2.28 km (1%) is in critical condition, 20.53km (9%) is poor and 80.22km (34.4%) is in fair condition. Regions 2, 4 and 6 have the weakest points in the line of defence. A 1 meter rise in sea level is expected to increase the risk of inundation across all administrative regions; however, Regions 4 and 6 have the highest expected exposure.**

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for sea and river defence.
The climate risks identified for sea and river defence infrastructure are clustered towards the higher magnitude end of the scale; two thirds of the risks identified were deemed "serious", with the remainder viewed as high magnitude. The risks of highest concern relate to sea level rise and increase in storm surge height causing overtopping of the current sea defence infrastructure (risk ref SRD1 and SRD5), damaging drainage and irrigation systems (risk ref SRD4) and increasing coastal erosion and sediment movements (risk ref SRD2) and destroying mangroves, which currently offer natural coastal protection (risk ref SRD3). All these risks are serious and they threaten Guyana's socio-economic development objectives.

Risk register for sea and river defence. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
SRD 1	Sea level rise and increase in storm surges causes overtopping of current sea defence infrastructures with the consequence that widespread flooding will occur	Yes	Almost Certain	Major impact	Serious
SRD 2	Sea level rise and increase in storm surges causes changes in water velocity and currents with the consequence of increased rate of movement of mud-bands and the erosion-accretion cycle	Yes	Almost certain	Major impact	Serious
SRD 3	Sea level rise causes destruction of mangroves and associated subsidence / erosion with the consequence that	Yes	Likely	Major impact	Serious

[17] The survey covered 91.2% of the total length of sea defence structures.

	the coastal sea defence system is threatened				
SRD 4	Sea level rise and increase in storm surge causes stress to aging sea defence infrastructure and drainage and irrigation systems with the consequence that socioeconomic development objectives are compromised	Yes	Likely	Major impact	Serious
SRD 5	Increase in storm surge height causes coastal flooding and erosion with the consequence that coastal infrastructure is damaged or destroyed	Yes	Likely	Major impact	Serious
SRD 6	Increase in extreme rainfall events causes flooding with the consequence that critical infrastructure (e.g. telecommunications, transport, energy, water, sewerage) is threatened	Yes	Moderate	Moderate impact	High
SRD 7	Increase in extreme rainfall events causes flooding due to additional stress on inadequate coastal drainage infrastructure with the consequence that socioeconomic development objectives are compromised	Yes	Moderate	Major impact	High

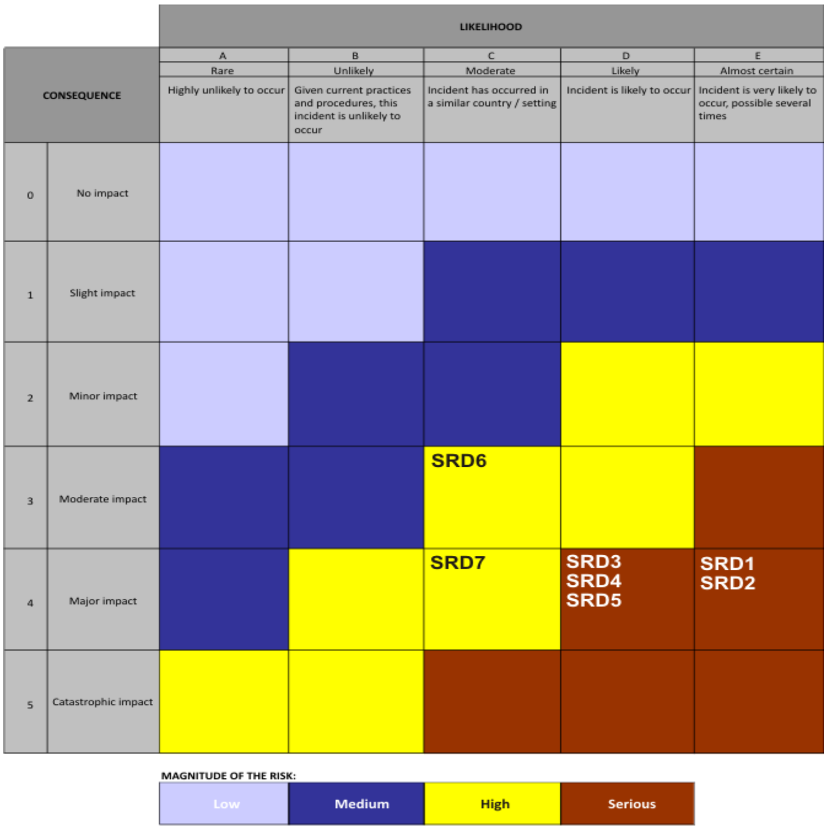

Figure 3.12: Risk matrix for the sea and river defence infrastructure.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for sea and river defence infrastructure have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Time: < 3 months (recovery time) Cost: <US$ 1,000/ m Resources: monitoring staff e.g. rangers, technical staff Losses: little to none <10%	Time: 3 months - 1year (recovery time) Cost: US$ 1,000 – 2,500/ m Resources: minimal trained professionals, trained labourers Losses: damage to property (10-20%)	Time: 1- 2years (recovery time) Cost: US$ 2500–3500/ m Resources: minimal expert staff & trained professionals, skilled labourers Losses: damage to property, disruption of livelihood, economic setbacks (social, economic, environmental) 20-40%	Time: 2- 5years (recovery time) Cost: US$ 3500 – 5000/ m Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, infrastructure, industry, agriculture (social, economic, environmental) 40-60%	Time: 2- 5years (recovery time) Cost: US$ 3500 – 5000/ m Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, infrastructure, industry, agriculture (social, economic, environmental) 40-60%

B: Future vision

Recommended Sectoral Objectives

- **Improve knowledge of flood exposure and vulnerable locations to inform investment in sea and river defences**
- **Use climate change information to inform land use planning and infrastructure developments consider the impacts of climate change**
- **Improve understanding of the benefits and challenges of managed retreat**

- **Improve the coordination/collaboration for sharing knowledge between local and regional governmental organisations whose mandates are similar to Guyana's. (i.e. countries that face similar risks with regards to sea level rise)**
- **Increase the institutional capacity to monitor and evaluate climatic impacts with a link to the design of projects through improved technologies and data collection**
- **Improve effectiveness of the policy framework associated with sea and river defence, with a workable link between development and implementation**
- **Foster cooperation between private and public sector entities and funding with key emphasis on the varying climatic conditions**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (∇), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-S	Inspect, monitor and collect data on environmental conditions and structural response at greater frequency	**SRD1 – SRD7**	∇ …	N	<u>MOPW,</u>MoA, MoLG
2-S	Update early warning systems to improve monitoring and implementation, for example, integrating an electronic monitoring for river and sea defence gate opening/closure and alert system	**SRD1 – SRD7**	*	N	<u>MOPW,</u>CDC, Hydromet
3-S	Ensure that early warning systems utilize CIMH 3 months forecasts and transboundary information (e.g. from Brazil) and long-term climate change projections	**SRD1 – SRD7**	*	N	MOPW,CDC, Hydromet
4-S	Conduct hazard and vulnerability mapping nationally to identify and prioritise coastal areas that are most vulnerable to the impacts of climate change, particularly flooding	**SRD1 – SRD7**	∇	N	MOPW,GL&SC , MOA
5-S	Conduct feasibility studies on the potential for planned gradual retreat; relocation of key sectors and infrastructure (e.g. roads, energy) away from the coast to less vulnerable areas and to attract people to move inland,	**SRD1, SRD3, SRD4, SRD5, SRD6, SRD7**	∇ *	N	MOPW,MOA, MOLG, MOH, GL&SC, GT&T, GPL, GWI, MOF, GFC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
6-S	Develop a widespread educational awareness program	**SRD1 – SRD7**	∇ *	N	<u>MOPW,</u>MoA, EPA, MoF

	on the importance of monitoring and evaluation for adaptation				
7-S	Train local community members in skills required for monitoring and evaluation and reporting	**SRD1 – SRD7**	*	L	MOPW, MoA, MoLG
8-S	Develop and implement capacity building program to undertake climate-related research, feasibility studies, vulnerability/hazard and risk assessments	**SRD1 – SRD7**	*	N, S, L	MOPW,UoG
9-S	Provide training and support to the MOA and MOPW to help them integrate climate resilience into all development projects. This could be through the use of the Caribbean Climate Online Risk and Adaptation TooL (CCORAL) and other relevant tools	**SRD1, SRD3, SRD4, SRD5, SRD6, SRD7**	*	N	CCCCC, UoG
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
10-S	Develop a Public Investment Plan that will provide a single guide and reference to rural infrastructure investment in Guyana over the next 10 years, and building on the Agricultural Support Services Programme, Agricultural Export Diversification Programme and Sea Defence Rehabilitation. This will make public investment in the sector more stable and sustainable	**SRD1, SRD3, SRD4, SRD5, SRD6, SRD7**	*	N	MOPW, MOLG, D & I, MOAA
11-S	Revise Sea Defence Act (Chapter 64:02) to take into account climate change considerations	**SRD1 – SRD7**	*	N	MOPW,EPA, MOLG, GFC, DECC, Attorney General's Chambers
12-S	Review and re-formulate land-use planning policies to address the location of infrastructure, housing schemes, agricultural development schemes and other land uses such as commercial and industrial, to reduce risk of inundation deriving from sea-level rise and storm surges, and to strengthen resilience	**SRD1, SRD3, SRD4, SRD5, SRD6, SRD7**	∇ … *	N	MOLG, MOPW,MOA, GL&SC
13-S	Integrate climate change adaptation measures into the	**SRD1, SRD3,**	∇ …	N	MOPW,MOA, GFC, MOLG,

	integrated coastal zone management plans (ICZM) and urban planning; developing new building codes that include risk assessment; implementing of an emergency response plan and upgrading early warning systems	**SRD4, SRD5, SRD6, SRD7**			MoLG, GL&SC, CDC, EPA
14-S	Develop Coastal Zone Management System to monitor and create an inventory of coastal resources to determine risk, and monitor development in the vulnerable coastal plain	**SRD1 – SRD7**	∇	N	<u>MOPW,</u>MOA, GFC, MOLG, MoLG, GL&SC
15-S	Develop appropriate policy and legislation for the enforcement of setbacks in vulnerable areas, limiting/prohibiting buildings and other major developmental work in vulnerable coastal areas and encouraging gradual retreat to higher grounds	**SRD1 – SRD7**	∇ **…**	N	MOPW,MOA, MOLG, GL&SC
16-S	Based on feasibility study in action 5-S, consider planned gradual retreat to higher grounds by making land available in the interior and planning for resettlement of inhabitants	**SRD1 – SRD7**	*****	N	MOPW,MOA, MOLG, Health, MoLG, GL&SC, GT&T, GPL, GWI, MOF, GFC
17-S	Mainstream climate change into due diligence, feasibility studies, financing, EIAs and design specifications (terms of reference and budgets) for infrastructure projects	**SRD1, SRD4, SRD5, SRD6, SRD7**	*****	N	<u>MOPW</u>
Pillar 4 Actions: Generation and application of technologies					
18-S	Construct, maintain and reinforce sea defence and water infrastructure, informed by climate impact studies. This may include increased use of dykes, levees and flood walls/flood gates and tidal barriers, as well as reinforcement/retrofitting of sea wall, revetments and bulkheads	**SRD1, SRD2, SRD4, SRD5, SRD7**	∇ **…** *****	N	<u>MOPW,</u>D & I
19-S	Reconstruct and retrofit approximately forty (40) km of the most critical sea and river defences in coastal regions	**SRD1, SRD4, SRD5, SRD7**	∇ **…**	N	<u>MOPW</u>
20-S	Expand mangrove beds (natural sea defence) which not only stabilises the coastlines but also	**SRD1 – SRD7**	∇ **…** *****	N	MOPW,<u>MOA</u>

	provides protection for the sea wall				
21-S	Relocate critical infrastructure to less vulnerable areas, away from the coast	**SRD1, SRD4, SRD5, SRD6, SRD7**	*****	N	MOPW, MOA, MOLG, MOH, MoLG, GL&SC, GT&T, GPL, GWI, MOF, GFC
22-S	Integrate and implement early warning systems	**SRD1 – SRD7**	∇ **…**	N, S, L	CDC, Media, Hydromet, R&SD, CIMH
Pillar 5 Actions: Financing instruments					
23-S	Secure adequate financing for adaptation works and permanent financing for adequate maintenance	**SRD1 – SRD7**	∇	N	MOF

Tourism

A: Current situation
Socio-economic importance
• Tourism, an important economic activity in Guyana, is centred mainly on ecotourism in the hinterland area. Activities include horse riding, hunting, fishing, swimming, sport fishing, yachting and bird-watching. While most ecotourism activities take place in the hinterland, most of the tourism infrastructure is located in the coastal zone. • On average, the total contribution of travel and tourism to GDP was 7.6%. • In the same year, the sector directly supported 8,000 jobs (3.3% of total employment). If jobs indirectly supported by the industry are included, then the contribution to employment was 19,000 (8% of total employment).
Climate vulnerability profile
• With its close connections to the environment and climate itself, tourism is considered to be a highly climate-sensitive industry. Due to the fact that the tourism industry is heavily dependent on environmental conditions and quality, a wide-range of climate-induced environmental changes will have significant effects on tourism at the local and national destination level. • The concentration of tourism infrastructure (e.g. airports, ports, hotels) along the coast increases the exposure of the sector to sea level- and storm surge-related flood damage. Stakeholders commented that tourists frequent the sea walls, some of which are already in a poor state of repair and will be further impacted by coastal erosion and inundation. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s. • The tourism sector is also vulnerable to flooding from rainfall, which can cause damage to tourism infrastructure along the coast and in the hinterland (e.g. washing out roads), making it difficult to access tourist activities (e.g. eco-tourism). For example, in May 2015 sections of the Linden-Lethem road were washed away due to heavy rainfall, causing two major culverts to break and leaving travellers stranded. Planks were temporarily installed across gaps to allow smaller vehicles to cross; however these were reported to have been safe only if there was no rainfall • Eco-tourism activities are vulnerable to climate-driven changes in ecosystems and biodiversity. Stakeholders commented that this is particularly true for areas such as the Rupununi Region, which is identified as a pristine eco-tourist destination, where any changes in weather and climate would have detrimental impacts. For instance, migration of birds from popular nesting areas (e.g. Mahaicony River, Abary Areas, and Victoria) will impact tourism activities in these locations. Species are also sensitive to wildfires, potentially leading them to migrate from Guyana's savannahs into neighbouring countries. • Water is a critical system for tourism, as it supports a number of tourism-related activities, such as cleaning, consumption, landscaping and irrigation at resorts and for water-based sports. Water resources are sensitive to changes in temperature, rainfall and saltwater intrusion. Two main aquifers provide drinking water on the coastal plain and salt-water intrusion has already been observed. Saltwater intrusion is likely to be caused by both natural and human-induced processes (e.g. over-abstraction), however the dynamics between water systems, hydrology and the climate remain largely under-analysed. Sea

level rise is likely to only aggravate the situation. Drought periods also affect water supplies with knock-on effects for tourism; in May 2015, Regions 1 and 9 were affected by drought, causing lakes and rivers to dry up, leading to a higher cost of water which had to be transported from greater distances.

- People are critical for the functioning of the tourism industry, which is hospitality-based and requires significant face-to-face interaction. Climate change will affect the health of people employed in the tourism sector and tourists visiting Guyana, through exposure to temperature extremes and flood-related hazards, for example. The frequency of days and nights that are currently considered 'hot' are projected to increase substantially in all climate scenarios. Annual projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s. Heat-related health impacts may have a particularly strong effect on the tourism industry given that tourists are likely to be engaged in more outdoor activities, and hotter temperatures will not only make these activities uncomfortable, but also lead to higher demand for air conditioning, resulting in higher costs. Furthermore, if temperatures become too hot, visitors may find it too uncomfortable and choose to visit other destinations. Mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s. The largest increases in temperature are projected for the southern portion of the country.
- The capacity of the sector to deal with climate impacts is affected by a number of informational, financial and policy barriers. On the positive side, institutional capacity within the sector to deal with the impacts of climate change is viewed as moderately high, through capacity building programmes within MOT, THAG, GTA and tour operators.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the tourism sector.

Only a small number of risks were identified for the tourism sector. The highest magnitude risk relates to the damage sea level rise may have on tourism assets (e.g. national landmarks, beaches, coastal ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) (risk ref TO1). In addition to the detrimental impacts from environmental degradation, tourism-related revenue may also decrease.

Risk register for the tourism sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
TO1	Sea level rise causes coastal flooding and erosion with the consequence that tourism assets (e.g. national landmarks, beaches, coastal and interior ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) are damaged, there is an increased incidence of illness due to water and	Yes	Likely	Major impact	High

	vector-borne diseases, and tourism-related revenue decreases				
TO2	Increased rainfall causes flooding with the consequence that tourism assets (e.g. national landmarks, beaches, coastal ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) are damaged and tourism-related revenue decreases	Yes	Likely	Major impact	High
TO3	Decreased rainfall causes drought, with the consequence that tourism in areas such as the Rupununi is negatively impacted and revenue is lost.	Yes	Likely	Major impact	High
TO4	Incremental climate change causes migration of wildlife to more favourable habitats with the consequence that the wildlife-related tourism is negatively impacted and revenue is lost	Yes	Moderate	Moderate impact	High
TO5	Increasingly unpredictable weather patterns cause detrimental impacts on natural resources with the consequence that community-based tourism ventures are affected	Yes	Likely	Moderate impact	High
TO6	Extreme events causes negative impacts on wildlife and biodiversity with the consequence that the wildlife-related tourism is negatively impacted and revenue is lost	Yes	Unlikely	Minor impact	Medium

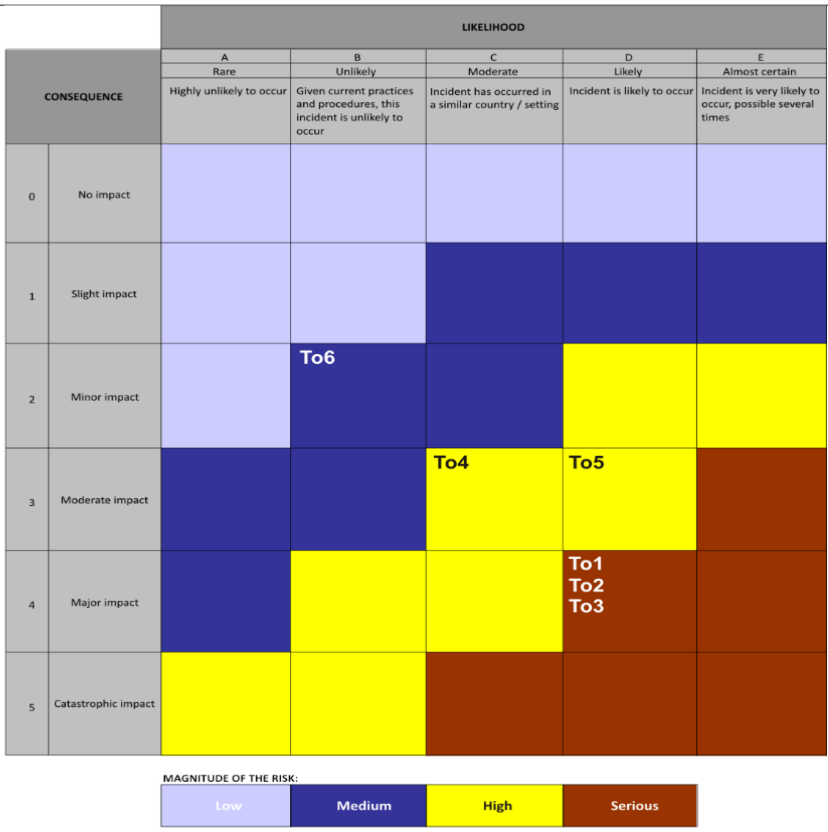

Figure 2: Risk matrix for the tourism sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the tourism sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Limited to affecting profits on a low scale Scarcely affects overall GDP 0.5 to 1.0 % reduction in average tourist arrivals Very low recording of animal migration	Reduction in tourist arrival between 1.5 – 3.0% 1.0% reduction I GDP	4 to 10 % reduction in tourist arrivals 1.5 to 4% reduction in GDP High level of pollution of livelihood, economic setbacks (social, economic, environmental) 20-40%	Reduction of 11 to 20% average tourist arrivals 5 to 9% reduction in GDP Reduced commercial activities Significant resource depletion in tourist destinations Widespread animal migration (social, economic, environmental) 40-60%	Low investment operations Loss of interest in the tourism sector (school systems) High rate of animal migration High incidence of resource depletion 50% decrease in marine and aquatic life forms More than 10% decrease in GDP More than 20% reduction in tourist arrivals

B: Future vision
Recommended Sectoral Objectives
• **Provide tourism businesses with the skills, training, knowledge and tools to understand and manage climate change risks** • **Foster coordination among governing bodies and relevant stakeholders within the tourism industry; to contribute information that will support the development of climate resilience strategies** • **Encourage the development of eco-sensitive ecotourism that has at its core the conservation of the natural resource endowment of Guyana** • **Develop, implement and enforce law, policy and regulation to integrate climate resilience into tourism operations**

Climate resilience actions proposed in Guyana

Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-To	Develop, implement and institutionalise a research and knowledge management	**TO1 – TO5**	*	N, S, L	GTA, DECC Tourism stakeholders

	programme through national institutions to address identified climate change vulnerability and resilience issues affecting the tourism sector				
2-To	Conduct analysis on past and current impacts of climate on tourism, including economic impacts, with specific reference to particular locations/ geographies within Guyana. Assess existing best practices in response to climate impacts	**TO2, TO3, TO4, TO5**	∇	N, S, L	MOT, GTA, Bureau of Statistics, DECC
3-To	Assess the economic implications of climate change on the tourism sector, particularly eco-tourism, with specific reference to particular locations/geographies within Guyana	**TO1 – TO5**	*	N	MOT, GTA, DECC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-To	Develop and implement awareness raising programme within the tourism sector at local and national levels on the implications of climate change	**TO1 – TO5**	∇	N	MOT, GTA, DECC,
5-To	Engage communities dependent on eco-tourism (such as forest based communities) on effective management of a variable and changing climate, including climate resilient development in community level decision making	**TO1 – TO5**	*	L	GTA, MOT, village councils
6-To	Provide training to tourism aspirants, through schools, universities, training institutes (e.g. Bina Hill Institute), and through work attachments, on the impacts of climate change and how to manage them. This should involve conducting relevant curriculum audits and identification of entry points for infusion of climate change information, and provision of relevant training for teachers who deliver the curriculum.	**TO1 – TO5**	*	N	MOT, MOE
7-To	Engage with private sector actors on the impacts of climate change and how to manage them	**TO1-TO5**	∇ *	N, S, L	THAG, Chamber of Commerce

Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
8-To	Amend tourism policy and legislation to include requirements for actors in the tourist industry to develop effective planning for climate resilience (e.g. the Accommodation Act, Lodges and Resorts Act)	**TO1 – TO5**	∇	N, S, L	MoLA, MOT, GTA, MOF, DECC
9-To	Develop guidelines for hotels, mostly located in the vulnerable coastal zone, including evacuation plans, insurance coverage, staff training, first aid kits, food and water storage and early warning systems	**TO1 – TO5**	∇	N, S, L	MOT, GTA, MOH, NIS, CDC
10-To	Develop a risk management strategy to address issues experienced by tourism businesses as a result of climate change (e.g. coastal flooding and soil erosion, increase in energy demand)	**TO1 – TO5**	*	N, S, L	MOT, GTA, CDC, MOPW
Pillar 4 Actions: Generation and application of technologies					
11-To	Support introduction of technologies for appropriate tourism establishments (e.g. hotels, resorts) to adapt to the impacts of climate change, for example water-efficient technologies (e.g. low-flush toilets, water-efficient taps, rainwater harvesting, drip irrigation systems), or energy-efficient technologies (e.g. energy-efficient appliances, smart lighting in hotels). Use of incentives (informational, capacity building) should be explored.	**TO3, TO5**	* ∇ …	N, S, L	MOT, GTA
Pillar 5 Actions: Financing instruments					
12-To	Source financing for research (e.g. to conduct feasibility studies), awareness raising and capacity building programmes	**TO1 – TO5**	∇	N, S, L	MOT, GTA, MOF, DECC
13-To	Identify and provide incentives for tourism businesses that support green tourism (e.g. encouraging the use of solar panels, sustainable waste management to avoid burning)	**TO1 – TO5**	…	N	MOT, GEA, Go-Invest

Trade

A: Current situation
Socio-economic importance
• **As a result of the small size of its internal market and historical patterns of development, Guyana is highly dependent on international trade as an engine of economic growth. It is also dependent on trade taxes as a source of government revenue.** • **Guyana's main export is gold, which accounted for 40.5% of exports in 2014, followed by rice and paddy, which accounted for 20.4%, bauxite, which accounted for 11.8% and sugar, which accounted for 5.9%. Timber, shrimp and prawns, fish and by-product, prepared foods, bottled rum and spirit and diamonds also constituted exports of importance.** • **As seen above, much of Guyana's exports are agricultural, for example sugar, which has primarily been exported to the European Union.**
Climate vulnerability profile
• **The trade sector is intrinsically linked to a number of other sectors, including agriculture, mining and transport. As a result, climate vulnerabilities in these sectors have the potential to impact trade and export earnings.** • **Much of Guyana's exports are related to the agricultural sector (e.g. sugar), which is extremely vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions and plant development and animal health. Any negative impacts of climate variability and change on agriculture will reverberate through economies where agriculture is a major contributor to total GDP.** • **Trade is highly dependent on functioning transport systems in order to move goods from Guyana to their international destinations and vice versa. Transportation hubs, such as ports and airports, as well as the transportation networks such as shipping routes, air routes and road and rail networks are vulnerable to weather-related disruption. For example, in May 2015, heavy rains washed out sections of the Linden-Lethem road, which is a critical connection between Guyana and Brazil; such events can restrict trade between the two countries. When transport disruptions occur, many supply chains break-down and take a long time to recover, with significant costs to individual businesses and the wider economy.** • **The clustering of transport infrastructure along Guyana's coast provides significant economic benefits to the national economy. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s.** • **Climate projections suggest that the proportion of rainfall occurring in heavy events may increase (although the trend is weak), particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April.** • **The capacity of the trade sector to adapt to the impacts of climate change was assessed by stakeholders as moderate.**
Climate risks and opportunities
The vulnerability profile described above creates a number of climate change risks for the trade sector.

Only a small number of risks were identified for the trade sector. The highest magnitude risks relate to climate impacts on the agricultural and mining sectors and the detrimental consequences this may have on export earnings, from sugar cane for example (risk ref T1) and gold (risk ref T2).

Risk register for the trade sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
T1	Increase in extreme rainfall events causes riverine flooding with the consequence that wharves and stellings that provide coastal and inland linkages, are damaged and riverine transportation is disrupted, with detrimental impacts for trade and industry	No	Moderate	Major impact	High
T2	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that ports are damaged or operations are disrupted, with detrimental impacts for trade and industry	Yes	Likely	Moderate impact	High
T3	Incremental climate change and extreme events causes a decrease in average agricultural production with the consequence that foreign exports decrease (e.g. sugar cane and rice) and revenue is lost	Yes	Moderate	Moderate impact	High
T4	Incremental climate change and extreme events causes drought and drying up of rivers (where gold is mined) with the consequence that rivers are no longer navigable (for transport of equipment) and gold export earnings decrease	Yes	Moderate	Moderate impact	High
T5	Incremental climate change and extreme events causes changes in biodiversity and natural forest habitats of wild birds with the consequence that foreign exports decrease and revenue is lost	Yes	Moderate	Slight impact	Medium

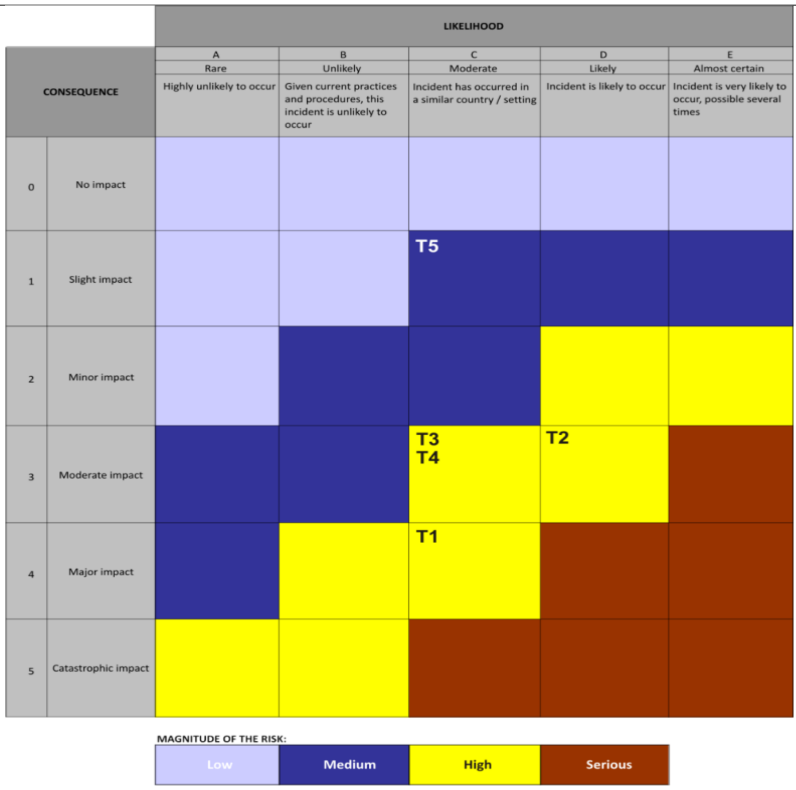

Figure 3.14: Risk matrix for the trade sector.

Likelihood scoring criteria. Based on feedback from the DECC, qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the trade sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Decrease of GDP by less than 0.2%	Decrease of GDP by more than 0.2% but less than 0.5%	Decrease of GDP by more than 0.5% but not exceeding 1%	Decrease of GDP by more than 1% but not exceeding 5%	Decrease of GDP by more than 5%

B: Future vision

Recommended Sectoral Objectives

- **Improve knowledge of how climate variability and change affect Guyanese trade (imports, exports and domestic trade) and what adaptation options are available**
- **Provide mechanisms to protect Guyanese businesses from climate variability and change, particularly supply chain disruption due to extreme weather events**
- **Introduce measures that encourage climate resilient technologies to be delivered through the market, which may include the provision of incentives for business**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-Tr	Undertake a climate vulnerability and risk assessment to understand climate impacts on significant current and future contributors to the Guyanese economy, including an assessment of impacts on future imports and exports	**T1 – T5**	▽	N, S, L	MOA, MNR
2-Tr	Undertake research on the climate/ disaster vulnerability of transport networks in Guyana to identify highly vulnerable locations, which may affect trade routes. Make recommendations on which transport assets should be made more resilient as a priority	**T1 – T5**	▽ …	N	CDC, MOPW,EPA, DECC
3-Tr	Identify and scope additional markets for exports, especially crops; explore trade diversification	**T1-T4**	▽ *	N, S	MOAA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-Tr	Promote education and social learning on climate change for private sector actors, including on successful case studies and maladaptation	**T1 – T5**	▽	N, S, L	MOA, MNR
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
5-Tr	Develop an enabling environment for climate resilient technology transfer (e.g. removal of technical, legal and administrative barriers; design of sound economic policy;	**T1 – T5**	▽	N, S, L	MOA, MNR

	regulatory frameworks and transparency)				
T6-Tr	Strengthen Guyana's trade diversification programme to diversify production and export base, reducing reliance on climate-sensitive commodities	**T1 – T4**	∇	N	Ministry of Foreign Affairs
Pillar 4 Actions: Generation and application of technologies					
7-Tr	Upgrade coastal and hinterland airstrips (e.g. in Oglem Hampton Court, Lethem, Skeldon, Blairmont) to enhance preparedness for emergencies and reduce their vulnerability to floods (e.g. through equipping with supplies in case of emergency, raising above flood height)	**T1 – T4**	*	N, S	MOPW
8-Tr	In areas prone to flooding/drought, organise a fleet of boats/planes to transport food and critical supplies in times of emergency	**T1 – T4**	*	N, S, L	MOPW, MOB
Pillar 5 Actions: Financing instruments					
9-Tr	Develop affordable credit and finance mechanisms to enable businesses to secure funding for resilience-building. Mechanisms will be required for all businesses from the sole trader (e.g. microfinance and credit unions) to large companies	**T1 – T5**	∇	N, S, L	GRA, MOF, Commercial Banks, NGOs
10-Tr	Examine whether appropriate insurance opportunities are available for Guyanese businesses to protect them from losses and interruptions arising from climate variability and change. Develop and support appropriate opportunities where there are gaps	**T1 – T5**	∇	N, S, L	MOA, MNR
11-Tr	Develop financial and fiscal measures to incentivise investment in goods and services (including new technologies and manufacturing processes/ equipment) that will assist in building resilience to existing climate vulnerability and climate change. Technologies could include renewable energy	**T1 – T5**	∇	N, S, L	GRA, EPA, Ministry of the Presidency, MOA, Go-Invest

	systems, water treatment and sewage treatment plants				
12-Tr	Promote and provide financial support to business start-ups that deliver climate resilient solutions, such as renewable energy systems, water-efficient technologies etc.	**T1 – T5**	∇	N, S, L	Ministry of the Presidency

Transport

A: Current situation
Socio-economic importance
• **Guyana's transport system consists of road, marine and air transport. On average, the sector "transport and storage" contributed 6.7% of GDP.** • **Guyana has a 3995 km road network, which serves a national fleet of more than 80,000 vehicles.** • **The public transport system is dominated by privately-owned mini-buses in urban areas, and these connect urban centres with rural areas. Mass transport systems in Guyana are poor; barriers toward enhancing the system include limited integrated land use planning, cost-effectiveness issues due to a limited population to serve and commuter preferences for private cars. New public transport systems will require expanded roadway capacity, modern terminals and roadside infrastructure such as and parking bays and bus stops, and developing such infrastructure will require significant investment.** • **The main port of Georgetown is located at the mouth of the Demerara River and other water transport infrastructure is located along the banks of the navigable rivers, namely, the Essequibo, Demerara and Berbice. In addition to the wharves and stellings that provide coastal and inland linkages, there are facilities that handle both the country's overseas and local shipping requirements. Ports, wharves and stellings play an important role in supporting economic activities in the hinterland, since they act as a crucial connection between sea and land transport. They are also an important source of employment.**
Climate vulnerability profile
• **The characteristics of Guyana's transport sector make it vulnerable to climate and weather-related hazards. This stems from the concentration of infrastructure along the coast and rivers, and the inadequate maintenance of roads and bridges.** • **The clustering of infrastructure along the coast provides significant economic benefits to the national economy. However, it also increases the vulnerability of the economy to the impact of climate change, namely sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s.** • **The main port of Georgetown and other maritime infrastructure along the banks of the navigable rivers are vulnerable to sea level rise, storm surge and riverine flooding associated with heavy rainfall events. Stakeholders commented that poorly maintained ports and harbours (wharves) may experience loss of materials as a result of inundation (e.g. decking).**

- **The capacity of the transport sector to adapt to the impacts of climate change was assessed by stakeholders as moderate to high. In terms of information, the sector has been strengthened through numerous donor-funded projects Institutional capacity was assessed as moderately high, with stakeholders acknowledging that the mandate of the NDCs, RDCs, GWI (utilities) include scope for collaboration. The strength of the policy and regulatory environment was assessed as moderately low, with stakeholders commenting that improving the policy framework is a continuous process. Access to finance was viewed as moderate, with stakeholders commenting that financial resources were strong through donor-funded projects. However, minimal finance is allocated to climate resilience in the aviation, river or minor road sectors.**

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the transport sector

All the risks identified for the transport sector have a high or moderate magnitude; no risks have been assigned with a sufficiently high likelihood or consequence to make them a "serious" risk. The highest magnitude risks relate to damage to critical transport infrastructure from flooding, due to overflowing drainage canals and culverts (risk ref TP1), sea level rise and storm surge (risk ref TP3 and TP3), or landslides (risk ref TP2). Conversely, decreases in precipitation may mean that some rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) is no longer accessible (risk ref TP5). Climate-related disruption to ports, wharves, stellings and roads has the potential to have knock-on consequences for trade and industry.

Risk register for the transport sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
TP1	Increase in extreme rainfall events causes flooding, due to overflowing drainage canals with the consequence that critical transport infrastructure (roads, bridges and culverts) are damaged or destroyed, particularly along the coastal lowlands and in the hinterland	Yes	Moderate	Major impact	High
TP2	Increase in extreme rainfall events causes flooding and landslides with the consequence that rural transport networks are damaged or destroyed, and communities and commercial enterprises in the hinterland are cut off	Yes	Moderate	Major impact	High
TP3	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that ports are damaged or operations are	Yes	Likely	Moderate impact	High

	disrupted, with detrimental impacts for trade and industry				
TP4	Increase in extreme rainfall events causes riverine flooding with the consequence that wharves and stellings that provide coastal and inland linkages, are damaged and riverine transportation is disrupted, with detrimental impacts for trade and industry	No	Moderate	Major impact	High
TP5	Decrease in mean annual rainfall causes lower river levels with the consequence that rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) are no longer accessible, with detrimental impacts for trade and industry	Yes	Moderate	Major impact	High
TP6	Increase in number of extreme 'hot days' causes paved (tarmac) airport runways to melt / bleed with the consequence that airport operations are impacted and maintenance costs increase	Yes	Unlikely	Major impact	High
TP7	Increase in mean annual temperature and increase in number of extreme 'hot days' causes aviation equipment to be operating near or above critical temperature thresholds with the consequence that aircraft underperform, affecting maximum weight and fuel consumption, resulting in weight restrictions (especially at airports with short runways) and additional costs	Yes	Unlikely	Major impact	High
TP8	Increase in extreme rainfall events cause surface flooding of airports due to overflowing drainage systems with the consequence that airport operations are disrupted	Yes	Moderate	Moderate impact	High
TP9	Increase in number of extreme 'hot days' causes paved (tarmac) road surfaces to melt / bleed with the consequence that road networks are damaged and maintenance costs increase	Yes	Unlikely	Moderate impact	Medium

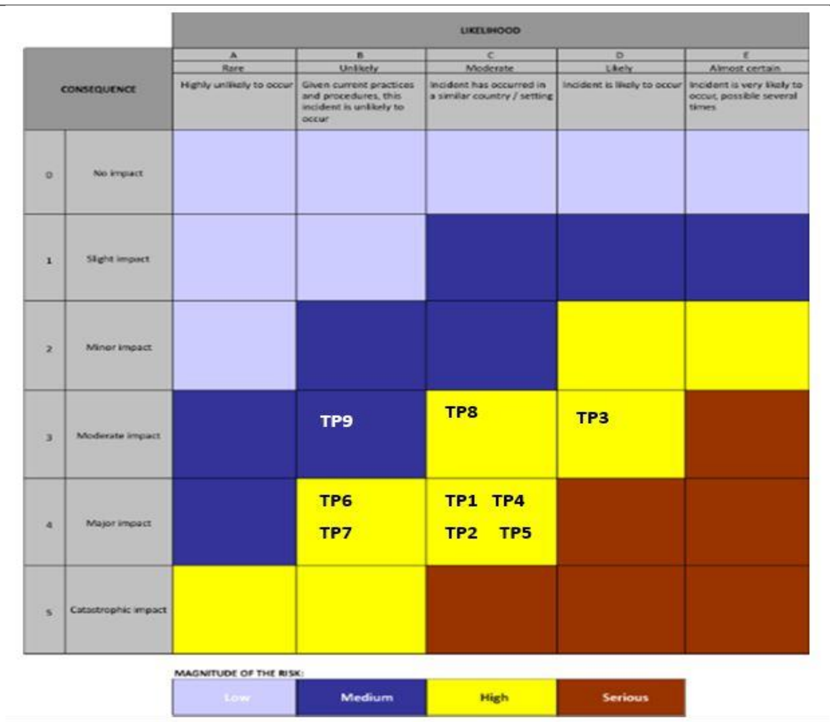

Figure 3.15: Risk matrix for the transport sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the transport sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Time: < 6 months (recovery time) Cost: US$ 100,000 Resources: minimal trained professionals, trained labourers Losses: time, little to none.	Time: 6 months - 1year (recovery time) Cost: US$ 100,000 – 250,000 Resources: minimal trained professionals, trained labourers Losses: time (delays)	Time: 1- 2years (recovery time) Cost: US$ 250,000 – 500,000 Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: Life, property, time	Time: 2- 5years (recovery time) Cost: US$ 500,000 – 1 M Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, time, additional budgetary allocations	Time: > 5years (recovery time) Cost: US$ 10,000/m (US$1M/km) Resources: expert staff, trained professionals, skilled/trained labourers Losses: Life, property, inaccessible area, damage to collector, feeder and main NADSC pavement layer-material strength, time, GDP

B: Future vision
Recommended Sectoral Objectives
• **Improve the coordination and collaboration between local, regional and international bodies and to implement changes in the design of transport systems** • **Improve the effectiveness of the transport division's policy framework, with a workable link between development and implementation** • **Foster international cooperation and funding (from private and public sector entities) with a key emphasis on climate change** • **Maximise the available funds in the agency's budget allocated to capacity building of personnel with emphasis on climate change resilience, adoption of good practice and development of innovative solutions**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-Tp	Undertake research on the climate/ disaster vulnerability of transport networks in Guyana to	**ALL**	▽ …	N	CDC, MOPW,EPA, DECC

	identify highly vulnerable locations. Make recommendations on which transport assets (construction materials) should be made more resilient as a priority				
2-Tp	Develop a functional GIS database which captures relevant climatic data with regards to the design of Guyana's land, water and air transport systems	**ALL**	*	N	MOPW
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
3-Tp	Raise awareness of and provide training for relevant Ministry of Public Infrastructure staff and Guyanese engineering firms of the impacts of climate change on the transport sector and how to build climate resilient infrastructure. Use of Caribbean Climate Online Risk and Adaptation TooL (CCORAL) training is one option to consider	**ALL**	∇	N	MOT, GTA, DECC, MOPW,CCCCC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
4-Tp	Integrate a climate resilience component into all transport infrastructure project terms of reference, EIAs and feasibility studies (road, rail, maritime, aviation)	**ALL**	∇ …	N	DECC, MOPW,MoA, MDLE
5-Tp	Integrate climate resilience into next review of transport sector legislation, regulations, codes of practice, quasi-regulatory guidance and policy	**ALL**	∇ …	N	DECC, MOPW,CDC
Pillar 4 Actions: Generation and application of technologies					
6-Tp	Conduct a Technology Needs Assessment (TNA) for all components of the transport sector	**ALL**	*	N, S, L	To be confirmed
Pillar 5 Actions: Financing instruments					
7-Tp	Source funding for capacity building programs on climate change resilience, adoption of good practice and development of innovative solutions	**ALL**	*	N	MOF, MOPW

Water

A: Current situation
Socio-economic importance
• **Water is a crucial resource for virtually all other sectors in Guyana, and conversely, is also affected by activities from many other sectors (e.g. pollution from mining activities, inadequate household waste management). Guyana uses both surface and groundwater resources for agricultural, industrial, and domestic purposes.** • **Surface water resources are abundant across the country, with brackish to saline water on the coast. In the coastal plain, where roughly 90% of the population live, residents depend almost entirely on groundwater supply to meet domestic needs. Georgetown is an exception, as 30% of the water used is surface water from the East Demerara Water Conservancy (EDWC). Water conservancies have two functions: to provide flood regulation and to facilitate irrigation. Changes in population, agricultural demand, land use and sea level rise have stressed the irrigation and drainage canals system. Consequently, continuous maintenance, rehabilitation and upgrading is undertaken.** • **In the hinterlands, a combination of groundwater and surface water extraction with domestic rainfall harvesting is used. Some areas are highly dependent on surface water sources, for instance in Bartica, 100% of the water supply is from surface water, and similarly in Wismar and Linden, the sole water source for the new treatment plant is the Dakoura Creek. As such, all land-based activities (e.g. agriculture, mining) have the potential to affect the water quality of these surface sources.** • **The majority of government investment in water is allocated to agricultural water resources and water supply and sanitation. Significant progress has been made over the past twenty years in achieving access to improved drinking water sources. The sewerage system covers a small proportion of the population, and the rest relies on individual solutions. Improved sanitation coverage was 88% in urban areas, and 82% in rural areas.**
Climate vulnerability profile
• **The vulnerability of Guyana's water sector stems primarily from two climate-related factors; first, extremes in rainfall, with excess rain fall leading to flooding and lack of rainfall leading to water deficit, and second, sea level rise and storm surges leading to flooding. There are also a number of other factors which increase the sensitivity of the water sector and have contributed to the almost seasonal flooding along the coast, including the effectiveness of the drainage and irrigation and sea defence systems, the gradient of the land, and the conditions of the water storage areas.** • **The water sector is sensitive to changes in precipitation, particularly the regular droughts that take place across the country, which show a strong correlation with El Niño conditions. Drought conditions can cause groundwater deficits, as exemplified in late 2014 – early 2015 when a lack of rainfall caused decreased water levels in the wells and other water sources in Region 9 (Upper Takutu-Upper Essequibo) and parts of Region 1 (Barima-Waini). Stakeholders commented that in Regions 5 and 6, hot weather (and less precipitation) had caused water levels to drop and iron content, which clogs and restricts the flow of water, to rise. These impacts are likely to become worse given projections across a range of future climate change scenarios, which indicate decreases in seasonal precipitation (up to 6mm for the 2030s, 17mm for the 2060s and 20mm for the 2090s) and increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there**

is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated. Drought also impacts water in conservancies, especially if they occur during the secondary wet season November to January.

- Coastal populations depend almost wholly on groundwater for domestic supply, with the exception of Georgetown, which uses 30% surface water from the East Demerara Water Conservancy (EDWC). A dense network of drainage and irrigation canals transects the coastal zone and connects to the EDWC, which provides regional agricultural lands and urban areas with irrigation and drinking water. During times of heavy rainfall this system acts as a regional drainage and flood control mechanism. Regular maintenance is crucial to maintain the efficient operation of the drainage system, lack of which can result in the growth of vegetation which impedes flow and increases siltation. The EDWC itself is under considerable stress already. Relief canals (built to stop the EDWC dam from overtopping) are currently operating with limited effectiveness, due to changes in land use (as their use for emergency relief normally floods inhabited lands downstream) and sea level rise. Degradation of the EDWC has been compounded by a number of recent severe weather events, such as the floods of 2004-2005. Overtopping of the dam during these rains has weakened the already vulnerable system, increasing its sensitivity to further sea level rise, storm surge and flooding and threatening water resources in the coastal zone. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s.
- Salt-water intrusion has already been observed in Guyana's groundwater resources, but dynamics between water systems, hydrology and the climate remain under-analysed. Coupled with over-abstraction and inadequate recharge, sea level rise viewed as the main threat to coastal aquifers. Surface water resources are vulnerable to salinization from storm surge and contamination from flood events, leading to reduced water quality and sanitation for populations living in or close to these environments. However, this risk can be easily mitigated through adequate well-head protection. In the interior regions where gold and diamond mining activities have changed and/or inhibited water flows, surface water pollution and salinization is currently a critical issue, which may be further exacerbated in a changing climate.
- The water sector depends on a stable energy supply, which is used for treatment and puMoPWng, among other uses. Energy systems are sensitive to changes in climatic variables, particularly increases in temperature extremes. Guyana's plans to exploit the country's significant hydropower potential are sensitive to changes in precipitation and compounding impacts on water resources.
- The capacity of the water sector to adapt to the impacts of climate change was assessed by stakeholders as moderate. Institutional resources were assessed as moderate. Stakeholders commented there is a need to strengthen coordination among agencies and recommended the reinvigoration of the National Water Council. Human resources were assessed as moderate, and stakeholders noted the need for stronger agencies (GWI, river and sea defence, MMA, Hydromet, NDIA, MoH, EPA and GNBS). An Integrated Water Resource Management (IWRM) plan is still in a draft stage, as is a Waste Water Strategy.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the water sector, as detailed in the risk matrix below.

Due to the cross-cutting nature of water use, all the sectors covered in this chapter of the CRSAP have water-related risks, highlighting the need for cross-sectoral collaboration. A number of direct risks were identified for the water sector, covering water supply and sanitation, with the majority clustered at the higher magnitude end of the scale. These relate to risks to water supply due to sea level rise and saline intrusion of aquifers, freshwater systems and water supply distribution networks (risk ref W1), incremental changes in rainfall and temperature affecting surface water systems (e.g. rivers, creeks, ponds, springs and wells, particularly for riparian communities in the hinterland) (risk ref W3 and W2) and groundwater recharge (risk ref W5). The final high magnitude risk is linked to flooding of the low coastal plain, including Georgetown, and interior townships, due to overflowing drainage canals causing damage to water supply and sewerage systems and networks (risk ref W4).

Risk register for the water sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. The scoring criteria for likelihood and consequence are provided at the end of the table.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
W1	Sea level rise causes saline intrusion of aquifers, freshwater systems and water supply distribution networks with the consequence that water supplies are threatened	Yes	Almost certain	Major impact	Serious
W2	Incremental climate change and extreme events particularly increased frequency of droughts, causes water shortages with the consequence that household water supplies are threatened, particularly in areas reliant on surface water resources	Yes	Almost certain	Major impact	Serious
W3	Incremental climate change and extreme events particularly increased frequency of droughts, causes rivers, creeks, ponds, springs and wells in riparian and hinterland regions to dry up / shrink in size with the consequence that drinking water becomes scarce and community health and wellbeing are threatened	Yes	Almost certain	Major impact	Serious
W4	Increase in extreme rainfall events cause flooding of the low coastal plain, including Georgetown, and interior townships, due to overflowing drainage canals with the consequence that water distribution pipes, treatment plants and puMoPWng equipment, as well as sewage puMoPWng systems, are damaged	Yes	Almost certain	Major impact	Serious

W5	Decrease in mean annual rainfall causes reduced groundwater recharge with the consequence that water shortages occur (however, recharge patterns will be variable across the country, depending on different hydrogeology and aquifer systems)	Yes	Likely	Major impact	Serious
W6	Decrease in mean annual rainfall causes soil degradation and erosion, leading siltation of rivers and lakes with the consequence that water supplies are impacted	Yes	Moderate	Major impact	High

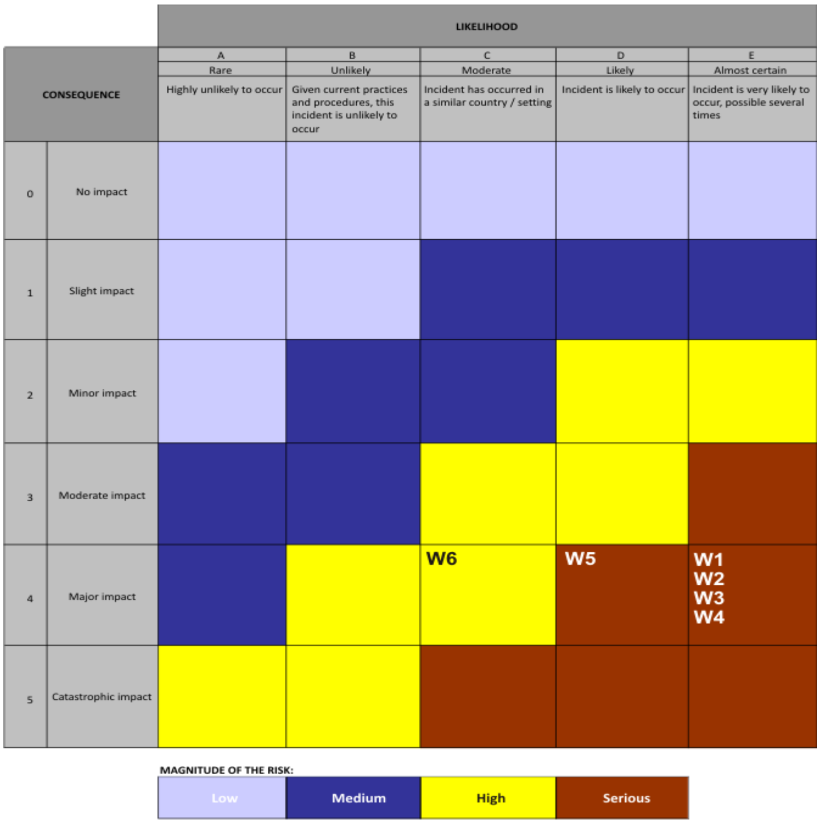

Figure 3.16: Risk matrix for the water sector.

Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to Ooccur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Consequence scoring criteria. The descriptors for the water sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
<u>Flooding</u> Economic: increased cost/expenditure for cleaning supplies at a household level Water treatment options <u>Drought</u> Heat stress	<u>Flooding</u> Socio-economic: closure of schools & business Delays and absences at enterprises (business, commercial) <u>Drought</u> Health impacts – rashes allergies	<u>Flooding</u> Contamination of domestic water supply e.g. shallows wells in Hinterland areas <u>Drought</u> Destruction of agriculture and vegetation (pest, insects)	<u>Flooding</u> Social: High incidences of water borne diseases Social – displacement Social/health – pit latrines Economic – salt water intrusion/ inundation of agricultural lands, surface water Environmental – degradation of ecosystems/ loss of habitat <u>Drought</u> Low water levels impacting river transportation therefore Low productivity Loss of shallow wells → increased exposure to water borne diseases due to contaminated water Wilting of plants → lack so sustenance at community levels e.g. Hinterland Region Accessibility to water supply → rice farmers (agricultural) →	<u>Flooding</u> Loss of livelihood at community level → household level Loss of lives <u>Drought</u> Loss of livelihoods at community and household levels (particularly in the Hinterland areas)

			Irrigation Loss of freshwater supply	

B: Future vision
Recommended Sectoral Objectives
• **Improve knowledge of social vulnerability to climate-induced changes in water resources** • **Increase availability and accessibility to water resources and supply in the face of a changing climate, particularly for indigenous communities, namely provision of reliable supply, especially during drought, improved quality of potable water and to reduce the risk of saltwater intrusion** • **Promote integrated water resources management** • **Build research and technical capacity in context of water resources management** • **Examine and assess the state of water aquifers, particularly in areas where indigenous communities are reliant on groundwater and where economic activities are conducted (e.g. mining) to ensure the aquifers are not compromised** • **Improve water management during climate-related disasters, to avoid contamination and associated health issues**

Climate resilience actions proposed in Guyana					
Ref	**Action**	**Link to risk (ref.)**	**Scaled-up (∇), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation					
1-W	Develop and implement comprehensive national research programme on social, environmental and economic baselines, climate science, vulnerability, impacts and risk management	**W1 – W6**	∇	N	MoLG, MoA, <u>UG</u> (SEES), MNR
2-W	Conduct analysis on past and current impacts of climate on water, including economic impacts	**W1 – W6**	*	N, S, L	MoLG, MMA, <u>MoLG,</u> MoE, UG, MoF, GTA
3-W	Undertake research into the functioning of watersheds, the impacts of economic activities (e.g. mining, agriculture) and possible alternative livelihoods for affected communities. For example, a community in Wisma has witnessed a decrease in	**W1, W2, W3, WS, W6**	*	S, L	<u>MoLG, UoG</u>

	functioning watersheds from 5 to 1 due to mining activities using other sources.				
Pillar 2 Actions: Institutional framework and capacity building, education and awareness					
4-W	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation	**W1 – W6**	∇	N	MOT, GTA, DECC, MOA, MOLG, MOF, MOAA
5-W	Promote & implement awareness raising programme on the impacts of climate change on water resources and how to manage these impacts, including monitoring and evaluation	**W1 – W6**	∇	N, S	National Water Council* GWI, DECC, MoH
6-W	Strengthen and implement awareness raising programme on addressing water management issues and water contamination post-disaster	**W1, W2, W3, W5, W6**	∇	N	CDC, GWI, MoH, EPA, MoLG
7-W	Explore the feasibility of well drilling to create a source of water for vulnerable communities	**W1-W6**	*	S, L	MoLG
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning					
8-W	Advance an Integrated Water Resource Management approach, including establishment of a national water council	**W1, W2, W3, W5, W6**	∇ *	N	MoLG
9-W	Develop a more robust framework for monitoring and evaluation	**W1 – W6**	∇	N, S, L	Attorney General's Office, MOLG, National Water Council (to be reinstated)
10-W	Develop policy and legislation to promote water saving measures	**W1, W2, W3, W5, W6**	* ∇	N, S, L	Attorney General's Office, MOLG
Pillar 4 Actions: Generation and application of technologies					
11-W	Improve sanitation systems and access to potable water	**W1 – W6**	∇	N, S, L	MoH, GWI, GNBS, MoLG
12-W	Develop climate-resilient infrastructure to ensure availability of clean drinking water	**W1 – W6**	*	N	MoLG, GWI, UoG
13-W	Develop and upgrade infrastructure for water supply, irrigation, drainage and flood protection, in order to increase the efficiency of water use, including storage and	**W1 – W6**	∇	N	GWI, NDIA, MMA, MoLG

	distribution, without compromising sanitation systems				
Pillar 5 Actions: Financing instruments					
	No actions identified				

Monitoring and evaluation of adaptation actions and processes

In light of Guyana's vulnerability, GoG has already started to take action to build resilience and enhance capacities to adapt to current and projected future climate impacts. GoG is committed to sustaining economic prosperity, environmental security and social well-being. In addition to these efforts, Guyana has begun to implement practical measures to build climate resilience.

The Mangrove Restoration Project aimed to bolster sea defences against rising sea levels is one such example. There are also on-going interventions to enhance sea defences to address adverse climate change impacts, which include securing bilateral technical and financial support for adapting local infrastructure to climate change; loans to upgrade infrastructure to, inter alia, better cope with climate impacts.

Significant efforts have also been made in managing the risks of flooding by upgrading critical sections of water management infrastructure such as the East Demerara Water Conservancy (EDWC), and strengthening institutional capacities for hydraulic and hydrological modelling and data management.

Table presents these national-scale programmes and projects on climate resilience to date.

In addition to action at the national level, Guyana is also involved in climate change at the international level through the UNFCCC. Guyana ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since that time, two National Communications have been prepared and submitted to the Convention. These National Communications, among other things, highlight Guyana's particular vulnerability to climate change as well as the efforts to plan adaptation and build resilience to climate change. Guyana has cemented its commitment to global climate action by ratifying the Kyoto Protocol in 2003 and the Doha Amendment to the Protocol in 2014, and by submitting its Intended Nationally Determined Contribution to the UNFCCC in 2015. Further, Guyana ratified the United Nations Convention on Biological Diversity in 1994 and the United Nations Convention to Combat Desertification in 1997.

At the regional level, Guyana is also a signatory to the CARICOM Liliendaal Declaration (July 2009), the Regional Framework for Achieving Development Resilient to Climate Change (July 2009) and its Implementation Plan (March 2012). These three foundational documents set out the Caribbean Community's (CARICOM's) response to climate change and provide helpful guidance on the impacts Caribbean countries face and the policies, strategies and actions they need to consider.

Table 3.4: Climate resilience programmes and projects

Title	Year	Executing organisation	Description
Guyana Coastal Adaptation and Resilience Project	2023-2026 (Current)	GRIF (Office of the President)	For a total project budget of US$45 million, this project seeks to The project development objective is to enhance climate adaptation and reduce flood risk in urban and rural areas in the coastal plain of Guyana. Under Component 1, the proposed Project will finance repair, rehabilitation, and replacement of existing drainage infrastructure. Should new drainage and flood management infrastructure be financed, these will not be located on the Essequibo or Courantyne rivers, their tributaries, or connected canals. These investments will consider both existing and projected future land uses (rural, semi-urban, urban), population growth and urbanization, exposed assets, and relevant climate change impacts to support climate adaptation.
Cunha Canal Rehabilitation Project	2016-2019	GRIF (Office of the President)	This project resulted in enhanced capacity of the Cunha Canal to drain the East Demerara Water Conservancy (EDWC) and local agricultural areas in this territory, reducing vulnerability to climate change.
Climate risk adaptation and insurance in the Caribbean (Belize, Grenada, Guyana, Jamaica, Saint Lucia)	2012-2014	Munich Climate Insurance Initiative (MCII). *(Funder: German International Climate Initiative).*	This project developed solutions for managing weather-related risks such as heavy rainfall and flood and supported the development and launch of public safety networks and public-private insurance schemes for vulnerable population groups. This project contributes to the delivery of the LCDS priority of 'developing innovative financial risk management and insurance measures to resiliency'.
Sustainable coastal zone protection through mangrove management	2009-2014	National Agriculture Research and Extension Institute (NAREI), Ministry of Agriculture. *(Funder: European Union (EU) Global Climate Change Alliance).*	This initiative was focussed on restoring and planting new mangrove forests to contribute to carbon sequestration, forest preservation and adaptation through the strengthening of natural sea defences and supporting coastal zone biodiversity. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Conservancy Adaptation Project (CAP)	2007-2013	Ministry of Agriculture; the World Bank. *(Funder: Global Environment Facility (GEF), Special Climate Change Fund (SCCF)).*	This project aimed to reduce the vulnerability of catastrophic flooding in the low-lying coastal area that is currently threatened by sea level rise. It was developed as a comprehensive upgrading program of the EDWC and lowland drainage system, aimed at increasing discharge capacity and improving water level management. This project contributes to the delivery of the LCDS priority of

			'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Project for the Rehabilitation of the East Demerara Water Conservancy I(EDWC)	2011	*Funder: Japan International Cooperation Agency (JICA)*	Phase I aimed to facilitate the procurement of equipment for the rehabilitation of banks in order to improve flood control capacity of the EDWC. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Project for the Rehabilitation of the EDWC II	2011	*Funder: Japan International Cooperation Agency (JICA)*	Phase II of the rehabilitation of EDWC project was focussed on four intake structures: Ann's Grove, Hope, Annandale and Nancy, and two relief sluices: Maduni and Sarah Johanna. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Mainstreaming Adaptation to Climate Change (MACC): Caribbean Community	2003-2009	CCCCC, CARICOM, World Bank, Government of Canada, GEF, Government of US. *(Funder: GEF Trust Fund).*	The objective of the MACC project was to facilitate an enabling environment for climate change adaptation in the Caribbean Community small islands and coastal developing states participating in this effort. In Guyana, among other things, a vulnerability and adaptation assessment was conducted in the agricultural sector, and an adaptation strategy was elaborated for this sector (see National Adaptation Strategy to Address Climate Change in the Agricultural Sector above). This project contributes to the delivery of the LCDS priority of 'switching to flood resistant crops'.

The institutional framework for monitoring climate adaptation in Guyana involves government agencies, NGOs, and international organizations working together. Key institutions for these activities include the Guyana Environmental Protection Agency (EPA), the Ministry of Agriculture, the Ministry of Natural Resources, and the Guyana REDD+ Investment Fund (GRIF). Additionally, collaboration with regional bodies like the Caribbean Community Climate Change Centre (CCCCC) and international entities such as the United Nations Development Programme (UNDP) may be part of the framework. Led by Government, these agencies support efforts to collect data, assess risks, implement adaptation measures, and monitor progress in addressing climate change impacts in Guyana

Monitoring and evaluation for climate adaptation in Guyana involves assessing the effectiveness of strategies implemented to adapt to climate change impacts, such as sea-level rise, changing rainfall patterns, and extreme weather events. This includes tracking changes in key indicators like agricultural productivity, coastal erosion rates, water availability, and community resilience. Additionally, stakeholder consultations and regular data collection would be essential for accurate assessment and adjustment of adaptation efforts.

In Guyana, climate adaptation is monitored through various mechanisms, including:

1. **Government Initiatives**: The government of Guyana establishes agencies or departments tasked with monitoring and implementing climate adaptation measures. These agencies collect data, conduct research, and coordinate efforts to address climate-related challenges.
2. **International Support**: Guyana receive support from international organizations, such as the United Nations Framework Convention on Climate Change (UNFCCC), which provides guidance and assistance in monitoring climate adaptation efforts.
3. **Research and Data Collection:** Monitoring involves collecting data on climate change impacts, vulnerability assessments, and adaptation strategies. This data is used to track changes over time and assess the effectiveness of adaptation measures.
4. **Community Engagement:** Local communities play a vital role in monitoring climate adaptation. They report changes in weather patterns, impacts on agriculture, water resources, and other sectors, providing valuable insights into adaptation needs.
5. **Partnerships and Collaborations:** Collaboration with research institutions, non-governmental organizations (NGOs), and other stakeholders helps strengthen monitoring efforts by sharing expertise, resources, and best practices.

Overall, a multi-faceted approach involving government initiatives, international support, research, community engagement, and partnerships is crucial for effectively monitoring climate adaptation in Guyana.

The following steps are conducted for each adaptation programme as part of the Monitoring and Evaluation Framework:

1. **Assessing Effectiveness:** Monitoring allows policymakers and stakeholders to evaluate the effectiveness of adaptation measures in reducing vulnerabilities and enhancing resilience to climate change impacts.

1. **Tracking Progress:** tracking the progress of adaptation initiatives over time, is utilised for identifying successes, and areas needing improvement.
2. **Allocating Resources:** Monitoring data informs decision-making processes, enabling the allocation of resources to the most effective adaptation strategies.
3. **Learning and Knowledge Sharing**: Monitoring facilitates learning from past experiences and sharing best practices across sectors and regions.
4. **Adaptive Management:** It supports adaptive management approaches by providing timely feedback to adjust strategies based on emerging challenges and opportunities.

Information related to averting, minimizing and addressing loss and damage associated with climate change impacts

The adverse, and potentially catastrophic, impacts of climate change are already being experienced in Guyana. Since the 1960s, Guyana has observed marked increases in temperatures, sea levels and the frequency and intensity of extreme rainfall events. The impacts on Guyanese people, society, economy and environment, during flooding events in 2005, 2006, 2008, 2010, 2011, 2013, 2014 and 2015 and the droughts of 1997-8, 2009-2010 and 2015 are poignant examples of the devastation which can be caused by climate change. Flooding in 2005, for example, caused damage estimated at US$ 465 million (60% of GDP) and during the drought in April 2015 potable water had to be trucked into communities in Regions One and Nine. The potential increase of the frequency and intensity of extreme events is especially alarming given Guyana's particular vulnerability to climate change.

The first half of 2021 saw catastrophic flooding and impacted large parts of the population. Over 74,000 acres (43,473 acres of cash crops and 30,684 acres of rice) of farmlands and over 20,000 farmers were affected. The 2021 flood is likely to be comparable to the 2005 flood which affected close to 37% of the population and caused economic damage equivalent to 60% of GDP. Some areas experienced 120-150 centimetres of standing water, which remained for several days. A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts on the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica, and Mahaica/West Berbice. Region Four was most severely affected in the 2005 flood (though less affected in the 2021 flood), experiencing close to 55% of the total damage, followed by Regions Two (23%) and Five (19%). Considerable losses were recorded in the sugar, rice, livestock, and other crops (fruits, vegetables, roots and tubers, and herbs and spices) subsectors.

Climate models project that temperatures will increase and that sea levels and the height of storm surges will rise. Projections also indicate that average annual precipitation will decrease and that the proportion of heavy rainfall events will increase, though there is greater uncertainty about these values. This in turn is expected to exacerbate adverse social, economic and environmental impacts and act as an additional stress factor on systems with vulnerabilities derived from non-climate drivers.

Guyana has already started to take action to build resilience to change impacts and to enhance capacities to adapt. At a global level, Guyana ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since that time, two National Communications have been prepared and submitted to the Convention. In 2015, Guyana submitted its Intended Nationally Determined Contribution to the UNFCCC and its NDC in 2016. Further, Guyana ratified the United Nations Convention on Biological Diversity in 1994 and the United Nations Convention to Combat Desertification in 1997.

At the national level, Guyana has prepared a Low Carbon Development Strategy (LCDS) to foster low carbon and climate resilient development. The LCDS, prepared in 2009 and updated in 2013, highlighted the importance of adaptation and building resilience and in this regard identified thematic priorities such as upgrading infrastructure to protect against flooding, hinterland adaptation, addressing systematic and behavioural concerns, and developing innovative financial risk management tools among others. The LCDS is supported by sectoral policies including the National Integrated Disaster Risk Management Plan, the National Strategy for Agriculture in Guyana, and the Sea and River Defense Policy among others. Guyana has also made progress in implementing adaptation and resilience building actions principally through interventions to the drainage, irrigation and sea defense systems to reduce the risks of flooding.

Obligations of States and other actors to prevent, mitigate and remediate impacts of climate related loss and damage on human rights

Financial capacity

Economic resources, or finance, is a key determinant of adaptive capacity and an enabling factor for implementation of adaptation measures. Separate from the national budget, the main source of climate finance in Guyana has been via its Memorandum of Understanding (MOU) with the Kingdom of Norway through which Norway pledged to provide eq. US$ 255.5 million between 2010 and 2015 to help deliver 'low carbon, low deforestation, climate resilient development' in Guyana. Guyana has also received grant and loan based funding, though a relatively small amount in comparison to other Caribbean countries.

In its Intended Nationally Determined Contribution (INDC), the GoG indicated that given its limited resources, Guyana will continue work on water management infrastructure; sea defenses rehabilitation; improving water supply and sanitation; introduction of new agricultural techniques such as hydroponics and fertigation; and the inclusion of climate change considerations in sectoral planning documents.

Nonetheless, it noted that significant resources will be required to build resilience in Guyana including through the implementation of the CRSAP. It was estimated that Guyana will require up to US$ 1.6 billion in the period to 2025 for adaptation and resilience building. The Financing Strategy, presented below, is intended to chart the course for accessing the financing Guyana needs to adapt and build resilience to climate change. Financial institutions have a significant role to play in this process.

Policy/ regulatory environment

Guyana's long-term vision for a green and climate resilient economy is guided by the LCDS. Significant strides have been made in the policy and regulatory environments of the most vulnerable sectors. For example, the National Strategy for Agriculture in Guyana 2013 – 2020, outlines plan for enhancing climate change management including through a disaster risk reduction programme. Further, the National Adaptation Strategy to address Climate Change in the Agriculture Sector outlined specific actions to reduce sectoral vulnerability and mainstream climate considerations into agricultural policy and practice.

Climate change was one of the key rationales in the development of the National Land Use Plan including considerations of the viability of long-term settlement on the coast and the consideration of climate change impacts in zoning areas for development. Moreover, the Sea and River Defenses Policy includes strategic direction on sea defense goals including goals for climate resilience.

Cooperation, good practices, experience and lessons learned

Cooperation is a key component of Guyana's climate agenda. Cooperation and collaboration occur at: the local, regional and international levels:

Table 3.5- Institutional Mandates for implementing climate actions

Level		Climate-Related Mandate
Local cooperation	Department of Environment and Climate Change (in the Office of the President)	The DECC has the overall responsibility for coordinating and aligning the efforts of various government agencies around the issue of climate change.
	The Multi-Stakeholder Steering Committee (MSSC)	The MSSC provides technical advice and guidance on the implementation of Guyana's LCDS and supports stakeholder engagement. The Committee is comprised of representatives

		from the government, indigenous NGOs, the private sector, labour, forestry, mining, youth, women, academia, NGOs and civil society.
	Guyana Forestry Commission (GFC) and REDD Secretariat (RS)	The GFC and the RS oversee the key technical aspects of REDD+, including the development and implementation of a monitoring, reporting and verification system (MRVS) for REDD+.
	Hydrometerological Service (Hydromet), Ministry of Agriculture	Hydromet is responsible for observing, archiving and understanding Guyana's weather and climate. It provides meteorological, hydrological, and oceanographic services in support of Guyana's national needs and international obligations.
	Environmental Protection Agency (EPA) (within the Ministry of the Presidency)	The EPA is the GoG agency responsible for overseeing the effective management, conservation, protection of the environment, as well as the assessment of the impacts of developmental activities on the environment.
	Civil Defence Commission (CDC)	The CDC has the responsibility for coordinating and monitoring disaster risk management and comprehensive disaster management in Guyana.
Regional	Caricom	Caricom, the Caribbean Community, is an intergovernmental organisation that is a political and economic union of 15 member states throughout the Americas and Atlantic Ocean.
	Amazon Cooperation Treaty Organization (ACTO)	ACTO is the only socio-environmental block in Latin America and is intergovernmental organization formed by the eight Amazonian countries: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela Among the common working areas among the countries is that of Climate Change. This thematic area has the objective to coordinate and harness efforts in the region to counter the impacts of climate change, mainly by protecting the Amazon and its local populations identifying alternatives to strengthen regional cooperation.
international	Kingdom of Norway	During the period 2009 to 2015, Guyana earned US$224 million dollars in payments for forest climate services from Norway. These revenues were invested in protection against climate change; supporting vulnerable groups such as Indigenous People through activities such as land titling and development, job creation and other adaptation priorities that included flood prevention infrastructure.
	Multilateral Development Banks	Guyana has worked closely with development partners such as the World Bank, IDB, UNDP, the FAO, Munich Climate Insurance Initiative (MCII). *(Funder: German International Climate Initiative), among others, to finance and implement adaptation projects. (refer to Table 3.4)*
	UNFCCC	Guyana ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since that time, two National Communications have been prepared and submitted to the Convention. These National Communications, among other things, highlight Guyana's particular vulnerability to climate

		change as well as the efforts to plan adaptation and build resilience to climate change.

Stakeholder involvement, including subnational, community-level and private sector plans, priorities, actions and programmes.

Guyana's Biennial Transparency Report was informed by the Guyana's Climate Resilience Strategy & Action Plan (CRSAP). The CRSAP was developed using a methodology based on international best practice, consistent with the UNFCCC Least Developed Country Expert Group guidance document, 'National adaptation plans: Technical guidelines for the national adaptation plan process', whilst remaining unique and pragmatic to the specific needs and situation in Guyana.

Stocktaking and literature review: The CRSAP builds on existing available data, information and practice and has involved extensive stocktaking and literature review of relevant policies and strategies, peer-reviewed academic and grey literature. This ensures that the latest information is incorporated within the CRSAP and opportunities to maximise synergies with existing and/or on-going regional and national initiatives are fully exploited.

Stakeholder engagement and consultation: Engaging stakeholders at both the national and sub national levels adds great value to the process of developing the CRSAP, because it ensures that the final plan responds to stakeholder needs and can be supported by those implementing and affected by it. Through a series of one-to-one and small focus group meetings, workshops and email/telephone correspondence, stakeholders' views have been shared and integrated into the CRSAP. The CRSAP has also been presented to a wide audience in a workshop setting, before and after final drafting. The full list of engagement events is presented below:

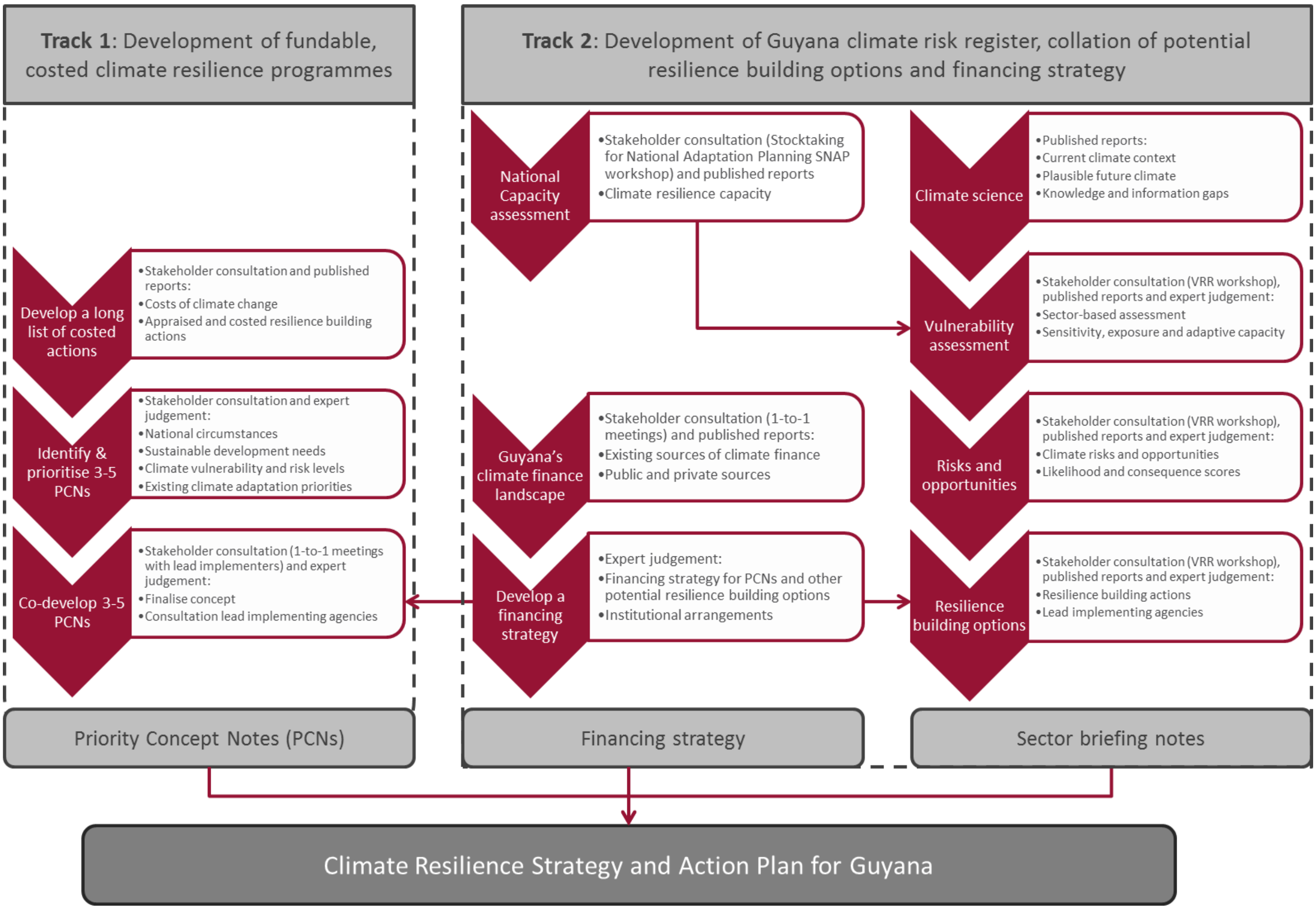

Figure3.17: Overview of the methodology used to develop Guyana's CRSAP

Table 3.5 provides a summary of each stage of stakeholder engagement utilised in CRSAP development and a description of stakeholders engaged.

Format	Stakeholders engaged
Inception focus group meetings	OCC; PMO; the Low Carbon Development Strategy (LCDS) Multi Stakeholder Steering Committee; representatives from government, civil society, academia, NGOs and the private sector.
SNAP workshop	51 state and non-state representatives of sectors in which climate change impacts are direct and present, sectors which are more indirectly affected and which are important 'decision-making' hotspots, and representatives of coastal and hinterland populations were invited.
Email and telephone engagement	>140 representatives from government, civil society, academia, NGOs and the private sector were engaged.
Vulnerability, Risk and Resilience (VRR) workshop	67 representatives from key sectors across Guyana, state and non-state actors, national and sub-national decision makers, a range of regions and representing a variety of demographics were invited.
Policy shapers meetings	Senior policy makers, including Ministers, Permanent Secretaries and Directors of 10 key state and non-state actors were engaged in one to one meetings.
Final CRSAP workshop	94 representatives from key sectors across Guyana, state and non-state actors, national and sub-national decision makers, a range of regions and representing a variety of demographics were invited.
Periodic one-to-one meetings throughout life of project	Representatives from government, civil society, academia, NGOs and the private sector.

Chapter 4 - Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement

The Concept of MRV

International Context

The United Nations Framework Convention on Climate Change (UNFCCC) is the foundation for the current system of reporting of information related to the global intergovernmental action to combat climate change. As per its Article 12, it requires all Parties to communicate to the Conference of the Parties (COP) information relevant to the implementation of the Convention. This is a key element that supports the provision of reliable, transparent, and comprehensive information that allows for assessing the progress in the implementation of the Convention [1].

Throughout the years, the arrangements for national reporting have evolved into a more comprehensive measurement, reporting, and verification (MRV) framework. This concept of MRV was first adopted in 2007 through the Bali Action Plan at the 13th Conference of the Parties (COP 13) of the UNFCCC [2] and provides the foundation for the subsequent elaboration of the existing comprehensive MRV framework for developing country Parties. The concept of MRV was further elaborated in decisions adopted at subsequent COPs and several decisions were adopted detailing guidance on the establishment of the provisions for national frameworks for MRV. More recently it has been extended and reinforced under the Enhanced Transparency Framework (ETF) of the Paris Agreement in 2015, which aims to provide a clear understanding of Parties' climate change action including good practices, priorities, needs and gaps [3].

The ETF includes new reporting requirements which are further defined in the Modalities, Procedures, and Guidelines (MPGs). The MPGs define the set of rules for reporting and review of information submitted by Parties under the ETF of the Paris Agreement and outline in detail the reporting requirements for all country Parties, developed and developing country Parties alike, to the Paris Agreement [4].

As such, the ETF dilutes the difference between the reporting requirements of developed and developing countries, and the enhanced reporting provisions under the Paris Agreement will therefore provide substantial obstacles to developing countries and imply a strengthening of the reporting requirements for developing country Parties, regarding frequency and scope of reporting. It is thus important for all countries to make decisions regarding the institutionalisation of its MRV frameworks to ensure their capacity to provide high-quality data in the right formats and at the right time.

However, it is important to note that the MPGs provide flexibility to those countries that require it in light of their capacities and to least-developed-country (LDC) Parties and small island developing states (SIDS). Although Guyana is recognised as a SIDS, preparations for the ETF have already been initiated.

Components of MRV Frameworks

Developing and setting up comprehensive national MRV frameworks is thus an essential element for developing country Parties to comply with the enhanced international reporting requirements. Developing a national and integrated MRV framework can be seen as a way of systematising the activities needed for reporting by:

- **Formalising institutional arrangements** defining clear roles and responsibilities of all stakeholders involved.
- **Developing step by step manuals** (named as MRV procedures and protocols) defining all the activities to be done under the MRV (data collection, estimation, verification, reporting).
- **Setting up data management systems** for data sharing, archiving and dissemination.

There are several elements under the UNFCCC and the Paris Agreement that require the provision of reliable, transparent, and comprehensive information. Each of these elements possesses unique characteristics, involves distinct scopes, and diverse data implications. It is therefore essential to comprehend the nature of each element, as they contribute to the comprehensive reporting requirements, ensuring a thorough understanding of the multifaceted aspects involved in compliance with the UNFCCC and the Paris Agreement. The different subsystems within a national and integrated MRV framework are depicted in Figure 4.1.

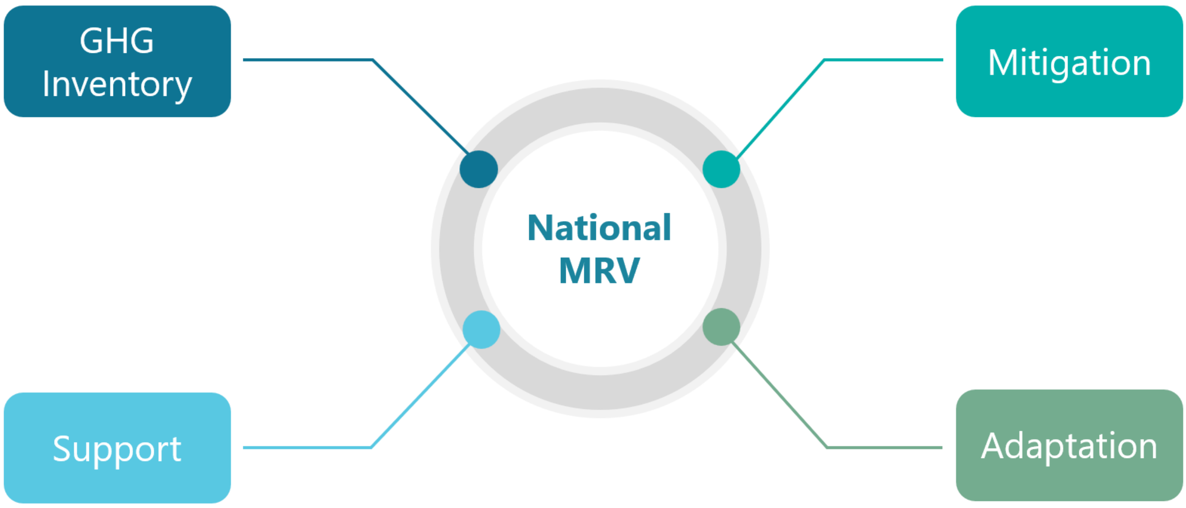

Figure 4.1. MRV subsystems of a national MRV framework.

The National MRV Framework of Guyana

The Government of Guyana has proactively worked towards strengthening its national MRV framework for climate change reporting. In establishing a national MRV framework, Guyana has a unique opportunity to efficiently conform to the requirements of the approaching ETF and initiate the incorporation of institutional arrangements that encompass all MRV subsystems essential for implementing the Paris Agreement.

Over the years, Guyana has diligently built capacities and implemented various policies that serve as a solid foundation for the enhanced reporting structure. Once these efforts are formalised and officially adopted, they will play a crucial role in systematically monitoring Guyana's endeavours and ensuring compliance with the existing framework for international progress reporting on a continuous basis.

As such, Guyana is now in the crucial stage of defining the systems required to estimate the national greenhouse gas (GHG) inventory, determine and track mitigation actions, and define the support needed and received in compliance with the reporting requirements under the UNFCCC and the Paris Agreement. The country has already established a national Reducing Emissions from Deforestation and Degradation (REDD+) monitoring, reporting, and verification system (MRVS) and has advanced work on developing sectoral MRV frameworks for the agriculture and energy sectors of the national GHG inventory.

Overall Coordination of National MRV Framework

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.

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.

Institutional Arrangements

The core components of a national MRV framework hinge on well-structured institutional arrangements that ensure the seamless flow of information from various stakeholders, including government agencies, the private sector, non-governmental organisations (NGOs), and international institutions. These arrangements set a clear framework for the flow of data and information.

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 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.

DECC has been taking on aspects of a coordinating role, working with key agencies in this process. DECC has several data sharing agreements (DSA) or memorandums of understanding (MoUs) with other public and private entities to facilitate the process and plans to initiate other such agreements to mainstream data provision. DECC works with local and international consultants. This process is depicted in Figure 4.2.

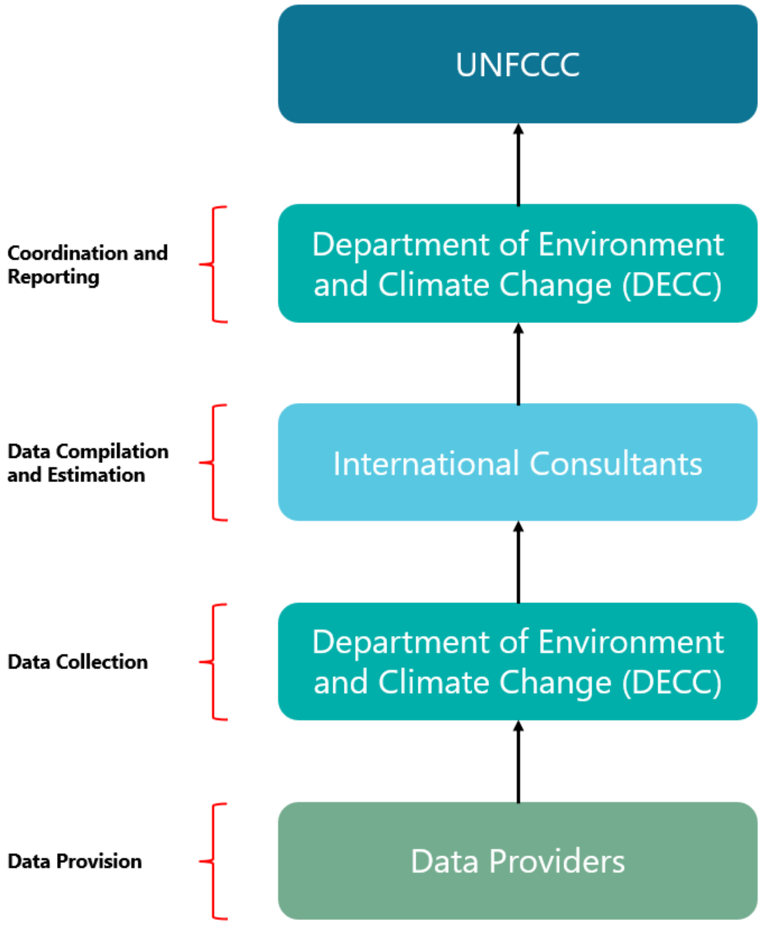

Figure 4.2. Guyana's current institutional arrangements.

Guyana has been actively developing and setting up a national MRV framework aimed at putting in place a sustainable institutionalised framework with clear processes and procedures. As the country progresses towards the establishment of a national MRV framework, the following key activities will be prioritised in its development within each sector:

- Building on existing foundations placing emphasis on leveraging existing processes and procedures to form the basis of the national MRV framework.
- Creating easy to follow systems that exploit synergies between various reporting components, ensuring efficiency and coherence.
- Defining distinct roles and responsibilities to streamline the functioning of the national MRV framework.
- Securing data flows through diverse legal instruments that are tailored to the specific circumstances and nature of the entities involved.
- Ensuring stakeholder engagement from conceptualisation of the national MRV framework to establish trust among stakeholders to encourage the seamless provision of data and to build technical capacities to enable stakeholders to continuously update and enhance their data.
- Incorporating gradual implementation and continuous improvement of the national MRV framework to ensure the long-term sustainability in order to comply with all requirements of the ETF.

MRV of GHG Inventory

To ensure the sustainable preparation and reporting of the national GHG inventory without relying on international support, the country is actively working on establishing a GHG inventory MRV framework that encompasses all relevant sectors.

The recently designed energy sector MRV framework [5] and MRV framework for the agriculture sector in Guyana [6] exemplify these ongoing initiatives, while the industrial processes and product use (IPPU) and waste sectors will be designed in 2024. This will enable Guyana to sustainably complete and accurate information to estimate GHG emissions in all the relevant Intergovernmental Panel on Climate Change (IPCC) sector categories, sub-categories and sources of the national GHG inventory of Guyana. Such endeavours will allow Guyana to ensure national capacity to communicate reliable, transparent, and comprehensive information allowing to meet the enhanced reporting requirements under the Paris Agreement of the GHG inventory to the UNFCCC and take informed policy decisions at national level.

As part of the GHG inventory MRV framework, the establishment of well-considered, relevant institutional arrangements are a key enabling factor for the continued estimation, compilation and timely preparation and submission of Guyana's national GHG inventory. The general institutional arrangements within the GHG inventory MRV framework of Guyana have designated a responsible entity or entities in the country, as follows.

Policy oversight and verification

The Office of the President is the designated policy-making, oversight and verification body of the information to be submitted to the UNFCCC. The Office of the President has the high-level decision-making power that is required of this role, and the designation of the Office of the President for providing the final approval of all reports before they are sent to the UNFCCC ensures that the feedback of a variety of ministerial representatives is considered, helping to leverage synergies and implement climate action as well as encourage buy-in in terms of international climate reporting across the public sector. In accordance with Guyana's Constitution, decisions made by the Office of the President, are implemented by the Permanent Secretary.

National coordination and reporting

The Department of Environment and Climate Change (DECC) is assigned the role of coordination and reporting. The DECC is the designated national focal point (NFP) in Guyana, and GHG Inventory compilation and UNFCCC reporting fall under this agency. As the DECC has already taken on aspects of coordination and reporting in prior inventory cycles and additionally has coordination responsibilities with respect to climate change activities as a core aspect of its institutional mandate, it will be well-equipped to take on this role within the GHG inventory MRV framework. Building on the coordination role already assigned to DECC, ideally, this agency should house the National Inventory Coordinator, whose main responsibility will be the coordinating and overseeing of the national MRV framework implementation and administration.

Technical Quality Assurance

The national MRV framework proposes to establish an inter-agency technical committee. The composition of this inter-agency technical committee will require further attention, which Guyana aims to conduct in 2024. As such, the establishment of an inter-agency technical committee will require additional input to identify relevant and willing institutions with the capacities and interest to contribute to the inter-agency technical committee.

Sectoral data collection and estimation
Sectoral data collection and estimation involves taking charge of gathering data for a specific sector. The objective is to streamline communication with pertinent stakeholders, ease reporting, and assume the responsibility of estimating emissions and removals for the corresponding subsector.

Data provision
There is a substantial list of data providers which play a crucial role in providing essential data for the estimation of the GHG emissions. These data providers engage in the collection of crucial information from a multitude of sources, encompassing public records, surveys, sensors, research findings, databases, social media, and other diverse formats.

Figure 4.3 presents the institutional arrangements for the national GHG inventory MRV framework of Guyana.

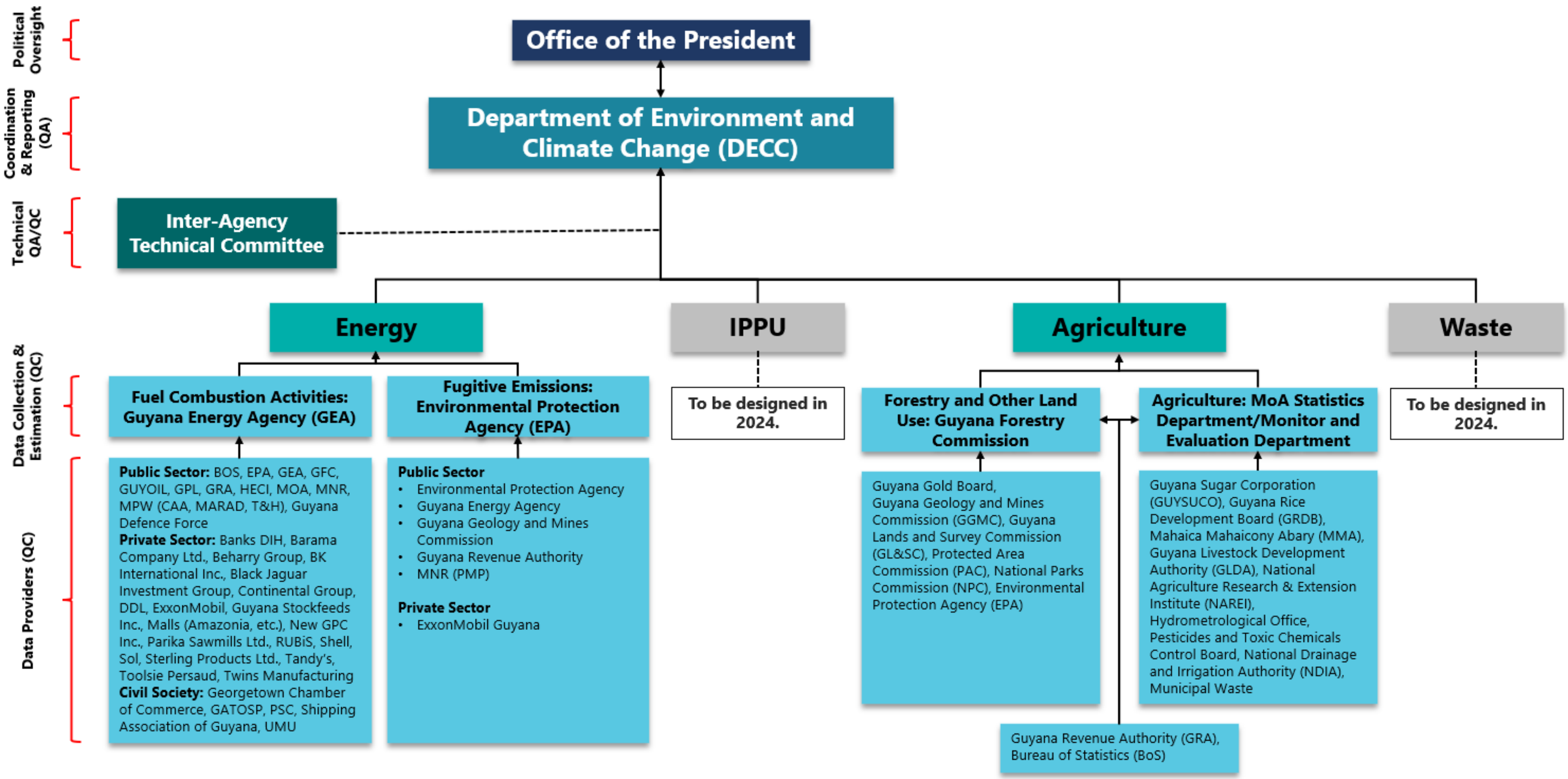

Figure 4.3. Institutional arrangements for the GHG inventory MRV framework.

These core functions, as part of the designed national GHG inventory MRV framework, each require conducting specific activities, hold certain responsibilities, and be in the possession of several expected capacities. Figure 4.4 provides an overview of the process between each of the roles and responsibilities. It shows the flow of the steps that are conducted by each function and the activity that is being conducted in each step.

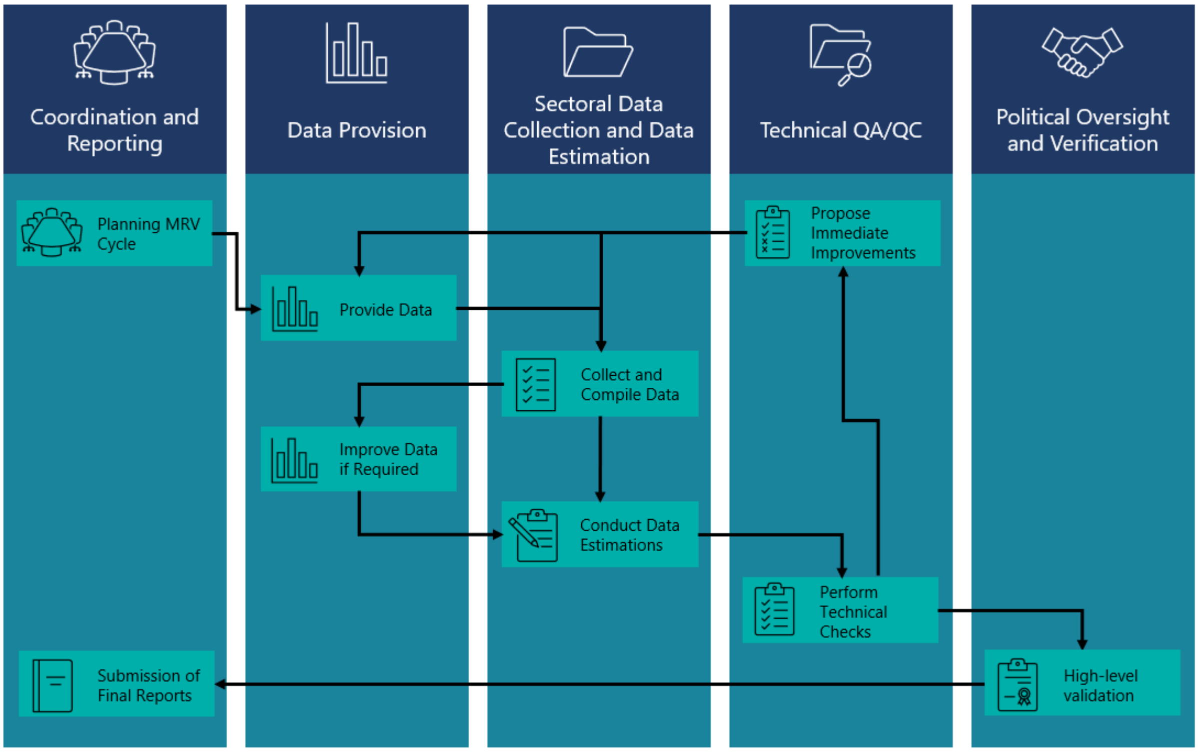

Figure 4.4. Overview of the processes between the different roles and responsibilities within the GHG inventory MRV framework.

REDD+ MRVS

Guyana has established and implemented a REDD+ monitoring, reporting, and verification system (MRVS), which is fully operational. REDD+ refers to a process moderated by the UNFCCC which supports countries' efforts to reduce emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks.

In 2009 the Governments of Guyana and Norway agreed to cooperate on broader emission reduction goals under the umbrella of UNFCCC-REDD+. The activity resulted in the development of a MRVS for a comprehensive, consistent, transparent, and verifiable assessment of forest area change [7]. Through this, the Government of Guyana aims to protect and maintain its forests in an effort to reduce global carbon emissions and at the same time attract resources to foster growth and development along a low carbon emissions path.

As an initial step to the implementation of a REDD+ MRVS for Guyana, a road map for the development of a MRVS for REDD+ participation for Guyana was designed. Furthermore, a capacity gap assessment was done to evaluate Guyana’s capacities and REDD specific characteristics to provide the basis to specify the recommendations and next steps for developing capacities for the implementation of an MRVS for Guyana.

As such, the overall goal was a capacity development process to establish a sustained MRVS for implementing REDD policies and results-based compensation in Guyana and the development of a national REDD+ MRVS which uses a phased approach along a roadmap that specifies near-term priorities & long-term targets.

The execution of the work is centralised at the Guyana Forestry Commission (GFC) agency within the Ministry of Natural Resources. The GFC is the focal agency for coordinating all aspects of data collection, analysis, research execution and assessments and for routine continuous monitoring of the system.

Roadmap Phase 1

The MRVS roadmap for phase 1 (2010 to 2014) was designed to guide the development of a MRVS for REDD+ in Guyana [8]. Seven key areas as immediate activities for starting the capacity development process for Guyana were identified for the first phase:

1. Develop and implement a national mechanism and institutional framework.
2. Conduct a comprehensive forest area change assessment for a historical period.
3. Build carbon stock measurement capacities.
4. Develop MRVS for a set of REDD demonstration activities.
5. Engagement with international community.
6. Sustained internal communication mechanism on MRVS.
7. Conduct/support research on key issues.

As such, phase 1 included a detailed capacity assessment based on the state of the existing national forest monitoring technical capabilities and the requirements for implementation of the MRVS in order to define a detailed plan to establish sustained MRVS capacities within the country and to bridge the gap in capacities. Through the realisation of phase 1 of the roadmap, Guyana made significant achievements in implementing a national forest monitoring and MRVS. The key achievements under phase 1 are summarised in Table 4.5 [8].

Table 4.5. REDD+ MRVS roadmap phase 1 achievements (2010 to 2014).

Priority	Key areas of achievement
Objectives	Gather and integrate information & fill data gaps for national REDD opportunities, scoping, and REDD+ implementation.
Key results and national capacities developed	• MRVS roadmap completed, MRVS Steering Committee formed and meets quarterly. Partnerships established with bodies such as CI, World Wildlife Fund (WWF), Iwokrama, etc. • Dedicated national focal points for Low Carbon Development Strategy (LCDS), REDD+, and IPCC and capacity built within each. • Data collection, analysis and reporting capabilities built in forest area change assessment and forest carbon measurement and monitoring, and interim reporting with standard operating procedures and protocols developed. • Data available on forest carbon, forest area, land use and allocation, historical drivers of change and current drivers, location specific details on forest change. Methods, and training materials. Satellite imagery. • Assessment of historical emissions, two/three annual periods of emission estimates, Proposal for forest reference emission level (FREL) for REDD+ for submission to UNFCCC in last quarter of 2014 [9] Exploring co-benefits and synergies.
Objectives	Develop capacities, conduct historical monitoring, and implement a (minimum) IPCC Tier 2 national forest carbon monitoring, establish the FREL and report on interim performance.
Key results and national capacities developed	• Capacities in place for consistent and continuous acquisition and analysis of key data for Tier 2 nationally and Tier 3 for demonstration/activity sites including international reporting using IPCC - Land Use, Land Use Change and Forestry (LULUCF); uncertainty assessment; MRVS improvement plan developed. • FREL established based on historical data, and future developments using internationally accepted methods. • Regular reporting on REDD demonstrations and interim performance • Continued engagement with key national stakeholders for REDD+ implementation and assuring long-term sustainability of MRVS capacities (i.e. universities).
Objectives	Establish consistent and continuous MRVS supporting national REDD+ actions and international IPCC good practice reporting and verification.
Key results and national capacities developed	• IPCC key category analysis completed, key elements operating at Tier 3, Independent international review of MRVS reporting. • Institutional capacity to deliver verified and compliance assessment. Facilitate verification and process involved. • National data infrastructure of management data and land cover data established. Central database continually updated. • Integration of key aspects of new and improved technologies in areas of accuracy assessment, monitoring of forest degradation, high resolution data coverage, exploration of radar-based data usage in Recover Project, etc.

Roadmap Phase 2

The overall aim of phase 2 of the roadmap (2015 to 2019) was to consolidate and expand capacities for national REDD+ monitoring and MRVS [8]. This supports Guyana in meeting the evolving international reporting requirements from the UNFCCC as well as continuing to fulfil additional reporting requirements e.g., meeting obligations under the bilateral cooperation agreement with the Government of Norway. It also supported Guyana in further developing forest monitoring as a tool for REDD+ implementation. Consolidating and expanding capacities following phase 2 of the roadmap allowed Guyana to fulfil its REDD+ objectives to:

- Underpin and stimulate strategies and priorities for REDD+ implementation.
- Track performance of REDD+ activities and their impacts (carbon & non-carbon).
- Continue to support the building of capacity for MRVS implementation at the government and non-government levels and with other parties that have a role in MRVS related activities.

Three specific areas were identified where key activities are recommended in order to consolidate and expand capacities:

1. Consolidate capacities and routine REDD+ monitoring and MRVS.
2. Develop national forest monitoring as a tool for REDD+ implementation.
3. Knowledge sharing and capacity building.

As such, the focus of phase 2 of the roadmap was to retain the reporting standards and capacities already achieved while also streamlining processes, improving functionality, and reducing operational costs (i.e. the reliance on commercial image data) post-2019. The key achievements under phase 2 are summarised in Table 4.6 [8].

Table 4.6. REDD+ MRVS roadmap phase 2 achievements (2015 to 2019).

Priority	Key areas of achievement
1. Consolidate capacities and routine REDD+ monitoring and MRVS.	
Continue routine monitoring of activity data and emission factors	• Capacities developed at the GFC, to continue monitoring activity data and emission factors on a routine basis in Guyana, which provided annual estimates of forest-related emissions. • Developed methods for accounting for additional activities, including shifting cultivation and degradation from mining, infrastructure, and illegal logging. • Developed an improved long-term monitoring plan for Guyana's forest monitoring.
Refining the measurement and reporting of forest degradation	• Developed and adopted a definition of degradation. • Consolidated analysis of relevant drivers of forest degradation. • Definition for monitoring forest degradation and modalities for monitoring each driver of forest degradation finalised.
Improve emission factors for some specific processes (towards Tier 3)	• Eliminated stratification based on additional field plots and developed country-wide emission factors by activity, with low uncertainty. • Continued field-based measurements on forest carbon stocks and stock changes, allometry, and increasing total plots and ensuring the entirety of the country was well represented. • Emission factors from shifting cultivation finalised and monitoring protocols finalised.
Advance uncertainty assessments	• Uncertainty assessment completed on other types of errors in addition to sampling errors in the emission factors (e.g. Monte Carlo approaches).
Develop foundations and data sources for a REDD+ SIS	• Guyana's First Summary of Information (SoI) completed on REDD+ Safeguards and submitted to the UNFCCC.
2. Develop national forest monitoring as tool for REDD+ implementation.	
Institutional arrangements and multi-sector engagement	• Multi Sector Engagement launched and active with data sharing operationalized. • Agreement developed in the form of a MoU for use of data across agencies and partners.
Expand national monitoring to include local communities and stakeholders	• Standard Operating Procedures developed including user friendly documentation for non-technical users. • Technical capacities of local forest-based communities built in monitoring of community forest resources (Community MRV).
Options for near-real time monitoring for high priority sites	• Data agnostic system developed benefitting from the testing completed on different data streams and their usefulness and integration for near-real time monitoring. • A framework developed to use near-real time monitoring to ensure compliance.
3. Knowledge sharing and capacity building.	

Priority	Key areas of achievement
Exchange of information and capacities with national stakeholders	• A system of communication and explanation of the national forest monitoring system to different governmental actors initiated. • Agreement with the University of Guyana on data sharing, use and feedback.
Engage in South-South collaboration	• Project partnerships created in the Guiana Shield Region and Amazon Basin through Amazon Cooperation Treaty Organization (ACTO) and Ecosystemic Services Observatory of the Guiana (ECOSEO) Projects. • Training and Capacity Building programme continuous.
Scientific work, publication and synthesis	• Partnership established with the University of Guyana. • Publications in scientific Journals and Technical Conferences. • Guyana experiences in research collaborations and international processes shared with international partners including Global Forest Observations Initiative (GFOI), National Aeronautics and Space Administration (NASA), Google Earth Engine, and Forest Carbon Partnership Facility (FCPF).

Roadmap Phase 3

The overall objective for phase 3 of the roadmap (2020 to 2025 and beyond) is to maintain an efficiently functioning MRVS that meets international and national requirements and that supports natural resources management in Guyana [10]. This will support Guyana in meeting the evolving international reporting requirements from the UNFCCC as well as continuing to fulfil additional reporting requirements. The MRVS will address the needs of the Paris Agreement and the guidance of the accompanying Katowice Rulebook on the enhancing the transparency framework, the reporting needs related to Biennial Update Reports (BUR) and Biennial Transparency Report (BTR) and tracking of Guyana's progress in implementing its NDC commitments. It will also support Guyana in further developing forest monitoring as a tool for REDD+ implementation. Consolidating and expanding capacities following phase 3 of the roadmap will allow Guyana to fulfil its REDD+ objectives to:

- Underpin and stimulate strategies and priorities for REDD+ implementation.
- Track performance of REDD+ activities and their impacts (carbon & non-carbon).
- Continue to support the building of capacity for MRVS implementation at the government and non-government level and other parties that have a role in MRVS related activities.

Three specific areas were identified where key activities are recommended in order to consolidate and expand capacities:

- Maintain fully operational MRVS and mainstream results at policy, decision making and stakeholder levels locally and internationally.
- Consolidate existing REDD+ monitoring and MRVS processes.
- Mainstreaming reporting and verification systems for MRVS applications and agreements.

Within the third phase emphasis will be placed on consolidating existing methodologies to meet annual forest change reporting requirements, while also improving the system to provide regular forest change updates and to make the data layers generated more readily available. This shift is seen as an important step in making the current system more sustainable by integrating the MRVS monitoring function into sustainable management of Guyana's natural resources, and the development and implementation of appropriate land use policies.

After twelve years of annual monitoring (2010-2022), of equal importance is the dissemination of MRVS results, engagement in dedicated research, and the communication and sharing of knowledge within and outside of Guyana.

MRV of Mitigation Actions

Guyana is actively engaged in implementing various mitigation actions and the country is exploring the establishment of an MRV framework dedicated to tracking the progress of mitigation efforts. In these instances, the existing approach is project-based, relying solely on data obtained from sources associated with mitigation action funding.

Recognising the importance of a more comprehensive and systematic approach to MRV of mitigation activities, Guyana is currently in the process of establishing a robust mitigation MRV framework, commencing in 2024.

MRV of Support

Guyana plans to develop an MRV framework and methodology for tracking climate support needed and received as part of the national MRV framework. This will enable the assessment of needed technological, financial, and capacity-building support, as well as tracking the support received.

Guyana is currently in the process of developing a robust support MRV framework for which work will start in 2024.

National MRV Data Management System

Although not yet in place, Guyana is intending to develop a sector led data management system as part of its national integrated MRV framework. The country will work to create a structure to feed information from the sector level into a reporting system for the UNFCCC. The envisioned data management system will collate data at the sector level and support the organisation, storage, and archiving of Guyana's information utilised within its national MRV framework. This, in turn, will play a crucial role in shaping national policies and plans while ensuring the fulfilment of the country's reporting obligations to international agreements.

By creating this networking structure, the national MRV, with implementation at the sector level generating inputs for a dedicated data management system, Guyana aims to integrate all MRV subsystems. This approach is designed to facilitate the fulfilment of commitments under both the UNFCCC and the Paris Agreement, providing an effective solution for comprehensive and streamlined reporting processes.

The data management system for Guyana's national MRV framework will be developed based on several key considerations:

1. **Agreement on consistent and comparable definitions:** Adopting consistent and comparable definitions, abbreviations, and acronyms will support alignment of datasets, which allows for more detailed comparisons and, ultimately, better informs policy discussions.
2. **Stakeholder engagement and consultation during design and development:** Identifying and engaging stakeholders is crucial for the design of the data management system. This process offers various benefits, such as aligning the system with national priorities, securing early buy-in from key user groups, and building capacity to reduce data entry errors. Stakeholder engagement also aids in maintaining public support and refining the system by gathering feedback on specific needs and functional components during requirements gathering and testing.
3. **Gradual implementation and continuous improvement framework for long-term sustainability:** Regular enhancements to the data management system will be anticipated to align with evolving policy landscapes and enhance overall system functionality. This will ensure the adaptability to policy changes and the ability to harmonise data from various reporting elements.

4. **Build sense checking into systems to ensure robust data systems:** Input errors are likely to occur when large volumes of data are submitted to the system, undermining users' confidence in the data quality. To mitigate these errors, checks will be incorporated into the data submission process including safeguards to ensure data integrity. This will ensure user confidence in the robustness of the data, which will ensure that the data is used for decision-making.
5. **Create data security and integrity controls:** Security measures will be incorporated for authenticating access to ensure that the data on the system is protected.
6. **Training and support to ensure that the system is used effectively and reduces user error:** Enhanced user understanding of the data management system improves the accuracy of data submissions. Post-system development, supporting and building the capacity of climate data management users will be ensured for smooth operations. In addition, the diverse capacities among reporters are recognised and an ongoing system for user training will significantly improves data submission quality.

As such, the data management system of Guyana is planned to digitise the various aspects of climate change actions and tracking. This encompasses the storage and archiving of data related to GHG inventories, mitigation actions for NDC tracking, and support. The system will be designed to monitor the country's adherence to international commitments under the UNFCCC and the Paris Agreement and generate information to inform national and regional policies related to climate change action and support.

The National Data Management Authority (NDMA) is the legislative authority for data management, storage, and archiving. Established by the National Data Management Authority Act in 1983, the NDMA is tasked with developing automated solutions to enhance efficiency in the public sector in Guyana. By supporting government agencies and ministries, the NDMA ensures the delivery of government services on an interconnected mediation platform. This positions the NDMA as the ideal entity to oversee the data management system, safeguarding its confidentiality, integrity, and availability through its cyber security department.

Capacities at the sector level will be enhanced to consistently generate required data for UNFCCC reporting.

GHG Inventory Module

It is planned for the GHG inventory module within the data management system to utilise the IPCC Inventory Software for the management, storage, and generation of national GHG estimates. This software allows multi-user access from a centralised location, producing reporting tables in the required format for submission to the UNFCCC. This minimises the risk of errors during data transfer into the mandated table format. As such, the IPCC Inventory Software serves as an ideal database for storing and managing GHG data of Guyana as part of the national MRV framework.

All agencies contributing information for the national GHG inventory must input their data into the data management system. Once entered into the IPCC Inventory Software, all information informing the estimates is archived when the inventory version is archived. The dedicated server housing this data is managed and hosted by the NDMA, the agency overseeing the overall management of the data management system.

Mitigation Module

The mitigation module will oversee the management, storage, and archiving of national-level mitigation actions utilising the mitigation tracking tool that Guyana is currently developing. The DECC will hold the responsibility for managing this data, while the NDMA will administer access to the data collection tool based on DECC guidance. Consequently, all documents related to mitigation projects for UNFCCC reports will be stored by the NDMA, accessible upon request.

Support Module

The support module will handle the management and storage of information related to financial, technological, and capacity-building transfers. The data management system will be linked to the support tracking tool that Guyana currently is developing.

Overview

The data management system will enable multi-access and multi-use for the various users. Its implementation will occur in phases, consolidating all components of various MRV subsystems into a unified data system (Figure 4.7).

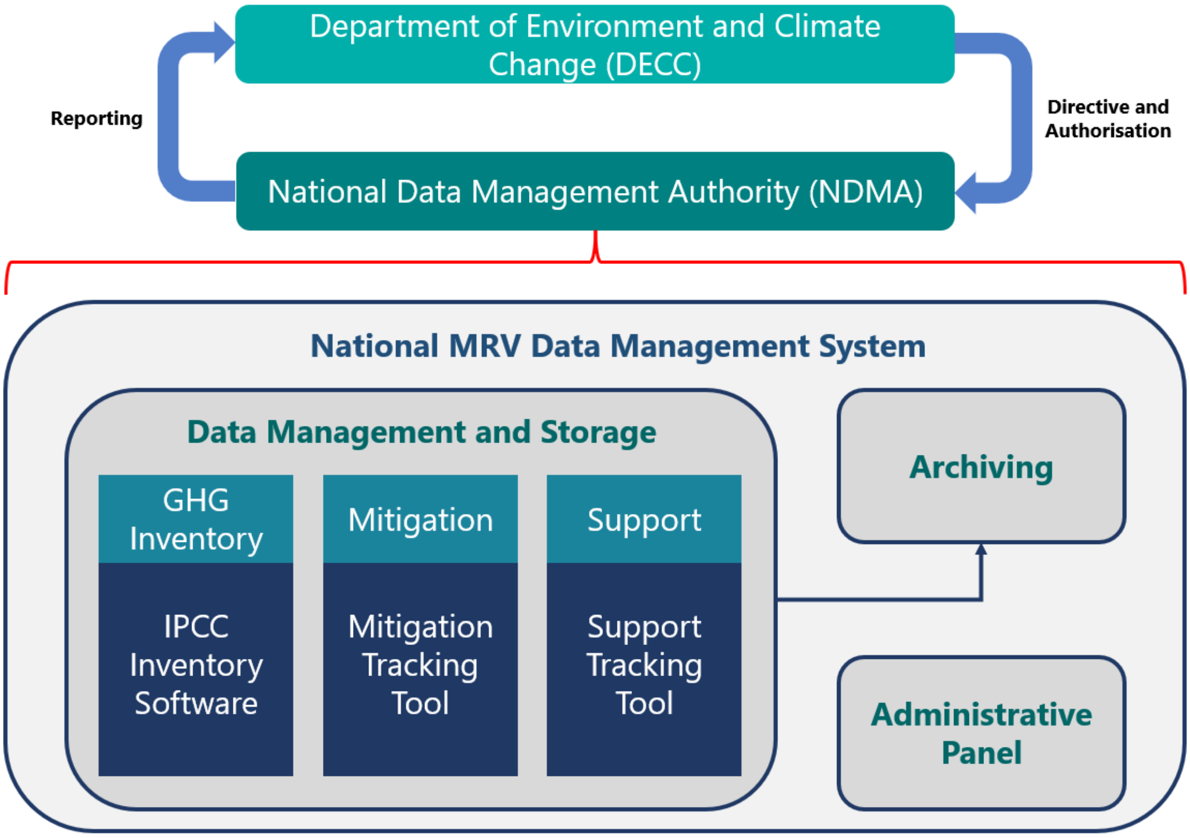

Figure 4.7. Overview of proposed national MRV data management system of Guyana.

Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates

Guyana was among the countries that submitted its NDC in October 2015 to the UNFCCC under the Paris Agreement. In keeping with Paris Agreement (Article 4, paragraph 2), which requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve, Guyana's NDC outlined domestic conditional and unconditional contributions to the global effort to combat climate change.

Guyana's NDC recognizes the land use and forest sector as a key sector for its unconditional and conditional commitments, together with the energy sector. In this regard, Guyana's contribution to the Paris Agreement draws on the LCDS and early REDD+ efforts in order to continue promoting a combination of conservation and sustainable management practices as key climate change mitigation measures.

At the national level, unconditional and conditional commitments established in the NDC – together with the National Forest Policy, Codes of Practise for Timber Harvesting for Sustainable Forest Management – established the overarching guiding instruments and systems in Guyana to support country efforts on reducing emissions in the forest sector by 2025.

The unconditional and conditional commitments identified in Guyana's NDC covered the forestry, energy, and adaptation sectors.

Guyana's Nationally Determined Contributions for the Forestry Sector

Within the forestry sector, deforestation and forest degradation have been caused by mining and logging. These activities have generated considerable economic and employment opportunities – yet also are responsible for greenhouse gas emissions. Since 2008, Guyana has advocated for the REDD+ mechanism within the UNFCCC – to provide economic incentives that value the global climate benefits provided by the world's tropical forests, and ultimately to outcompete economic alternatives which lead to greenhouse gas emissions. In time, these valuations may be augmented by mechanisms that also value the biodiversity and water regulation services which benefit the entire Western Hemisphere and the world.

Since 2008, Guyana has pursued a set of actions that advance this vision – and as a result, has maintained one of the (and often, the) lowest deforestation rates in the world.

Guyana's NDC – and the supporting Forest Reference Emissions Level (FREL), which is part of the UNFCCC's REDD+ architecture – set out the combination of domestic and international actions required to achieve the overall global goals of REDD+ in Guyana.

Unconditional Contributions

- Ensure compliance with the various Codes of Practice to realise sustainable forest management (SFM);
- Maintainance of a high level of timber legality, including the finalisation and implementation of the Voluntary Partnership Agreement (VPA) under the EU Forest Law Enforcement Governance and Trade (EU FLEGT);
- Improve added-value activities locally to assist in creating a higher potential for carbon storage in long-term wood products.

Conditional contributions

- Since 2009, with payments from the Government of Norway, Guyana had sustained progress on REDD+ in line with the overall vision set out in 2008. Guyana's NDC outlined how this progress on REDD+ would be continued if payments for climate services like those provided under the Guyana-Norway Agreement could be continued, whether through further bilateral agreements with Norway or other governments, or through a market based mechanism. Regardless of whether post-2015 payments were through a bilateral or a market mechanism, international payments would be based on the FREL as assessed and accepted by the UNFCCC. The FREL was assessed and accepted - using a total carbon stock of forests in aboveground and belowground biomass of 19,197,411,268 tCO_2e, Guyana's assessed and accepted Reference Level for is therefore 48.7 $MtCO_2e$.
- Use of Reduced Impact Logging (RIL) with the potential to reduce annual emissions by 13.5%
- Completion and maintenance of building the national MRVS, provided that adequate financial resources are available to do so.

Further detail on the REDD+ approach is provided below.

Energy Sector

Unconditional Contributions

Guyana's NDC set out a goal to develop a mix of wind, solar, biomass and hydropower to supply both the demand of the national grid and the energy requirements for towns and villages in Guyana's hinterland.

The Government of Guyana also works closely with farmers in agricultural areas across Guyana to encourage the use of bio-digesters to reduce waste, produce biogas and provide affordable, healthy and efficient cooking means at the household level.

Legislation was enacted to remove import duty and tax barriers for the importation of renewable energy equipment, compact fluorescent lamps and LED lamps to incentivize and motivate energy efficient behavior. Guyana continued to conduct energy audits and replace inefficient lighting at public, residential and commercial buildings to reduce energy consumption. Public education and awareness programmes will continue to play a major role in providing consumers with information and tools to reduce energy consumption and expenditure.

Guyana implemented other policies to encourage energy efficiency and the use of renewable energy, including building codes and net-metering of residential renewable power.

Conditional Contribution

Guyana's NDC set out a commitment to eliminating near complete dependence on fossil fuels. Given Guyana's solar, wind and hydropower, the country set out that with adequate and timely financial support, Guyana could develop a rapid move towards renewable power supply by 2025.

Adaptation

Unconditional contributions

Guyana's NDC set out an intention to continue basic work on integrated water management infrastructure, which includes the construction, rehabilitation and maintenance of conservancies and canals, and sea defences, water supply and sanitation, as well as the introduction of new agricultural techniques such as hydroponics and fertigation. Climate change considerations were to be mainstreamed in all sectors of national development.

The NDC set out an intention to prepare a Climate Resilience Strategy and Action Plan (CRSAP) which was expected to provide a comprehensive framework for adaptation and resilience building in Guyana, but it would require significant resources to implement it.

Conditional contributions

Given the requisite support, Guyana's NDC set out commitments to undertake actions in the following areas:

- Implementation of the CRSAP.
- 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 flood resilient varieties which are:
  - Drought tolerant,
  - Disease resistant.
    - Develop environmental and climate change awareness programmes at all levels.
    - Developing innovative financial risk management and insurance measures.

REDD+ in Guyana

Guyana is committed to safeguarding its forests, recognising their vital role in mitigating climate change by absorbing substantial amounts of 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) [1]. 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) and containing an estimated 5.96 Gt of carbon in aboveground biomass which is equivalent to 21.8 Gt of CO_2 with the inclusion of soil carbon.

However, in addition to being one of Guyana's most valuable natural assets, these forests are suitable for logging and agriculture, and have significant mineral deposits. Mining is the primary driver of deforestation in Guyana18, 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.

To achieve a balance between preserving Guyana's forests as a global asset in the fight against climate change and at the same time meeting addressing poverty and other developmental challenges, Guyana has pursued a Low Carbon Development Strategy (LCDS).

[18] Decision 4, CP.15 paragraph 1(a) requests developing country Parties to identify drivers of deforestation and forest degradation resulting in emissions.

The latest revision of the LCDS sets out plans up to 2030 to maintain Guyana's low deforestation and high HFLD score [2] including through the use of economic incentives. These economic incentives are grounded in united Nations Framework for Climate Change (UNFCCC) modalities, including Reducing Emissions from Deforestation and Degradation (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.

Background to REDD+

'REDD' stands for 'Reducing emissions from deforestation and forest degradation in developing countries. The '+' stands for additional forest-related activities that protect the climate, namely sustainable management of forests and the conservation and enhancement of forest carbon stocks [3]. The primary objective of REDD+ is to encourage developing countries like Guyana to shift economic incentives so that they can actively contribute to climate change mitigation. This is achieved through economic incentives that value the globally-significant forest climate services provided by tropical forests, and to help with curbing, stopping, and reversing forest loss and degradation, while simultaneously enhancing the removal of greenhouse gases (GHGs) from the atmosphere through the conservation, management, and expansion of forests. There are five globally agreed-upon REDD+ activities that play a crucial role in mitigating climate change in the forest sector:

6. Reducing emissions from deforestation.
7. Reducing emissions from forest degradation.
8. Conservation of forest-carbon stocks.
9. Enhancement of forest-carbon stocks.
10. Sustainable management of forests.

Within the framework of these REDD+ activities, Guyana has been receiving results-based payments for REDD+ activities. The outcomes of REDD+ efforts are quantified in metric tonnes of CO_2e or GHG emissions reductions, leading to the creation of REDD+ Results Units (RRUs).

Guyana has long been a leader in working out how REDD+ can be evolved and strengthened. In 2008, Guyana set out to start building a mechanism for REDD+, through a three-phase process:

- Phase I – a bilateral agreement with a partner which shared Guyana's vision.
- Phase II – available market-based mechanisms.
- Phase III – a fully-fledged UNFCCC REDD+ mechanism.

In Phase I, the forest reference emission level (FREL) was assessed and accepted by the UNFCCC. Within the REDD+ framework and utilising the FREL, the Governments of Guyana and Norway established a REDD+ agreement in 2009, known as the Guyana – Norway Partnership. In the agreement, Norway committed to providing Guyana up to $250 million USD by 2015 for REDD+ results.

In Phase II, the FREL serves as a benchmark for voluntary carbon market engagement, and in Phase III, the mechanism will be seamlessly integrated once a UNFCCC REDD+ mechanism is fully operational [4].

In this context, Guyana has submitted its first REDD+ Technical Annex alongside its first Biennial Update Report (BUR), and is now submitting its first Biennial Transparency Report (BTR). The REDD+

Technical Annex outlines the country's endeavours in preserving environmental integrity and promoting the sustainable use of its forest resources. These efforts align with the promotion of sustainable development along a low-carbon pathway, in accordance with national priorities and international obligations [5]. The Technical Annex includes an overview of the FREL, GHG emission reduction results, consistency in methodology between REDD+ results calculation and FREL construction, details about the national forest monitoring system and the responsibilities of relevant authorities, as well as the necessary information for the reconstruction of the results.

The initial REDD+ Technical Annex details Guyana's achievements from 2013 to 2022

Phase II Transition to a Market-Based Mechanism: ART-TREES

For Phase II of Guyana's approach to forest climate services, Guyana has adopted the Architecture for REDD+ Transactions (ART) as the accreditation standard for integration with voluntary and carbon markets. The overall approach was set out in Guyana's LCDS 2030 – Appendices 1 and 2.

ART's "The REDD+ Environmental Excellence Standard", known as TREES, is ART's market-based approach to crediting REDD+ performance. TREES outlines the criteria for crediting emission reductions from REDD+ on both national and subnational scales. It encompasses rigorous standards for accounting and crediting, monitoring, reporting, and independent third-party verification, as well as measures for mitigating leakage and reversal risks, preventing double counting, ensuring robust environmental and social safeguards, and ensuring the transparent issuance of serialised TREES Credits on a public registry [6].

Guyana is in the process of revising the FREL and establishing a new baseline for comparing actual emissions [7]. This updated FREL will be effective from 2023 and was part of a nation-wide national consultation on the LCDS 2030. It will serve as a refinement of the 2015 FREL, incorporating stepwise improvements and additional data. Noteworthy revisions include:

- Inclusion of additional data collected, ensuring nationwide coverage and eliminating stratification based on the convergence of biomass values and updated emission factors.
- Adjustment of the reference period.
- Incorporation of all national drivers contributing to both deforestation and forest degradation.

Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement

The following summary tables present information that tracks progress on Guyana's NDC contributions. This is presented by sector:

Energy Sector

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 Works 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 under the purview of the Ministry of Public Works 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 CO2 emissions. Electricity generation in the three townships is diversified. Renewable energy solutions are introduced. 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.	3.67 tons CO2e / 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 CO2/MWh) to estimate the annual GHG emission reductions in tons CO2e per year. Grid emission factors for the Bartica Isolated system of Guyana (tons CO2/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 CO2e/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)	CO2	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. 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.	Not Applicable	Not Applicable

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

Name of Action	Guyana Utility Scale Solar Photovoltaic Program (GUYSOL)					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2022-2027	Guyana Power and Light Inc. (GPL)	CO2	Regions 2, 5, 6, 10	Power Generation

Description and Objective

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 CO2 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.

Quantitative Goals

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.

Steps Taken or Envisaged to Achieve Action

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.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
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.	37,500 tons CO2e / yr	According to the GUYSOL Project Summary Document, Linden is purposed to conserve 17,259 tons CO2/yr (at 22,500 MWh/yr in power generation), Essequibo to conserve 9,390 tons CO2e/yr (at 12,800 MWh/yr power generation), and Berbice to conserve 10,671 ton CO2e/yr (at 16,000 MWh/yr power generation), assuming Berbice´s grid emission factor of approximately 0.661 tons CO2e/MWh.

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 CO2e/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)	CO2, CH4, N2O	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 CO2e/yr	The pilot rice husk biomass power plant is purposed to generate 112 MWh/yr. A combined emission factor of approximately 0.9 tons CO2e/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)	CO2	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 CO2e/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 CO2 emissions.	841 tons CO2e/yr	The Leguan Solar PV farm is purposed to generate 899 MWh/yr. An emission factor of 0.936 tons CO2e/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 CO2e/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 Amaila 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.	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

Decrease in electricity generation costs. Avoidance of CO2 emissions.		annual GHG emission reductions. Grid emission factors for the Bartica Isolated system of Guyana (tons CO2/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)	CO2	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.	3,046 tons CO2e / 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 CO2e /MWh has been adopted to reflect the GHG

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		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 CO2e / 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 CO2e/MWh, the energy produced by these systems would prevent the generation of 5,518 tons CO2 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 CO2e	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	CO2	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)	CO2	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 CO2e / 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 CO2 emissions. Renewable energy solutions are introduced.	478 tons CO2e / yr	The annual power generation of 560 MWh/yr is multiplied by an emission factor of 0.854 tons CO2/MWh to estimate the annual GHG emission reductions. Grid emission factors for the Bartica Isolated system of Guyana (ton CO2/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 CO2e/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)	CO2	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.	ft3	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

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.	Not Estimated	Insufficient information available to estimate the GHG emission reductions.

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.		

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%

Name of Action	**Transitioning to National Energy Security: Bartica as a Model Green Town**					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Ongoing	2017-Ongoing	Office of Climate Change (OCC)	Not Applicable	Region 7	Energy Efficiency
Description and Objective						
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.

Quantitative Goals

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.

Steps Taken or Envisaged to Achieve Action

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

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions

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

Name of Action	Promotion of Energy Efficiency Measures in the Manufacturing and Service Sectors					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Completed	2011-2013	Guyana Manufacturing & Services Association (GMSA)	CO2	National	Energy Efficiency

Description and Objective
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.
Quantitative Goals
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 CO2e in the 5 pilot companies.
Steps Taken or Envisaged to Achieve Action
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.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions

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.	291 tons CO2e / yr	During the implementation years of the project (2012-2013) a total of 582 tons CO2e was reduced/saved. It is assumed that an equal share of GHG emission reductions occurred during these two years.

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
5 energy efficiency programs implemented in pilot companies.	#	0	5	5
15 energy efficiency experts trained on energy audits acting as energy efficiency MSMEs.	#	0	15	33
Increased awareness among 100 private sector companies on the demonstrative benefits of adopting energy efficiency measures and promotion at the national level.	#	0	100	85
5 MSMEs benefitting from clean or efficient energy.	#	0	5	5
Energy saved in kwh.	kWh	0	NA	824,186
At least 800 tons CO2, emissions reduced/saved.	tons CO2e	0	800	582
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

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)	CO2	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

Name of Action	Sustainable Business Models for Rural Electrification and Energy Access in Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling Activity	Completed	2015-2019	Hinterland Electrification company Inc. (HECI)	Not Applicable	Regions 1, 2, 7, 8, 9	Rural Electrification

Description and Objective

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.

Quantitative Goals

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.

Steps Taken or Envisaged to Achieve Action

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.

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
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.	Not Applicable	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.

Progress Indicators

Indicator	Unit	Baseline	Target	Progress
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)	CO2	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. Diversification of local economies and employment creation in renewable energies.	842 tons CO2e / 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 CO2e/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 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

Name of Action	Solar Home Systems					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Project	Ongoing	2021-Ongoing	Guyana Energy Agency (GEA)	CO2	National	Rural Electrification
Description and Objective						
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.						
Quantitative Goals						
Installation of thirty thousand (30,000) 150-watt solar home systems.						
Steps Taken or Envisaged to Achieve Action						
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).						

Estimated Outcomes	Estimated GHG Emission Reductions	Methodologies and Assumptions
Provide electricity to off-grid households and micro enterprises, through individual Solar Home Systems.	5,003.71 tons CO2e / yr	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 CO2/MWh to estimate the annual GHG emission reductions.

Progress Indicators				
Indicator	**Unit**	**Baseline**	**Target**	**Progress**
Installation of solar home systems	#	0	30,000	NA

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)	CO2	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

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)	CO2	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

Forestry Sector

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	CO_2	National	Forestry

			Climate Change (OCC)			

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 CO2 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)	CO2	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. 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.	Not Estimated	Insufficient information available to estimate the 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)	CO2	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 expected to be 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 CO2e	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 CO2e, the total reduction over the 2016-2030 period is estimated at 108.47 million tons CO2e.

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

Name of Action	Forest Carbon Partnership Facility Project in Guyana					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**
Enabling activity	Completed	2014-2020	Guyana Forestry Commission (GFC)	CO2	National	Forestry

Description and Objective

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.

Quantitative Goals

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.

Steps Taken or Envisaged to Achieve Action

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

Level in 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 CO2/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 FCPF REDD+ readiness process.		
Estimated Outcomes	**Estimated GHG Emission Reductions**	**Methodologies and Assumptions**
Institutional capabilities were built and mobilized to ensure successful execution of the R-PP. 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 MtCO2e 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 twelve national assessments (2010 to 2022) 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.	Not Applicable	Not Applicable
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 CO2e	The EX-ACT tool was used to calculate CO2e 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 CO2e 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 CO2e 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

Cross-Cutting Sector

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 Amerindian 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 September 2023, all villages have produced their village plans, to 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

Name of Action	**Strengthened Monitoring, Enforcement and Uptake of Environmental Regulations in Guyana's Gold Mining Sector**					
Type of Action	**Status**	**Duration**	**Implementing Entity**	**GHG Coverage**	**Geographic Scope**	**Sectoral Scope**

Project	Completed	2014-2017	Environmental Protection Agency (EPA) / Guyana Geology and Mines Commission (GGMC)	Not Estimated	National	Economic Development

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

Mitigation policies and measures, actions and plans

(***including those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement)***

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 and energy sectors as this is where the majority of Guyana's current and historical emissions are produced, and the objective of the LCDS, which aims to enhance clean energy and create incentives for a low-carbon economy through primarily the forestry sector. Furthermore, Guyana has actively participated in REDD+ and the latest developments in market-based mechanisms supported by the Paris Agreement. Further details regarding these activities are presented in Chapter 2 of this Biennial Transparency Report (BTR).

Guyana's domestic agriculture sector 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.

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.

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, upgrading from pit latrines to septic systems. 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.

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 4.8. 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

Forestry Sector

In addressing climate change within the forestry sector, Guyana is employing a combination of conservation and sustainable forest management strategies.

Within this 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 4.9. 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	Ongoing	108.47 million tons CO_2e per year [19]

[19] 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 [4]. Guyana has been issued 33.47 million

(MRVS) and Forest Climate Services Payment Mechanism		
Forest Carbon Partnership Facility Project in Guyana	Completed	Not Applicable

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 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 4.3. 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

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.

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Chapter 5 - Information on financial, technology development and transfer and capacity-building support provided and mobilized, needed and received under Articles 9–11 of the Paris Agreement

Information on financial support provided and mobilized under Article 9 of the Paris Agreement

In Guyana, substantial resources are mobilised to finance activities in the priority sectors, namely energy and forestry and, to a lesser extent, transport, as outlined in Guyana's Nationally Determined Contribution (NDC) [3] and Low Carbon Development Strategy (LCDS) [4]. Additionally, operational support for fulfilling reporting obligations under the UNFCCC is provided. The funding is obtained from various sources, including the country's budgetary investments, investment loans and grants from bilateral and multilateral entities, as well as through private sector investment.

A concise summary of the funding received and anticipated, categorised by source and financial instrument, is presented in Table 5.1.

Overall, the funding received by Guyana underscores a significant dependence in the past on bilateral support often disbursed as grants and on concessional loans from multilateral development institutions in the past. Moreover, the Global Environment Facility (GEF) [5] and the Green Climate Fund (GCF) [6] provided support in the form of project grants to fund projects aimed at enhancing the country´s operational capacity for climate action.

However, since 2022, this situation has changed with the vast amount of the funding yet to be received being formed of increasing mobilisation of market instruments and private sector investments as major sources of climate finance.

Table 5.1. Summary of total support received and anticipated.

Funding Source and Financial Instrument	Support received (USD)	Support anticipated (USD)
Bilateral	**322,748,817.00**	**886,143,847**
Concessional loan	**7,290,000.00**	**2,710,000.00**
Government of India	7,290,000.00	2,710,000.00
Grant	**95,458,817.00**	**17,433,847.00**
Government of Canada	350,000.00	
Government of India	62,126.00	
Government of Italy	1,275,000.00	3,045,000.00
Guyana REDD+ Investment Fund (GRIF) - Norwegian Agency for Development Cooperation (NORAD)	67,485,292.00	13,804,349.00
Government of Japan	675,000.00	
United Arab Emirates Caribbean Energy Development Fund (UAE-CREC)	2,300,000.00	
European Union Caribbean Investment Facility (CIF)	21,965,250.00	
German Development Bank (KfW)	146,149.00	584,498.00
Japan International Cooperation Agency (JICA)	1,200,000.00	
Loan		**646,000,000.00**
Export and Import Bank US (EXIM)		646,000,000.00
Results-based payment	**220,000,000.00**	**220,000,000.00**
GRIF - NORAD	220,000,000.00	220,000,000.00
Multilateral Climate Funds	**8,168,744.00**	**4,698,911.00**
Grant	**8,168,744.00**	**4,698,911.00**
Global Environment Facility (GEF)	6,731,617.00	4,122,202.00
Green Climate Fund (GCF)	1,292,950.00	
World Wildlife Fund (WWF)	144,177.00	576,709.00
Multilateral Development Banks	**86,821,990.00**	**10,595,452.00**

Concessional loan	**80,548,750.00**	**10,595,452.00**
Inter-American Development Bank (IDB)	65,918,750.00	10,595,452.00
Islamic Development Bank (IsDB)	14,630,000.00	
Grant	**6,273,240.00**	
IDB	2,473,240.00	
World Bank	3,800,000.00	
Private Sector	**152,100,000.00**	**1,555,500,000.00**
Equity	**2,100,000.00**	**955,500,000.00**
ExxonMobil		955,500,000.00
Private Sector Guyana	2,100,000.00	
Market-based Climate Finance	**150,000,000.00**	**600,000,000.00**
Hess Corporation	150,000,000.00	600,000,000.00

Support Received by Sector

Aligned with the priority sectors, the implemented climate change actions are closely tied to the reduction of GHG emissions in the energy sector and the increase of removals in the forestry sector. This involves the protection and reforestation of the vast Amazon Forest, alongside the expansion of renewable energy sources. Similarly, initiatives are underway to leverage cleaner fossil energy sources, particularly natural gas. Additionally, there are cross-cutting activities that offer climate change mitigation co-benefits, such as promoting sustainable practices in remote communities or providing operational support for climate change.

The subsequent sections detail climate change projects in Guyana, organised by sector. They provide key information on the received and anticipated funding, the status of implementation, and the involved donors and national entities.

Energy Sector

Given its status as the sector with the highest emissions, Guyana prioritises the energy sector in its climate change efforts, thus aiming to secure substantial funding to implement targeted actions. 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.

Table 5.2 provides an overview of the total number of supported actions, the total received amount, and the outstanding amount yet to be disbursed for these initiatives.

Table 5.2. Overview of funding status of energy sector actions.

Number of actions supported	**23**
Actions involving capacity-building	**15**
Actions involving technology transfer	**20**
Power Generation	12
Energy Efficiency	4
Rural Electrification	3
Training and Development	4
Total amount of support received	**$ 127,253,732 USD**
Power Generation	$ 34,401,492 USD

Energy Efficiency	$ 2,975,000 USD
Rural Electrification	$ 13,603,240 USD
Training and Development	$ 76,274,000 USD
Total amount of support anticipated	**$ 1,702,650,452 USD**
Power Generation	$ 1,696,895,452 USD
Energy Efficiency	$ 3,045,000 USD
Rural Electrification	$ 2,710,000 USD
Training and Development	$ 0 USD

The significant share of funding that is anticipated stems from one major project, namely the installation of a 300MW Gas-to-Power Plant, with a total cost of $ 1,601,000,000 USD, representing nearly all of the funding anticipated in this sector.

In Table 5.3, all completed, ongoing, or planned actions within the energy sector are listed. Additional information on the financial source, instrument, and the scope of each activity is provided. It is important to note that ‘funding anticipated’ denotes the ongoing requirement for disbursing financial resources to facilitate the implementation of the respective project or action.

Table 5.3. Detailed overview of support received and anticipated for energy sector actions.

Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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	✓	✓	✓	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	✓	✓	✓	Regions 2 and 3	Power Generation
Title	Expanding Bioenergy Opportunities in Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2008-2010	Completed	Inter-American Development Bank (IDB)	Government of Japan	Grant	675,000		✓	✓	✓	National	Power Generation
			Inter-American Development Bank (IDB)	Grant	250,000		✓	✓	✓		
Title	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	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2019-2020	Completed	Global Green Growth Institute (GGGI)	Green Climate Fund (GCF)	Grant	300,000		✓	✓		National	Power Generation

Title	**Guyana Utility Scale Solar Photovoltaic Program (GUYSOL)**										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2022-2027	Ongoing	Guyana Power and Light Inc. (GPL)	GRIF - NORAD	Results-based payment (Grant)		83,300,000	✓	✓	✓	Regions 2, 5, 6, 10	Power Generation
			GRIF - NORAD	Results-based payment (Grant)		1,500,000	✓				
Title	Pilot Rice Husk Biogas Power Plant										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2018-2021	Completed	Guyana Energy Agency (GEA)	Government of India	Grant	62,126		✓		✓	Regions 5 and 6	Power Generation
Title	Leguan 0.6MWp Solar PV Farm										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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	✓		✓	Region 3	Power Generation
Title	Amaila Falls Hydroelectric Project Preparation Studies										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2010-2011	Completed	Inter-American Development Bank (IDB)	GRIF - NORAD	Grant	1,210,000		✓		✓	Regions 3, 4, 5, 6, 10	Power Generation
Title	Wakenaam 0.75MWp Solar Farm										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2019-ongoing	Ongoing	Guyana Power and	UAE-CREC	Grant	2,300,000		✓		✓	Region 3	Power Generation

		Light Inc. (GPL)									
Title	Small Hydropower Project for the Cooperative Republic of Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2022-ongoing	Ongoing	Guyana Energy Agency (GEA)	Islamic Development Bank (IsDB)	Concessional loan	14,630,000		✓		✓	Region 9	Power Generation
Title	Promotion of Private Solar PV Rooftop Systems										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2020-2022	Completed	Guyana Power and Light Inc. (GPL) and private actors	Private Sector	Equity	2,100,000		✓			National	Power Generation
Title	Gas to Energy Project										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2023-ongoing	Ongoing	Ministry of Public Works	Export and Import Bank US (EXIM)	Loan		646,000,000	✓		✓	National	Power Generation
			Private Sector (ExxonMobil)	Equity		955,500,000	✓		✓		
Title	Caribbean Renewable Energy Development Programme										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2004-2015	Completed	Caribbean Community (CARICOM)	GEF	Grant	524,366		✓	✓	✓	Regional	Power Generation
Title	EcoMicro Guyana										
Duration	Status		Funding				Type of Funding				

		Implementing Entity	Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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		✓	✓	✓	National	Energy Efficiency
Title	Transitioning to National Energy Security: Bartica as a Model Green Town										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2017-ongoing	Ongoing	Office of Climate Change (OCC)	Government of Italy	Grant	1,275,000	3,045,000	✓	✓	✓	Region 7	Energy Efficiency
Title	Promotion of Energy Efficiency Measures in the Manufacturing and Service Sectors										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2011-2013	Completed	Guyana Manufacturing & Services Association (GMSA)	Inter-American Development Bank (IDB)	Grant	150,000		✓	✓	✓	National	Energy Efficiency
Title	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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2018-2022	Completed	Guyana Energy Agency (GEA)	Japan International Cooperation Agency (JICA)	Grant	1,200,000		✓		✓	Region 4	Energy Efficiency
Title	Sustainable Business Models for Rural Electrification and Energy Access in Guyana										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		

2015-2019	Completed	Hinterland Electrification Company Inc. (HECI)	Inter-American Development Bank (IDB)	Grant	1,333,240		✓	✓	✓	Regions 1, 2, 7, 8, 9	Rural Electrification

Title	**Sustainable Energy Program for Guyana**										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2013-2023	Ongoing	Guyana Energy Agency (GEA)	Global Environment Facility (GEF)	Grant	2,200,000		✓	✓	✓	Region 8	Rural Electrification
		The Hinterland Electrification Company Inc. (HECI)	Global Environment Facility (GEF)	Grant	2,780,000		✓	✓	✓	National	
Title	Solar Home Systems										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2021-ongoing	Ongoing	Guyana Energy Agency (GEA)	Government of India	Concessional loan	7,290,000	2,710,000	✓	✓	✓	National	Rural Electrification
Title	Power Utility Upgrade Program										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2014-2021	Completed	Guyana Power and Light Inc. (GPL)	Inter-American Development Bank (IDB)	Concessional loan	36,568,750		✓	✓	✓	Regions 2, 3, 4, 5, 6, 9, 10	Training and Development
			European Union Caribbean Investment Facility (CIF)	Investment grant	21,965,250		✓	✓	✓		
Title	Sustainable Operation of the Electricity Sector and Improved Quality of Service										

Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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		✓	✓	✓	National	Training and Development

Title	**Power Sector Support Program**										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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		✓	✓	✓	National	Training and Development
Title	Strengthening Capacity in Energy Planning and Supervision										
Duration	Status	Implementing Entity	Funding				Type of Funding			Geographic scope	Sectoral Scope
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2012-2016	Completed	Inter-American Development Bank (IDB)	Inter-American Development Bank (IDB)	Grant	740,000		✓	✓		National	Training and Development

Forestry Sector

The primary source of funding for climate change mitigation in the forestry sector is mobilised through the sale of forest climate services, which seek to put a fair value on the services provided by Guyana's forests as a national and global asset.

As set out earlier in this document, in 2009, Guyana's original LCDS set out a three-phase approach to the sale of these services, with Phase I being Results Based Payments from the Government of Norway, Phase II being integration with voluntary and compliance markets and Phase III being full integration with a UNFCCC-compliant system once operational.

Phase I saw the establishment of the Guyana REDD+ Investment Fund (GRIF) as the payment mechanism for the intermediation of funds received from Guyana's success in avoiding 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 fostered the provision of results-based payments, released upon the successful completion of specified forestry sector mitigation actions as outlined in the joint concept note [7].

Initially conceptualised as a multi-donor fund, the GRIF currently relies solely on the Norwegian Agency for Development Corporation (NORAD) as the participating jurisdiction.

Guyana has now entered into the second phase of its three-phase approach building on Phase I, where GRIF created the capacities that were required by Guyana as it entered into Phase II, with participation in the Architecture for REDD+ Transactions Environmental Excellence Standard (ART-TREES), tailored for both voluntary and compliance carbon markets with 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 the sale of the credits issued by ART-TREES are being used to finance additional climate change mitigation projects across various sectors.

As a result, the GRIF and receipts from the sale of ART credits, constitute key components of the LCDS and serves as a major long-term funding source in Guyana. Moreover, activities supported through the GRIF, and other forestry sector actions strongly consider the need for continued capacity building of national stakeholders and rural communities in order to create widespread awareness and empowerment on forest protection actions, thereby strengthening the effectiveness of the implemented forest conservation and reforestation projects. Following a similar objective, substantial transfer of technology is fostered in the implementation of Guyana´s MRVS for REDD+ which utilises innovative imaging and processing technology allowing for detailed monitoring of the country´s forested areas.

Table 5.4 provides an overview of the total number of supported actions, the total amount received, and the amount yet to be disbursed for these initiatives. Notably, the large share of anticipated funding in the forestry sector is largely driven by outstanding ART-TREES carbon credits awaiting disbursement.

Table 5.4. Overview of funding status of forestry sector actions.

Number of actions supported	**5**
Actions involving capacity-building	**5**
Actions involving technology transfer	**0**
Total amount of support received	**$ 351,175,362 USD**
Total amount of support anticipated	**$ 575,283,409 USD**

Table 5.5 presents all the forestry sector actions that are completed, ongoing or planned and provides additional information on the financial source, instrument, and the scope of each activity. It is important to note that ‘funding anticipated’ refers to the ongoing disbursement of the financial resources to implement the relevant project or action.

Table 5.5 Detailed overview of support received and anticipated for forestry sector actions.

Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2011-2017	Completed	Guyana Forestry Commission (GFC)	GRIF - NORAD	Grant	7,467,412		✓	✓		National	Forestry
Title	**Guyana-EU Forest Law Enforcement, Governance and Trade Voluntary Partnership Agreement**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2012-2025	Ongoing	Guyana Forestry Commission (GFC)	GRIF - NORAD	Grant	1,700,000		✓	✓		National	Forestry
Title	**Guyana REDD+ Monitoring Reporting & Verification System (MRVS)**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2010-2025	Ongoing	Guyana Forestry Commission (GFC)	GRIF - NORAD	Grant	19,387,073		✓	✓	✓	National	Forestry
			GRIF - NORAD	Results-based Payments (Grant)	190,000,000	60,000,000	✓				
			Hess Corporation	ART-TREES/Carbon Credits	127,500,000	510,000,000	✓				
Title	**Forest Carbon Partnership Facility Project in Guyana**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2014-2020	Completed	Guyana Forestry Commission (GFC)	World Bank	Grant	3,800,000		✓	✓		National	Forestry
Title	Securing a Living Amazon through Landscape Connectivity in Southern Guyana										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer	**Geographic scope**	**Sectoral Scope**
2022-2027	Ongoing	Environmental Protection Agency (EPA) / Protected Areas Commission (PAC)	Global Environment Facility (GEF)	Grant	1,030,551	4,122,202	✓	✓		Region 9	Forestry
			WWF	Grant	144,177	576,709	✓	✓			
			German Development Bank (KfW)	Grant	146,149	584,598	✓	✓			

Cross-cutting Sectors

In addition to activities in the energy and forestry sectors, a variety of cross-cutting projects are being implemented. Cross-cutting projects are those that impact two or more different sectors, encompassing activities addressing both mitigation and adaptation, as well as those providing mitigation co-benefits. Furthermore, projects focused on providing operational support and enhancing the capacity and readiness of national institutions for climate action fall under the umbrella of cross-cutting initiatives.

In Guyana, many of these projects are funded through the GRIF, generating co-benefits related to rural development and/or adaptation. Additionally, there are numerous projects aimed at providing operational support which tend to receive support in the form of grants provided by multilateral development funds such as the GEF or the GCF.

Table 5.6 provides a brief overview of the total number of supported actions, the total amount received, and the amount yet to be disbursed for these initiatives.

Table 5.6. Overview of funding status of cross-cutting sector actions.

Number of actions supported	11
Actions involving capacity-building	10
Actions involving technology transfer	0
Total amount of support received	$ 61,410,457 USD
Total amount of support anticipated	$ 103,804,349 USD

Much like the observed funding still anticipated in the forestry sector, the outstanding amount of support yet to be received is primarily linked to non-disbursed funds from carbon credits and from results-based payments of the GRIF. Notably, through the GRIF, extensive cross-cutting activities are supported which foster the access to and the training on information technologies in rural communities to enhance connectivity and accelerate the uptake of sustainable practices.

Table 5.7 outlines all cross-cutting sector actions, indicating whether they are completed, ongoing, or planned. Additional information is provided on the financial source, instrument, and the scope of each activity. It is important to note that ‘funding anticipated’ denotes the ongoing need for the disbursement of financial resources to facilitate the implementation of the respective projects or actions.

Table 5.7. Detailed overview of support received and anticipated for cross-cutting sector actions.

Title	**Amerindian Development Fund**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	**Financial Instrument**	**Disbursed (USD)**	**Anticipated (USD)**	**Financial Support**	**Capacity-building**	**Technology Transfer**		
2012-2016	Completed	Ministry of Amerindian Affairs (MoAA)	GRIF - NORAD	Grant	8,143,042		✓	✓		National	Hinterland Development
Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2012-2018	Completed	Ministry of Business (MoB)	GRIF - NORAD	Grant	5,127,476		✓	✓		National	Economic Development
Title	**Amerindian Land Titling**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2013-ongoing	Ongoing	Ministry of Amerindian Affairs (MoAA)	GRIF - NORAD	Grant	4,340,746	6,415,244	✓	✓		National	Hinterland Development
Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2017-ongoing	Ongoing	Office of the Prime Minister (OPM)	GRIF - NORAD	Grant	17,030,752	3,755,320	✓	✓	✓	National	Hinterland Development
Title	**Village Sustainability Plans**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2021-2025	Planned	Ministry of Amerindian Affairs (MoAA) / National Toshaos Council (NTC)	GRIF - NORAD	Grant		3,400,000	✓	✓		National	Hinterland Development
	Ongoing	Ministry of Amerindian Affairs (MoAA)	Hess Corporation	ART-TREE/Carbon Credits	22,500,000	90,000,000	✓				
Title	**Strengthened Monitoring, Enforcement and Uptake of Environmental Regulations in Guyana's Gold Mining Sector**										
Duration	**Status**		**Funding**				**Type of Funding**				

		Implementing Entity	Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer	Geographic scope	Sectoral Scope
2014-2017	Completed	Environmental Protection Agency (EPA)	GRIF - NORAD	Grant	803,653		✓	✓		National	Economic Development
Title	**Guyana-Norway Partnership Operational Support – GGGI**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2021-2024	Ongoing	Green Global Growth Institute (GGGI)	GRIF - NORAD	Grant	935,138	233,785	✓	✓		National	Operational Support
Title	**GRIF operational Support – Trustee**										
Duration	**Status**	**Implementing Entity**	**Funding**				**Type of Funding**			**Geographic scope**	**Sectoral Scope**
			Source	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		
2011-ongoing	Ongoing	World Bank	GRIF - NORAD	Grant	1,340,000		✓			National	Operational support
Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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		✓	✓		National	Operational support

Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	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		✓	✓		National	Operational support
Title	**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	Financial Instrument	Disbursed (USD)	Anticipated (USD)	Financial Support	Capacity-building	Technology Transfer		

2015-2016	Completed	Caribbean Community Climate Change Centre (CCCCC)	Green Climate Fund (GCF)	Grant	300,000		✓	✓		National	Operational Support

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6. Guyana Project Portfolio. Green Climate Fund (GCF). Retrieved from https://www.greenclimate.fund/countries/guyana
7. Guyana Norway Partnership, (2009). Joint Concept Note on REDD+ cooperation between Guyana and Norway. Retrieved from https://lcds.gov.gy/wp-content/uploads/2021/10/Joint-Concept-Note.pdf

Chapter 6 - Information on flexibility

Guyana has applied the following areas of flexibility in its reporting under this first submission of its Biennial Transparency Report:

GhG Inventory Reporting

- Reporting on Greenhouse Gas Inventory utilizes the template 2006 IPCC Guidelines, with common reporting tables (CRT) for the electronic reporting of the information in the national inventory reports to be submitted separately in 2024.

Timeframe: October 2024

NDC Reporting

- NDC reporting tables reflect status of progress for each area outline in Guyana's NDC. Projections coMoPWled will be submitted using the required templates as part of Guyana Third National Communication scheduled for submission in August 2024.

Timeframe: August/September 2024

National Adaptation Planning

- Guyana has in place a national strategy for low carbon development that addresses adaptation. There is also a framework document for climate adaptation and resilience in the form of Guyana's Climate Resilience Strategy and Action Plan. Guyana is currently in the process of updating its plans on adaptation towards a National Adaptation Plan (NAP). Adaptation areas outlined in the BTR includes many aspects already laid out in the National Strategy (Guyana's Low Carbon Development Strategy 2030), and the National Plan (Climate Resilient Strategy and Action Plan). The NAP will be advanced in 2024 and submit upon Completion.

Timeframe: first half 2025

Chapter 7 - Improvements in reporting over time

Areas of improvement identified by the Party and technical expert review team in relation to Party's implementation of Article 13 of the Paris Agreement (para. 7(a) of the MPGs)

Guyana intends to develop a sector led data management system as part of its national integrated MRV framework. The country will work to create a structure to feed information from the sector level into a reporting system for the UNFCCC. The envisioned data management system will collate data at the sector level and support the organisation, storage, and archiving of Guyana's information utilised within its national MRV framework. This, in turn, will play a crucial role in shaping national policies and plans while ensuring the fulfilment of the country's reporting obligations to international agreements.

By creating this networking structure, the national MRV, with implementation at the sector level generating inputs for a dedicated data management system, Guyana aims to integrate all MRV subsystems. This approach is designed to facilitate the fulfilment of commitments under both the UNFCCC and the Paris Agreement, providing an effective solution for comprehensive and streamlined reporting processes.

How the Party is addressing or intends to address areas of improvement as referred to in paragraph 7(a) of the MPGs (para. 7(b) of the MPGs)

Improvements will be addressed by implementing the main actions listed below:

- **Agreement on consistent and comparable definitions:** Adopting consistent and comparable definitions, abbreviations, and acronyms will support alignment of datasets, which allows for more detailed comparisons and, ultimately, better informs policy discussions.
- **Stakeholder engagement and consultation during design and development:** Identifying and engaging stakeholders is crucial for the design of the data management system. This process offers various benefits, such as aligning the system with national priorities, securing early buy-in from key user groups, and building capacity to reduce data entry errors. Stakeholder engagement also aids in maintaining public support and refining the system by gathering feedback on specific needs and functional components during requirements gathering and testing.
- **Gradual implementation and continuous improvement framework for long-term sustainability:** Regular enhancements to the data management system will be anticipated to align with evolving policy landscapes and enhance overall system functionality. This will ensure the adaptability to policy changes and the ability to harmonise data from various reporting elements.
- **Build sense checking into systems to ensure robust data systems:** Input errors are likely to occur when large volumes of data are submitted to the system, undermining users' confidence in the data quality. To mitigate these errors, checks will be incorporated into the

data submission process including safeguards to ensure data integrity. This will ensure user confidence in the robustness of the data, which will ensure that the data is used for decision-making.

- **Create data security and integrity controls:** Security measures will be incorporated for authenticating access to ensure that the data on the system is protected.
- **Training and support to ensure that the system is used effectively and reduces user error:** Enhanced user understanding of the data management system improves the accuracy of data submissions. Post-system development, supporting and building the capacity of climate data management users will be ensured for smooth operations. In addition, the diverse capacities among reporters are recognised and an ongoing system for user training will significantly improves data submission quality.

Areas of improvement that are related to the flexibility provisions used (para. 7(c) of the MPGs)

The following areas of flexibility provisions will be implemented:

- Guyana will advance the development of a National Adaptation Plan
- Capacities will be built at the sector level to develop MRV capabilities as needed for routine reporting

A. Reporting-related capacity-building support needs identified, including those referred to in chapter VI above and any progress made, including those previously identified as part of the technical expert review in chapter VII of the MPGs (para. 7(d) of the MPGs)

Main gaps are presented below:

Table 7.1 Constraints and gaps faced by Guyana and related needs.

Dimension	Constraints and Gaps	Associated needs	Measures to address constraints and gaps	Priority
GHG Inventory	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 Department of Environment and Climate Change (DECC) and other ministries for which funding is required to hire and employ adequately skilled persons, to provide training and to acquire material.	High
	The data collected for the inventory should be enhanced.	Technical / Capacity	Implement an effective and centralised monitoring, reporting, and verification (MRV) system to guide thorough data collection procedures in line with the reporting cycles under the UNFCCC. To do so, harness existing sectoral MRV approaches to streamline the procedures.	High
	Awareness on the required collaboration among data providers for GHG inventory coMoPWIation and lack	Capacity	Accelerate sectoral outreach as well as inter-institutional data-sharing agreements and memoranda of understanding. Foster awareness and trust	High

	of protocols in place to ensure data protection and confidentiality.		through high confidentiality standards and clear agreements.	
	Integrated databases and national statistics to facilitate the inventory development process.	Technical	Enhance key national statistics such as the Energy Balance, customs data, as well as forestry and agricultural information and develop effective databases to draw from for the inventory development.	High
	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	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
	National resources to achieve more ambitious forestry sector actions.	Financial	Mobilise additional funding for forestry sector projects.	Medium
	Resources and incentives to support research and guide the development and implementation of mitigation actions.	Financial / Capacity	Establish cooperation with national research universities and institutes to develop a strong knowledge basis in the country and to inform adequate policy decisions.	Medium
	Additional sectors such as agriculture, transport, industrial processes and product use (IPPU), and waste need to be 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
Policy and Cooperation Framework				
	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 Low Carbon Development Strategy (LCDS) and the nationally determined contribution (NDC) and streamlining the key objectives into sectoral development plans.	High
	Coordination and collaboration among agencies.	Technical / Capacity	Improve inter-institutional coordination through an effective MRV framework and increased awareness activities.	High
	Some reliance on donor finance for implementation of climate action.	Financial	Enhance private sector contribution to climate action through (1) incentive mechanisms and public-private partnerships, (nd (3) improving the Guyana REDD+ MRV framework (MRVS) to enable the sale of the highly innovative	Medium

	Architecture for REDD+ Transactions Environmental Excellence Standard (ART-TREES) carbon credits.	

Parties' domestic plans and priorities with regard to improved reporting pursuant to paragraph 7 of the MPGs are not subject to technical expert review, but the information may inform discussions on areas of improvement and identification of capacity-building needs between the technical expert review team and the Party concerned (para. 8 of the MPGs)

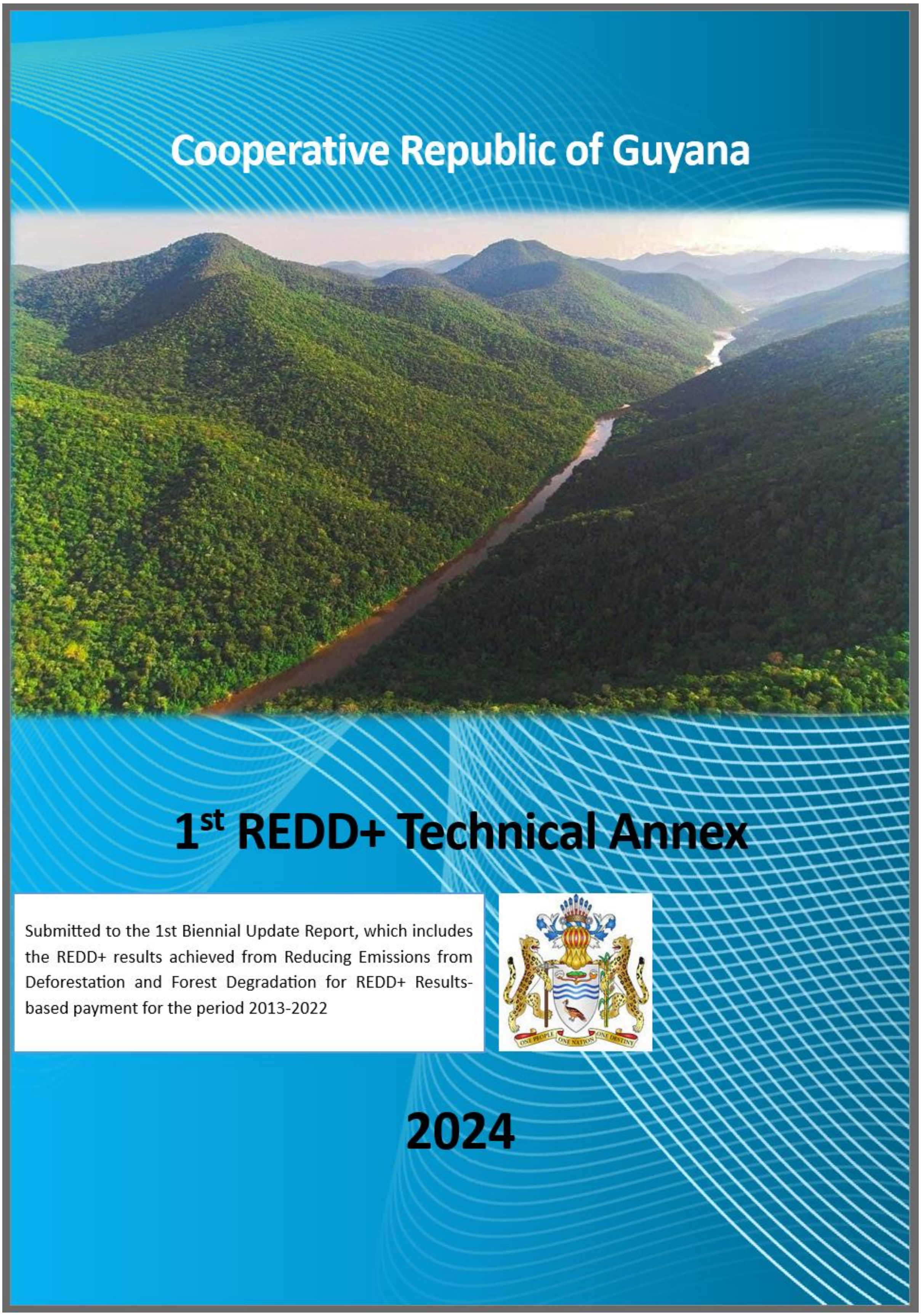
Any other information the Party considers relevant to the achievement of the objective of the Paris Agreement, and suitable for inclusion in its biennial transparency report

No information to be provided by Guyana at this time.

Annex

Annex I

Guyana's REDD+ Technical Annex



LIST OF EQUATIONS

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Acronyms

ART	Architecture for REDD+ Transactions
AT	Assessment Team
COP	Conference of the Parties
FREL	Forest Reference and Emissions Level
GFC	Guyana Forestry Commissions
GHG	Greenhouse Gas
GoG	Government of Guyana
HFLD	High Forest Cover/Low Deforestation
IPCC	Intergovernmental Panel on Climate Change
LCDS	Low Carbon Development Strategy
MRV	Measurement/Monitoring Reporting and Verification
NDC	Nationally Determined Contribution
NFMS	National Forest Monitoring System
REDD+	Reducing Emissions from Deforestation and Forest Degradation
TA	Technical Analysis
TREES	The REDD+ Environmental Excellence Standard
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market

INTRODUCTION

This Technical Annex provides additional information to Guyana's first Biennial Update Report of results achieved from Reducing Emissions from Deforestation and Forest Degradation REDD+. This annex has been developed per Decision 14/CP.19 (2013), requiring developing country Parties that wish to receive REDD+ results-based payments to submit their estimated calculation of GHG emissions reduction and removal enhancements related to forests to the United Nations Framework Convention on Climate Change (UNFCCC) as a technical annex to the BURs. This technical annex provides the information and data as requested in the Annex to Decision 14/CP.19, which provides guidance on the elements to be included in the technical annex as per paragraph 7 of Decision 14/CP.19, including six following contents: (1) Overview of FREL/FRL, (2) GHG emission reduction results, (3) consistency in methodology between REDD+ results calculation and FREL/FRL construction, (4) National forest monitoring system and responsibilities of relevant authorities, (5) Necessary information to allow for the reconstruction of the results, and (6) Compliance with paragraphs 1 (c)5 and 1 (d)6 of Decision 4/CP.15.

The Conference of the Parties encourages developing countries, such as Guyana, to contribute to mitigation actions in the forest sector by undertaking REDD+ activities: reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon stocks (decision 1/CP.16, paragraph 70). The activities are intended to contribute to the achievement of Article 2 of the convention, which aims at strengthening the global response to climate change within the context of sustainable development and fulfilling commitments made in the National Determined Contributions proposed by the Party in fulfillment of the obligations set out in Article 4, paragraph 3.

Countries participating in REDD+ are encouraged to develop national strategies or action plans outlining their approach to reducing emissions from deforestation and forest degradation, the conservation and sustainable management of forests, as well as the enhancement of forest carbon stocks. Establishing a forest reference level (FREL) is a crucial aspect of REDD+. The FREL serves as the benchmark against which emission reductions can be measured. One of the key aims of REDD+ is to provide financial incentives for developing countries to reduce emissions from deforestation and forest degradation. It also emphasizes the importance of implementing robust and transparent forest monitoring systems to track changes in forest carbon stocks. This requires the building of institutional and human capacity to effectively implement REDD+ activities, including systems for monitoring, reporting, and verification (MRV) and building the capacity of relevant stakeholders to ensure transparency and accountability in the implementation of the national REDD+ program.

Guyana is considered a member of the Small Island Developing States (SIDS) and is therefore granted flexibility (Decision 18/CMA.1 , 2018) in fulfilling its commitment to the Paris Agreement (PA) (PA, 2015). Guyana has taken advantage of Article 5.2 of the PA where REDD+ was recognized, by taking action to implement and support, including through results-based payments, the existing framework for activities relating to reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. However, despite the capacity and resource challenges, Guyana, in its effort to improve transparency, accountability, and consistency of its obligation to the PA, is submitting this Technical Annex, which outlines the efforts made by the country in safeguarding its environmental integrity and promoting sustainable use of its forest resources to leverage the promotion of sustainable development along a low carbon pathway following national priorities and international obligations.

As such, Guyana is honored to present this first REDD+ Technical Annex to its first Biennial Update Report, where the results achieved by the country are reported for the period 2013 to 2022. This is following the successful submission of the FREL in 2015, which covers a historic period ending in 2012. This reporting period (2013-2022) was selected to facilitate information consistency and adherence to reporting requirements, aligning with the updated GHG Inventory and reporting periods of the BUR, to which this REDD+ Technical Annex is attached.

This submission presents the results achieved following the jurisdictional approach since 2009 to establish the robust MRV system that generates consistent and accurate information with improvement over time to estimate Guyana's anthropogenic forest-related emissions by source and removals by sinks, forest carbon stocks and forest area changes following the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines.

National Circumstances

Guyana has the second highest percentage of forest cover on earth (85%), storing approximately 19.5 billion tons of CO2 e, and one of four countries in the world verified to have a sustained High Forest Low Deforestation (HFLD) state, containing high levels of biological diversity and endemism (LCDS, 2022). It is home to a variety of known animal species, including the iconic Amazonian species: jaguar, giant river otter, harpy eagle, tapir, giant anteater, and giant armadillo. From the earlier FREL submission, Guyana has refined its mapping of agriculture areas, including potential areas for shifting agriculture, and this has been excluded from the forest cover map in keeping with Guyana's forest definition. Additionally, the forest carbon stock inventory was finalized to cover all areas of Guyana, resulting in an updated stock inventory. The country is also home to large numbers of plant species and natural savannahs, giving Guyana exceptionally high levels of endemism, according to the IUCN[20]. Guyana's ocean area, which is more than half of Guyana's terrestrial area, offers a new frontier for sustainable development through the expansion of the Ocean/Blue Economy. These ecosystems support diverse species to the extent that as of 2010, Guyana's species status was estimated at 8,000 plant species; 467 fishes; 130 amphibians; 179 reptiles; 814 birds; 225 mammals; 1,673 arthropods; over 1,200 fungi; 33 bacteria; 13 nematode; 44 algae; 17 molluscs; and, an estimated 30 viruses (EPA, 2014) According to the FAO[21] , Guyana has 1,182 native tree species. Guyana's biodiversity provides an essential basis for climate regulation, poverty reduction, provisioning of freshwater, economic growth and development in areas such as agriculture, forestry, and fisheries, payment for forest climate services, and community-based economies, particularly in hinterland communities. Loss of biodiversity and any disruption in the provision of ecosystem services would negatively impact the economy and, more particularly, the quality of life of the people of Guyana.

Guyana has approximately 18 million hectares of forest and has continuously worked with partners to sustain 99.5% of its forest while building the foundation of and developing a low carbon economy. Guyana's deforestation rates are among the lowest in the world, reported at 0.036% for 2022 (GFC, 2023). It is one of four countries forming the Guiana Shield, one of the most pristine rainforest landscapes in the world, comprising around 18% of the world's tropical forest carbon and 20% of the world's freshwater (LCDS, 2022).

Guyana's forest plays an essential role in addressing the global problem of climate change and its effects. At the same time, recognizing that these forest resources are a valuable natural asset for obtaining revenue for growth and development, in 2009, Guyana launched the first Low-Carbon Development Strategy (LCDS), which sets out a vision for inclusive, sustainable development while maintaining the country's forests, about 85% of the country's territory, to help meet some of the world's most urgent challenges. This commitment has not changed over the years and is further strengthened with the now-extended LCDS 2030, finalized in 2022.

The original LCDS 2009 set out a three-phase plan for accessing financing for forest climate services. This commenced with results-based payments under the Guyana-Norway Agreement (Phase 1), and in 2022, this transitioned to access to the voluntary and compliance markets (Phase 2) with a plan to transition to a fully-fledged UNFCCC market mechanism once this has been operationalized (Phase 3).

[20] IUNC: https://www.iucn.org/about-iucn
[21] FAO, Global Forest Resources Assessment, 2005.
http://www.fao.org/forestry/country/20807/en/guy/.

During Phase 1, the Guyana-Norway Agreement saw Guyana receive over US$220 million for its REDD+ performance during the period 2009-2015. Phase 2 saw payments from the voluntary carbon markets received for performance from 2016 onwards, albeit the first payments were received in 2022. To date in Phase 2, Guyana has earned US$187.5 million from sales in the voluntary carbon market (for results in the period 2016-2020), with a further US$100 million to come for the remainder of the period covered in this Technical Annex (2021 and 2022).

Building from these positive foundations, the expected opportunity to access carbon financing for forest climate services and other ecosystem services will continue to enable Guyana to participate in emissions reduction while, at the same time, growing its economy five-fold over 20 years, keeping energy emissions flat, investing in its people, both indigenous in the hinterland communities and the vast majority living along the coast, from climate change; create jobs; and integrate Guyana's economy with its neighbours (LCDS, 2022). Guyana

Guyana stayed true to the vision in 2009 to create a model low-carbon economy for the world and submitted its reference level for REDD+ to the UNFCCC in 2015. Based on Guyana’s performance, incentivised by results-based payments and then access to the voluntary carbon market, the country maintained an average annual low deforestation rate below 0.06% in the last ten years, with the latest being 0.036% in 2022.

Guyana is preparing to submit its revised FREL in 2024.

OVERVIEW OF GUYANA'S FREL/FRL

Guyana submitted its national proposed forest reference emission level (FREL) on December 8, 2014, in accordance with decisions 12/CP.17 and 13/CP.19. Following the process contained in the guidelines and procedures of the same, a draft version of the technical analysis (TA) report was communicated to the Government of Guyana, during which the facilitative exchange between the assessment team (AT) and Guyana enables the country to provide clarifications and information considered by the AT. Guyana resubmitted a modified version of its FREL on April 27, 2015, which took into consideration the technical input by the AT, and it is on the revised FREL that the technical assessment was conducted. The technical assessment report was published on October 13, 2015 (FCCC/TAR, 2015).

Guyana's FREL is based on a "combined reference level approach," which provides incentives for all categories of forest countries and encompasses REDD+ in its entirety. A full explanation of the background was set out in Guyana's initial submission in section 6.2 (page 44) but its rationale was summarized in the Eliasch Review[22], which was produced for the Government of the United Kingdom: "The combined [reference level] has the potential to be sufficiently comprehensive to attract countries at all stages of the deforestation process over both the short and long term. Countries with high historical rates of deforestation receive strong and realistic incentives to reduce forest emissions. At the same time, countries with standing forests and a track record of avoided deforestation would receive incentives to keep deforestation rates low, zero or negative (if, for example, rates of ARR are high). This rewards countries with a history of responsible forest policies while reducing the risk of international leakage of deforestation to these countries."

The FREL uses a global forest carbon emissions loss of 0.435%, the historical annual forest carbon emissions percentage of Guyana for the period 2001–2012 (0.049%), resulting in the FREL being 0.242% which is the average of the two. Guyana includes emissions from deforestation and forest degradation due to timber harvesting practices in its FREL. At that time, it excluded removals from carbon stock enhancements, though it should be noted that more than 80% of the national territory is forested. Historically, there have been few activities related to enhancing forest carbon stocks, for which the reference level was developed, covering the period 2001-2012. The FREL considers national circumstances and Guyana's ongoing development in creating new economic and social incentives, which can significantly impact rates of forest cover. Table 1 lists the main features of Guyana's FREL (FCCC/TAR, 2015).

Table 1 Summary of the Main Features of Guyana's FREL

Features of the FREL		Description
Proposed FREL (t CO2 e yr^{-1})	46 301 251	Calculated from the estimated combined Guyana and global reference emissions percentage of 0.242%. The reference level is represented as the number of emissions.
Type and duration of FREL	Combined reference level approach	Guyana's historical period of 2001–2012 is considered and adjusted for national circumstances combined with the global average reference level approach.
National/subnational	National	Guyana's FREL is of national coverage.
Gases included	CO_2	Only CO2 gases are included in the combined FREL.
Carbon pools included	Aboveground biomass, belowground biomass, Deadwood	All five carbon pools were considered for Guyana, but owing to limitations in the global data used to construct the combined FREL, only three pools were used.

22 Eliasch Review - GOV.UK (www.gov.uk)

Activities included	Deforestation Forest degradation	Includes the gross emissions from deforestation (excluding regrowth from deforestation and forest degradation), including all types of land conversion to non-forest land, and the gross emissions from selective logging under forest degradation.
Forest definition	Included	Minimum tree canopy cover of 30 per cent, minimum land area of 1 ha, and minimum tree height of 5 m in situ
Relationship with the latest GHG inventory	Methods used for FREL differ from the latest GHG inventory (2012)	The difference in methods is due to the use of updated data and the 2006 IPCC Guidelines used in the FREL as compared to 1996 used in coMoPWIing the GHG inventory reported in the Second National Communication.
Adjustment for national circumstances	Yes	The global emission levels were used for adjustments as Guyana's historical emission trend is unlikely to predict future emissions accurately.
Description of relevant policies and plans	Included	Included in section 6.1 of the FREL submission
Description of assumptions on future changes in policies	Included	The national circumstances and future perspective describe ongoing policy frameworks and planned new policies and measures.
Future improvements identified	Yes	Some technical improvements are identified, and their submission is planned.

Source: (FCCC/TAR, 2015), Annex

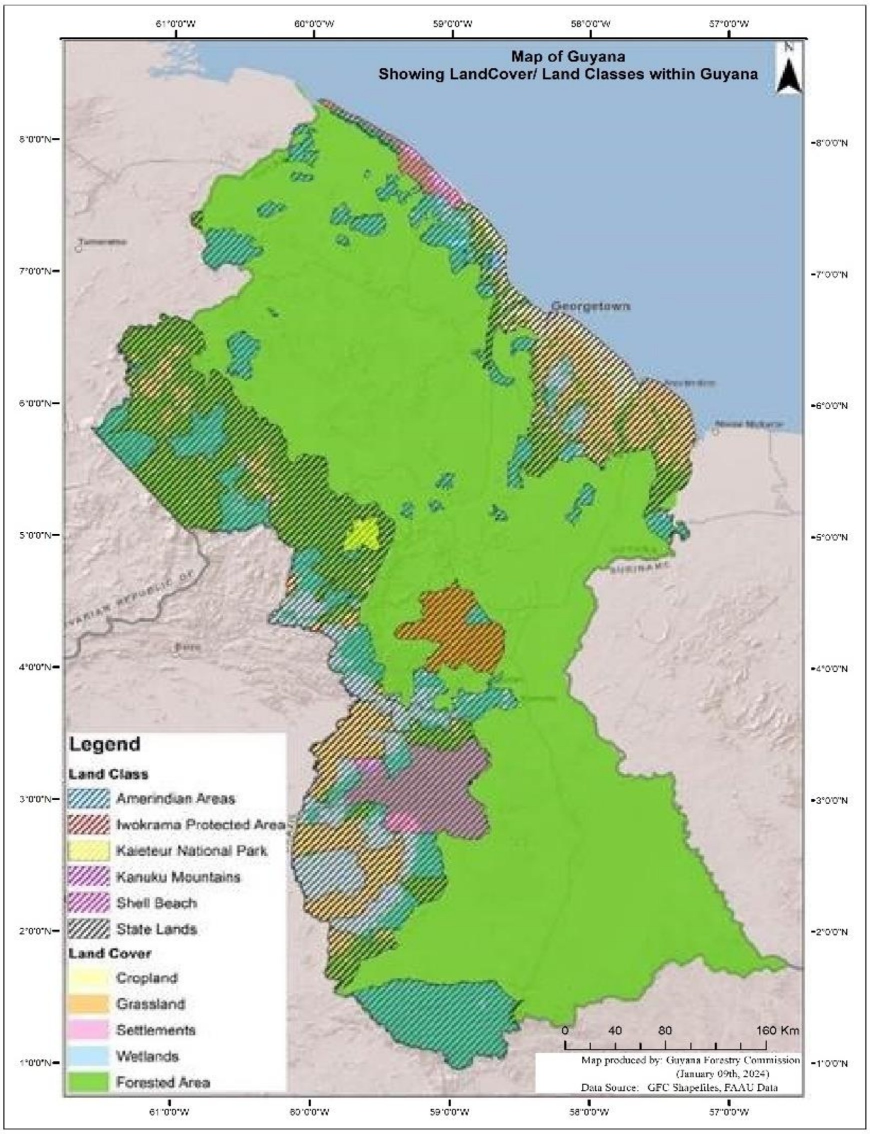
Information on Forest Definition and Land Tenure

In Guyana, the forest is defined as having "*a minimum area of land of 1 ha with tree crown cover of more than 30% with the potential to reach a minimum height of 5 m at maturity in situ*" (GFC, 2010). This definition is guided by the Marrakech Accords (UNFCCC 2001[23]) and the components suggested by the FAO. Guyana's forests are categorized as tropical rainforests, including high-density forests, secondary forests, mangroves, etc. Approximately 50% of Guyana's State Forest Estate is unallocated, while the remaining 50% is subject to sustainable utilization for commercial operation, whereby extraction levels are strictly monitored based on approved guidelines. These extractions result in deforestation and forest degradation.

Forests in Guyana are managed and administered under the Guyana Forestry Commission Act 2007 and the Forest Act 2009. There are four main forest tenure classifications in Guyana distributed across the national territory of 21.1 million hectares spanning from 2 to 8° N and 57 to 61° W, with a coastline running along the Atlantic Ocean of approximately 16km wide and 459 km long.

[23] Marrakech Accords (2001): https://unfccc.int/cop7/documents/accords_draft.pdf

- **State Forest Area** - According to the Forest Act Section 3, Chapter 61:01, it is defined as “an area of State Land that is designated as a State Forest” as per the gazette.
- **Titled Amerindian Lands** - The Amerindian Act 2006 provides for areas that are titled Amerindian villages. It includes lands initially titled and the extensions for which titles are issued.
- **Protected Areas -** These are areas that fall under the scope of the Protected Areas Act. To date, Iwokrama, Shell Beach, Kanuku Mountains, and Kaieteur National Park, which account for a total of 1.1 million ha, have been designated as Protected Areas (see **Error! Reference source not found.**).
- **State Lands** - State Lands are identified as areas that are not included as part of the State Forest Area that is under the mandate of the State. This category predominantly includes State Lands, with isolated pockets of privately owned land, excluding titled Amerindian lands.



Setting the FREL

Guyana's FREL is set at the national scale in compliance with the various UNFCCC requirements and is based on the detailed and robust analysis of historic emissions from deforestation and forest degradation for the period 2001 to 2012.

The table on the overleaf, lists the multiple variables and attributes used in developing Guyana’s FREL in compliance with the UNFCCC modalities and the various Decisions.

Table 2 UNFCCC Modalities Relevant to Guyana's National FREL

Guidelines	Description	Guyana's FREL
Decision 12/CP.17 Paragraph 10	Allows for a stepwise approach	FREL is at a national scale and includes all drivers of deforestation and forest degradation due to selective logging only.
Decision 12/CP.17 Annex, paragraph (c)	Pools and gases included	**Pools:** • Aboveground and belowground biomass • Deadwood is included in degradation from timber harvest only. **Gases:** CO_2
	REDD+ Activities: deforestation and forest degradation	**Deforestation Drivers:** Agriculture, mining, forestry infrastructure, and other infrastructure. **Forest Degradation** from timber harvesting only
Decision 12/CP.17 Annex, paragraph (d)	The definition of forest used is the same as that used in the national GHG inventory.	Minimum tree cover: 30% Minimum height: 5 m Minimum area: 1 ha
Decision 12/CP.17 Annex	IPCC guidelines and Guidelines used	IPCC 2003 and 2006 guidelines.
Decision 12/CP.17 II. Paragraph 9	To submit information and rationale on the development of forest RLs/RELs, including details of national circumstances and how the national circumstances were considered.	Guyana is an HFLD country (having over 87% forest cover and an average deforestation rate of below 0.06%). The FREL uses a holistic methodology that includes countries like Guyana, as well as other categories of forest countries and therefore avoids perverse incentives so as to act as an incentive against leakage and in support of additionality and permanence in countries like Guyana.

Construction of the FREL

Guyana's proposal for a Reference Level for REDD+ illustrated in Figure 3 is based on the Combined Reference Level Approach, in which a global forest carbon emissions loss ((Baccini, et al., 2012) was used, along with Guyana's historic emissions level for the same pools and period 2001 to 2012. The FREL was derived by averaging the global percentage of forest carbon emissions of 0.435% and Guyana's historical annual average of 0.049%, resulting in Guyana’s proposed FREL being set at 0.242%, which is equal to 46,301,251 t CO_2 e yr^{-1}.

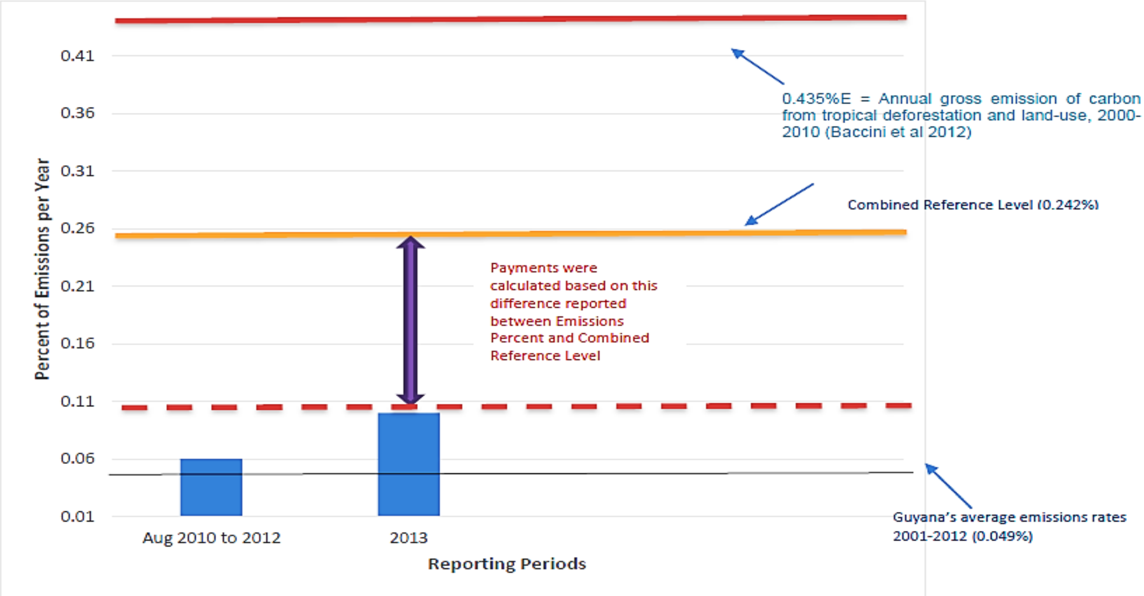


Figure 3 Guyana's for Reference Level for REDD. Source: (GoG, 2015) Fig. 8

Emissions Drivers Considered in the FREL

Emissions are calculated for each driver considered in Guyana's FREL and projected impacts. These drivers include forestry, mining, agriculture, infrastructure, and other developments. Table 3 lists the projected allocation of emissions each driver will contribute to the reference level. While the FREL is built on historical data, it is understood that adjustments will be made over time as existing and new policies are implemented, new data becomes available, methodology evolves, and national circumstances change.

Table 3 Guyana's FREL by Drivers

Drivers of Projected Emissions Level	Policies	Percentage of Contribution to Reference Level	Total Emissions attributed to driver (thousand tCO_2)
Forestry	EU FLEGT, Reduced Impact Logging and SFM, National Log Tracking and Chain of Custody Management.	20	9,260
Mining	EITI, Codes of Practice, Reduced Use of Mercury, More Efficient Technologies.	49	22,688
Infrastructure, including Brazil/Guyana Road	Scoping of Development, Environmental and Social Impact Assessment (ESIA).	9	4,167
Agriculture	Scoping of Development, ESIA.	4	1,852
Other Developments, such as in Alternative Energy	Scoping of Development, ESIA.	18	8,334
TOTAL			**46,301**

Source: (GoG, 2015) Table 13b

Annual REDD+ Performance Based on Reference Level

Annual Reported Emissions per cent under the FREL is computed by dividing the annual reported forest carbon emissions loss by the total forest carbon stock of Guyana that is concluded following measurement and verification, inclusive of the establishment of accuracy levels, which is then subtracted from the Combined Average of 0.242%. The Total carbon stocks in life biomass (aboveground and belowground pools) for Guyana is 5,218 million t C (area weighted average is 283 t C ha^{-1}), and the total emissions are 2.55 million t C yr^{-1}, giving an average rate of loss of 0.049%/year (GoG, 2015). These average carbon emissions of 46,301,251 t CO_2e yr^{-1} or 0.242% are used as the baseline for computing and reporting on Guyana's REDD+ activities. The Annual performance is measured against the proposed emissions by the drivers listed in Table 3.

Technical Evaluation of FREL/FRL

The UNFCCC Technical Assessment Report (TAR) of Guyana's proposed FREL/FRL recognized that the information used in its construction for reducing emissions from deforestation and reducing emissions from forest degradation is transparent and complete and is in overall accordance with the guidelines for submissions of information on FRELs (as contained in the annexe to decision 12/CP.17) (FCCC/TAR, 2015).

As a result of the facilitative interactions with the assessment team (AT) during the technical assessment (TA) session, Guyana submitted a modified submission considering the technical input by the AT, resulting in improvement in the transparency and completeness of the information, an effort the AT noted as commendable. The AT notes that the data used in the construction of the FREL are considered accurate. Guyana was encouraged to continually build on GhG datasets in the preparation of subsequent GHG inventory on forest-related emissions report submissions.

Guyana was commended for the information provided on its ongoing work in the development of FRELs to improve the accuracy and coverage of the estimations by the assessment team. The TAR also acknowledges that Guyana included in the FREL the most significant activity and pools in terms of emissions from forests and that the FREL covers the entire national territory of Guyana, complying with decision 1/CP.16, paragraph 70, on activities undertaken, paragraph 71(b), and decision 12/CP.17, paragraph 10, on implementing a stepwise approach.

The TAR acknowledged that the combined reference level approach used by Guyana in its submission was developed in 2009 before any of the relevant COP decisions were adopted. The AT concludes that the combined reference level approach applied by Guyana is appropriate as an interim approach.

A partnership between Guyana and Norway was agreed to and detailed in a joint concept note outlining the basis of Guyana receives results-based payments in accordance with agreed performance measures - with one of the main measures being the annual deforestation rate, measured against Guyana's FREL.

The intention expressed by Guyana to continue monitoring forest and its related emissions, continued efforts to estimate emissions from other drivers of forest degradation in addition to selective logging, which had not been quantified at that time, efforts to estimate removals due to regrowth, which has also not been quantified at that time; carrying out research and gathering information in order to improve the transparency and accuracy of the approach used to estimate its FREL; and efforts to prevent any double counting between deforestation and forest degradation in its future monitoring system, was commended by the TA in the TAR. Future technical improvements include improving the way effects of national circumstances, policies and programs are quantified and reflected in the FREL, assessing pools and gases included in the FREL, and considering non-CO_2 gas emissions when additional sources of emissions are included in the FREL was reported by Guyana.

GHG EMISSION REDUCTIONS AND REDD+ RESULTS

Guyana's unique position as a country with vast forests and diverse ecosystems provides significant opportunities for REDD+. Guyana balances its economic development goals with sustainability and takes a proactive approach to addressing emissions to mitigate the impacts of climate change. For consistency, transparency, and comparability purposes, this submission will only consider REDD+ covering the period 2013 to 2022. As such, the results present herein will reflect this period. Notably, there have been improvements since the submission of the FREL in 2015, which are reflected in the current BUR submission and this technical annex. Some of these differences are reflected in the drivers of deforestation and degradation, as well as the methodology and emissions factors used, which are discussed in the methodology section of this report REDD+ Results.

Guyana developed a framework for a national Monitoring Reporting and Verification System for REDD+ in 2009, outlining progressive steps over three phases to build and implement a complete MRV system, with the first year of reporting being 2010. From this period, the country generated annual REDD+ results, which are tracked and verified by a third party as part of its verification process embedded in its standard operating procedures, adding a layer of transparency to the results published annually. To date, twelve (12) annual MRV reports have been published, for which initial feedback is received and addressed before their finalization and publication. The primary purpose of these reports is to report on the country's annual REDD+ performance on deforestation and degradation and to provide critical information used to inform and shape national policies and strategies.

Annual Emissions from Deforestation and Degradation

In Guyana, forest is defined as "Land exceeding 1 hectare with trees exceeding 5m in height and 30% crown cover but not classified as agriculture, infrastructure or settlements" (GFC, 2017). An area is deemed deforested once the cover falls and remains below the elected crown cover threshold of 30%, which is guided by the GOFC-GOLD, 2010[24] definition of "the long-term or permanent conversion of land from forest use to other non-forest uses." Figure 4 presents Guyana's annual REDD+ performance by deforestation and forest degradation for the accounting period 2013-2022. Despite having information for all five IPCC-recommended carbon pools available, Figure 4 only includes emissions for the aboveground and belowground carbon pools to ensure alignment with the FREL as much as possible. Despite measuring additional drivers since the submission of the FREL, to ensure consistency in reporting against the FREL, only those drivers listed in the FREL are presented in Figure 4. In contrast, for completeness purposes, Figure 5 offers the emissions for all currently measured drivers.

[24] GOFC-GOLD (2010): https://redd.unfccc.int/uploads/63_33_redd_20120509_gofc-gold.pdf

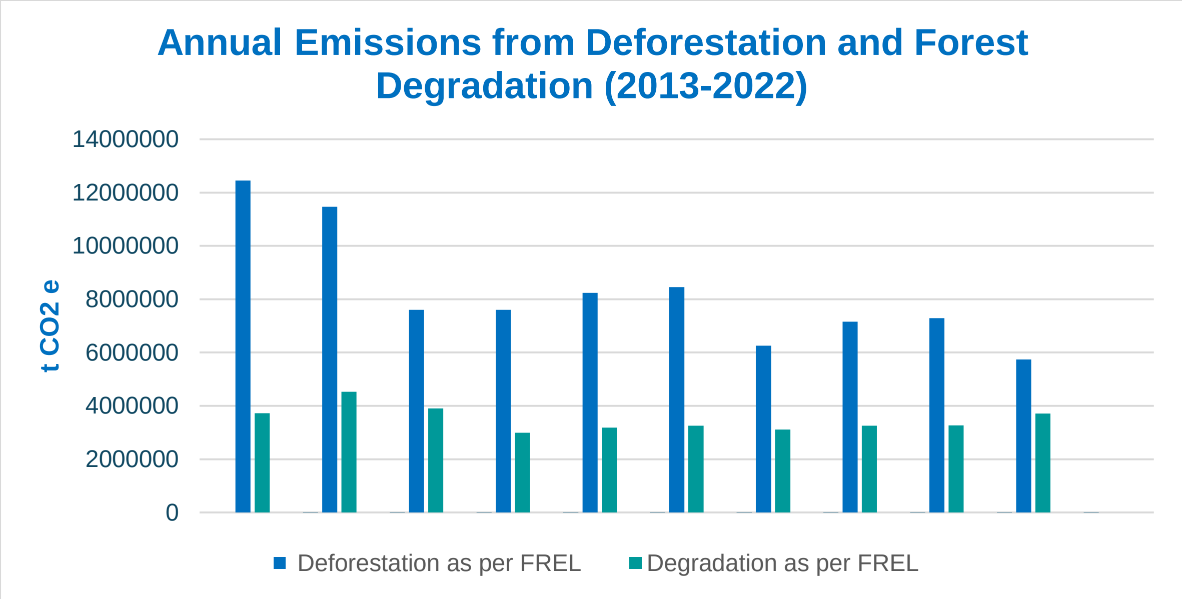


Figure 4 Annual Emissions from Deforestation and Forest Degradation as per FREL

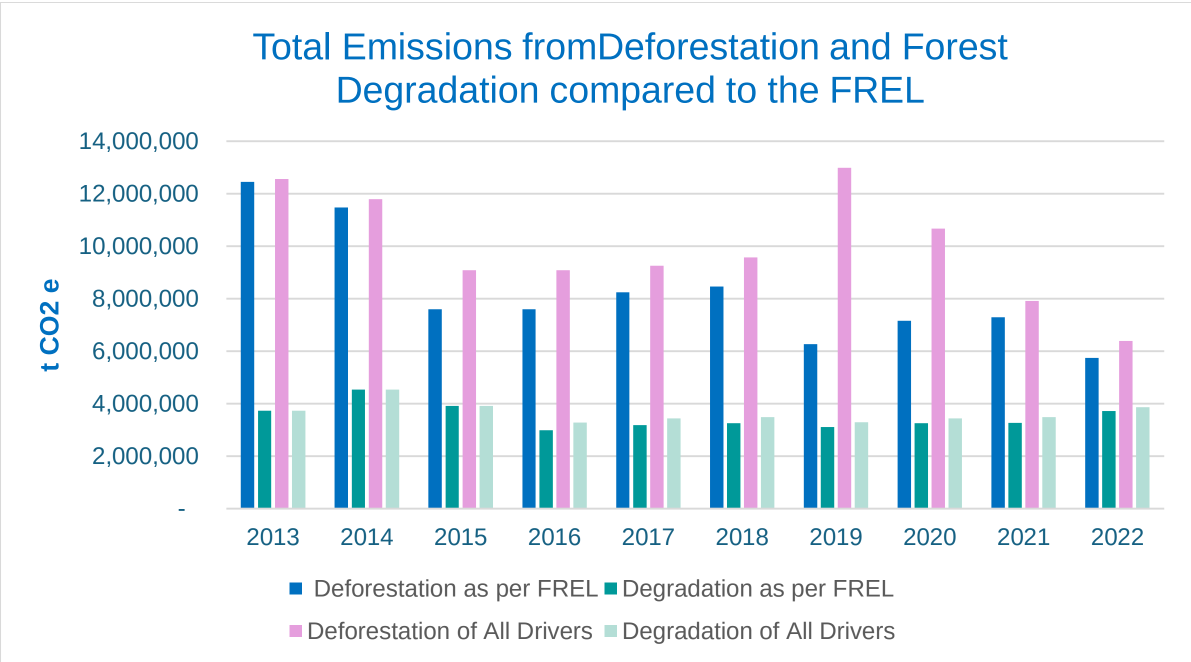
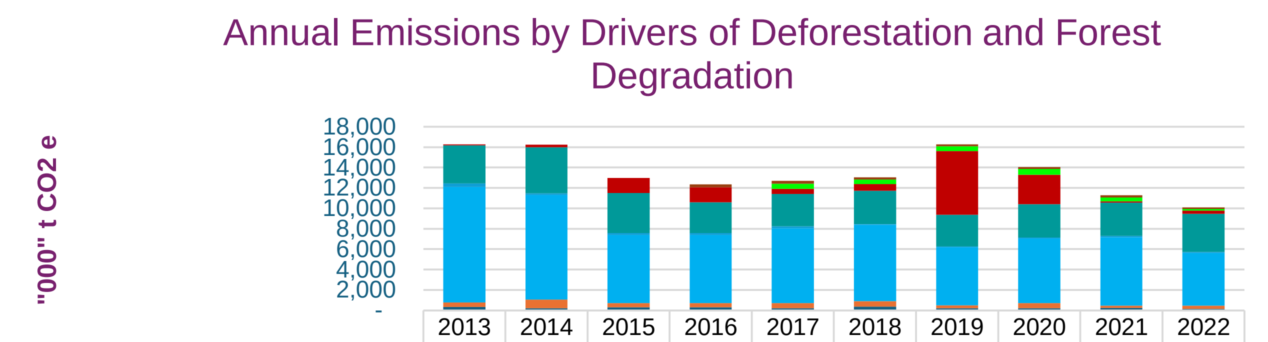


Figure 5 Actual Emissions from Deforestation and Forest Degradation compared to FREL

Over the reporting period, emissions resulting from forest degradation have remained largely consistent. However, deforestation fluctuates, mainly due to mining, which remains the major driver in Guyana, as seen in Figure 4 and Figure 5. The drivers of deforestation and forest degradation contributing to the annual emissions are presented in Figure 6. While emissions from forest degradation remain almost constant over the reporting period, those from deforestation fluctuate. While fire as a driver is not included in the FREL, it is being tracked as part of the current MRV system.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mining and Infrastructure Deg.	-	-	-	296	257	227	186	184	215	149
Shifting Cultivation	-	-	-	-	511	451	446	574	386	153
Fire	94	254	1,482	1,482	493	649	6,257	2,880	137	328
Logging	3,725	4,533	3,910	2,988	3,181	3,259	3,110	3,254	3,267	3,715
Infrastructure	337	139	214	214	192	66	51	101	115	109
Mining (medium and large scale)	11,343	10,275	6,679	6,679	7,329	7,508	5,733	6,354	6,721	5,184
Agriculture	443	853	396	396	498	534	257	510	225	294
Forestry infrastructure	325	201	308	308	224	351	223	193	225	153

Figure 6 Annual emissions by drivers of deforestation and forest degradation

It should be noted that the emissions from deforestation and forest degradation for these years presented in this REDD+ TA will not align completely with those reported in the greenhouse gas inventory chapter attached to the BUR, as the BUR includes the methodological advancements made since 2015 and revisions made to the crediting baseline. Since submitting the FREL, Guyana has improved its data collection and expanded the drivers, carbon pools, and gases covered to enhance the completeness and accurate reporting of the country's REDD+ Performance to enhance transparency. The new drivers that are included in the country's GHG inventory for deforestation are settlements and biomass burning, and degradation resulting from mining infrastructure, which are reflected in the national GHG inventory. Special studies were done on shifting agriculture which was previously presented as part of Agriculture. Shifting agriculture occurs in the hinterland areas of Guyana, and was separated out from agriculture. The mapping signature is unique as compared to other forms of agriculture, thereby avoiding double counting. Guyana's Standard Operating Procedures for Mapping, provides details on this. A revised FREL to be submitted will reflect the new national circumstances and include these updates.

REDD+ Results Relative to FREL

For the reporting period 2013 to 2022, Guyana's average annual emissions, as per the FREL, is 13,576,274 t CO_2e, while the average yearly reduction is 32,724,977 t CO_2e. These emissions vary over the years, as illustrated in Figure 7, with an almost consistent decrease in the country's emissions. From the results generated, Guyana is well below its FREL baseline, and considering the evolving national circumstances and data availability, the FREL is being revised. Table 4 lists the annual emissions by drivers reported in the FREL.

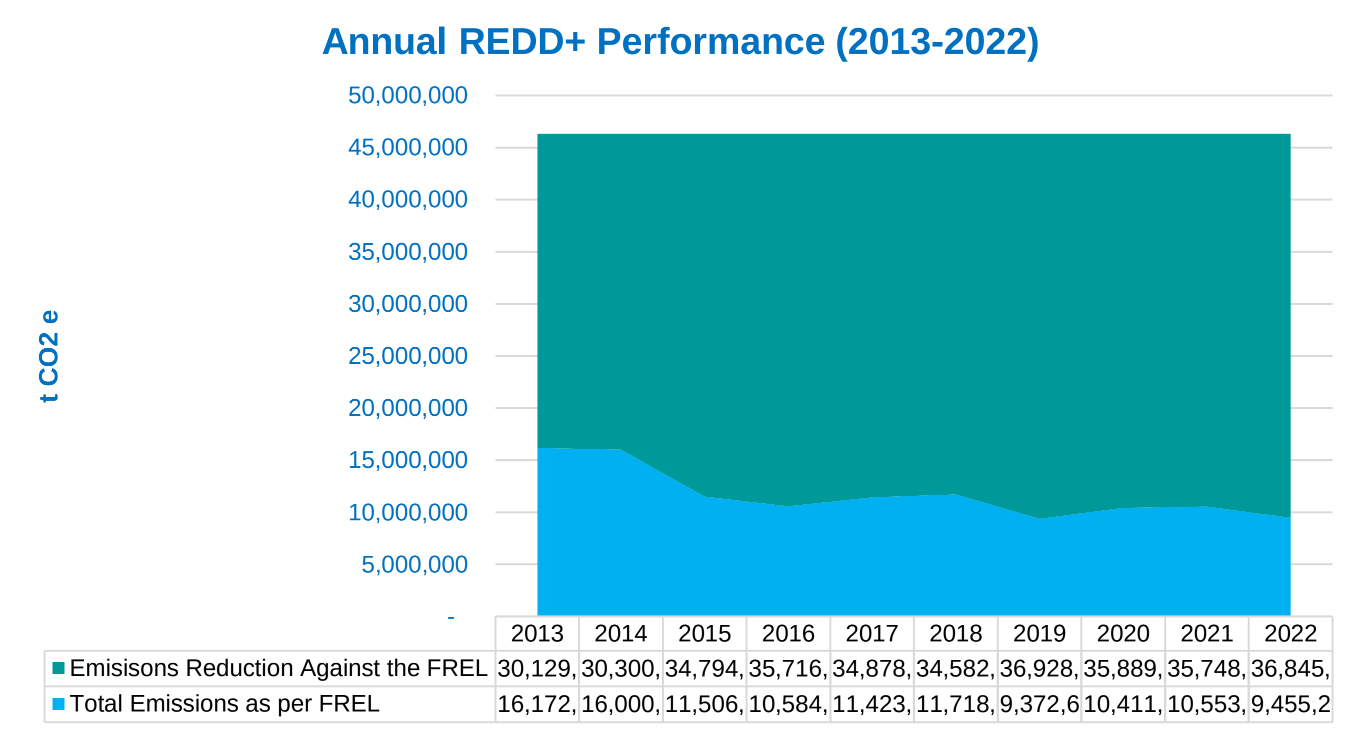


Figure 7 Annual REDD+ Performance in Relation to the FREL Baseline

Table 4 Annual Emissions by Drivers reported in the FREL

Drivers	Deforestation (t CO_2 e)				Forest Degradation (t CO_2 e)
	Forestry Infrastructure	Agriculture	Mining	Infrastructure	Logging
2013	324,987	442,603	11,343,021	336,804	3,724,737
2014	200,901	852,847	10,275,489	138,858	4,532,569
2015	308,245	395,629	6,678,969	213,703	3,910,404
2016	308,245	395,629	6,678,969	213,703	2,987,896
2017	223,551	497,929	7,328,943	192,038	3,180,717
2018	350,592	534,465	7,508,178	65,982	3,259,093
2019	222,567	256,793	5,732,569	51,210	3,109,512
2020	192,518	510,417	6,354,080	100,927	3,253,797
2021	224,536	225,477	6,721,316	115,223	3,266,693
2022	153,202	293,978	5,184,289	108,879	3,714,932

REDD+ Results-based Finance Received

Guyana's performance to date in relation to the baseline sent in the FREL, illustrates its performance well below that set, which has resulted in the country's being rewarded with carbon financing to date. For the period 2009-2015, Guyana received carbon financing based on results-based payments. One of the key considerations in Guyana's FREL for REDD+ was the integration of a financial incentives baseline with payment computation, which Guyana has successfully done to date. In the mechanism used in the bilateral agreement between Guyana and Norway, a sliding scale was integrated as part of the incentive mechanism. The performance generated by Guyana's forests was monitored, reported, and verified under the national-scale Monitoring, Reporting and Verification System (MRVS) put in place by the Guyana Forestry Commission (GFC). In expressing Guyana's commitment to REDD+ and prioritizing this commitment while developing, the 0.056% deforestation cap ceiling for emissions levels for the agreement period was established on which payments were made. In the years that Guyana exceeds this 0.056 % rate, the payments are reduced on a sliding scale up to the rate of 0.1 per cent, at which point, there are no payments made. On the signing of this agreement in 2009, the first climate finance payment was made. While the payments received and country performance stands outside of this reporting period for emissions covered in this report, they are included for clarity and completeness purposes. From this partnership, Guyana received a total of USD 220,800,000 for the performance period 2010 to 2015 (LCDS, 2022).

Table 5 Performance-based Carbon Finance

Year	Channel of Disbursement	Results-based payment
2009 Performance Payment	GRIF	30,355,594
2010 Performance Payment	GRIF	39,474,415
2011 & 2012 Performance Payment	IDB	80,034,965
2013 Performance Payment	GRIF	43,886,657
Direct Disbursement for Capacity Building and EU-FLEGT Projects	CI	14,815,886
Direct Disbursement for Village Sustainable Plans	CI	4,000,000
TOTAL RECEIVED FROM NORWAY		**212,597,518**
Investment Income – GRIF (World Bank Trustee Account)	**-**	**3,200,000**
Investment Income – IDB Renewable Energy Account	**-**	**5,100,000**
TOTAL REDD+ FINANCE		**220,800,000**

Source (LCDS, 2022)

While no other finance was generated under this agreement outside of those listed in Table 5 Performance-based Carbon Finance, Guyana maintained its MRV system to ensure permanence, which continues to generate results. This system has allowed Guyana to access the voluntary carbon market in 2022 – and to sell carbon credits for the period 2016-2030, including the period covered by this TA, for which it has successfully received USD187,500,000 to date, with a further US$100 million to come for the period covered in this TA. Guyana intends to continue to improve its system and pursue additional avenues for generating carbon financing while simultaneously fulfilling its obligation under the Paris Agreement of the UNFCCC.

CONSISTENCY OF METHODOLOGIES BETWEEN THE REDD+ RESULTS AND THE ESTABLISH FREL

The method used to generate the REDD+ results is consistent with the FREL. Both methods use the same forest definition and land use classification and share the same REDD+ activities, maintaining the same carbon pools, gases, and national scales. However, a few improvements can be found in the development of the activity data and emissions factors, owing to the availability of updated national data. These were as a direct follow up to the recommendations made by the Technical Review. This chapter presents the information necessary to allow for the reconstruction of the results and the methodologies used for their generation.

Use of the Most Recent IPCC Guidance and Guidelines

Both the FREL and this REDD+ Technical Annex (REDD+TA) used the 2006 IPCC Guidelines (IPCC, 2006); however, the emissions factors reflect improvements as more information, studies, and methodologies have resulted in changing approaches since the submission of the FREL. Table 6 summarises the use and consistency of methods used in the FREL and the REDD+ TA to enable reconstructions of the estimate's calculations.

Table 6 Comparison of FREL and REDD+TA for reconstruction of calculation

Parameters	FREL	REDD+TA
IPCC Guidelines	2006 IPCC Guidelines	2006 IPCC Guidelines
REDD+ Activities	Reduction from deforestation and forest degradation	Reduction from deforestation and forest degradation
Forest Definition	30% canopy cover, >1ha, >5m in situ	30% canopy cover, >1ha, >5m in situ
Carbon Pools	-Aboveground -Belowground biomass -Deadwood included in degradation from timber harvest only.	- Aboveground biomass -Belowground biomass -Deadwood included in degradation from timber harvest only.
Gas	CO_2	CO_2
Deforestation Drivers	-Forestry infrastructure -Agriculture -Mining (medium and large scale) -Infrastructure	-Forestry infrastructure -Agriculture -Mining (medium and large scale) -Infrastructure
Degradation Drivers	-Logging volume harvested	-Logging volume harvested
Forest Stratification	High Potential for Change More Accessible Area High Potential for Change Less Accessible Area Medium Potential for Change More Accessible Area Medium Potential for Change Less Accessible Area High Potential for Change More Accessible Area Low Potential for Change Less Accessible Area	Combined Single Stratum. The methods applied across all strata remain unchanged. Additional data was collected and added to the data sets.
Activity Data	Disaggregated by deforestation and forest degradation drivers by stratum	Disaggregated by deforestation and forest degradation drivers
Spatial Mapping	1ha minimum mapping unit	1ha minimum mapping unit
Emissions Factor	Developed by stratum (Tier 2).	Combine emissions factor (Tier 2).
Data Source	GFC Annual MRV Reports	-GFC Annual MRV Reports -Verification Reports

Methodology for Deriving the Activity Data

Guyana developed its activity data for deforestation and forest degradation using spatial and non-spatial methods. The spatial method is applied for tracking deforestation and some degradation depending on the area size against the forest definition. In contrast, the non-spatial method is applied to forest degradation resulting from logging. The activities developed and tracked in the GIS systems and databases are summarised and listed in Table 7 (GFC, 2023).

Table 7 Activities by Drivers of Deforestation and Degradation captured in the Activity Data

	Activity	Driver	Criteria	Supporting Info	Spatially Mapped
Deforestation	Roads	Infrastructure	Roads > 10m	Mapped layers, satellite imagery	Yes
	Mining	Infrastructure	Roads >10 m	Existing road network, satellite imagery	Yes
	Agriculture	Deforestation	Deforestation sites >1 ha, including shifting cultivation occurring outside the village buffer extent	Registered agricultural leases, satellite imagery	Yes
Forest Degradation	Forestry	SFM	Harvested timber volumes and illegal logging totals.	Annual harvest plans, GIS extent of timber concessions	No

For synergy and ease of reporting under the IPCC, the land use changes from forests are now being classified as transitioning to one of the other five land use classes (croplands, grassland, wetlands, settlement, and other lands). Natural events considered non-anthropogenic change are excluded from the deforestation or degradation estimates, which are typically non-uniform in shape and have no evidence of anthropogenic activity nearby. These are mapped in the GIS for completeness.

Methodology for Deriving the Spatial Activity Data for Deforestation

The datasets used for deriving the activity data from the change analysis have evolved as more tools and methods become available. Initially, the historical change analysis from 1990-2009 was conducted using Landsat imagery. In 2010, a combination of DMC and Landsat, 2011 onwards, was superseded with high-resolution images, including Rapid Eye and Sentinel. For 2015 and 2016, a combination of Landsat and Sentinel data was used, which is the preferred combination in the future to ensure sustainability and consistency in generating the activity data. During the reporting period, the forest/non-forest boundaries were improved, but the forest area also changed, particularly at two points in time, 2012 and 2014. While the data sets have changed in terms of the satellite image utilized, the methodology for change detection remains the same.

Guyana developed a process that enabled the tracking of changes in areas of more than 1 ha spatially over time and by drivers. The system is primarily built to track forest area changes in keeping with international best practices. The method utilizes a wall-to-wall approach that enables complete, consistent, and transparent monitoring of land use and land-use changes across the forest over time. The technique used allows for land cover change greater than one hectare in size to be tracked through time and attributed by its driver (i.e. mining, agriculture, infrastructure, or fire). The approach employed is to divide the country into a series of regularly spaced 24 x 24 km tiles. The mapping process involves a systematic manual review of each 24 x 24 km tile, divided into 1 km x 1 km tiles at a resolution of 1:8000. If a cloud is present, multiple images over that location are reviewed.

Guyana's GIS-based monitoring system is designed to map change events in the year of their occurrence and then monitor any changes over the area each year. If an area remains constant, the land-use class and change driver are updated to stay consistent with the previous analysis. However, where change is detected, this is recorded using the appropriate driver. Each change is attributed to the acquisition date of the pre- and post-change image, the driver of the change event, and the resultant land-use class. Upon completion of the change detection per tile, they undergo a quality assurance quality control process, after which they are stitched together. After stitching, the total area per driver is generated, and this total undergoes the final level of quality assurance.

The mapping criteria are set and dictated by a set of mapping rules on how each event is classified and recorded in the GIS under a standard operating procedure guideline developed as part of the MRV system. The input process is standardized using a customized GIS tool, which provides a series of pre-set selections that are saved as feature classes. The mapping process is divided into mapping and QC. The QC team operates independently of the mapping team and is responsible for reviewing each tile as it is completed. Additional GIS layers are also included in the decision-making process to reduce uncertainty. The decision-based rules are outlined in the mapping guidance documentation or Standard Operating Procedures (SOPs).

In 2018, the forest area was revised to remove areas of historic shifting cultivation that surrounded settlements. This change was made based on a study that concluded that these areas should be considered non-forest, which aligns with Guyana's forest definition (GFC W. I., 2019b).

All mapped results are subject to an Independent Accuracy Assessment. These Reports are published as part of the MRVS Reports and conclude that the reported nationally mapped results compare closely to the independent findings.

Methodology for Deriving Non-Spatial Activity Data for Degradation

The primary sources of degradation are those associated with logging, including forest management-related losses, selective harvesting of timber, logging damage and illegal harvesting. This information is non-spatial and is extracted from a database being administered and managed by the Guyana Forestry Commission (GFC).

Forest Management and Production Data

Forest management includes selective logging activities in primary or semi-primary forests. The requirement is that areas under sustainable forest management (SFM) be rigorously monitored and activities documented, including harvest production data, which are used to estimate degradation. By applying the gain-loss method of the 2006 IPCC Guidelines, the production data is used in combination with default expansion factors to account for the loss.

Production volumes are recorded on declaration/removal permits issued by the GFC to forest concession and private property holders. Upon declaration, the harvested produce is verified, and permits are collected, checked, and sent to the GFC's Head Office, followed by data input into the central database. The permits include details on the product, species, volume, log tracking tag number used, removal and transportation information, and, in the case of large timber concessions, more specific information on the location of the harvesting. Production reports are generated by various categories, including total volume, submitted to multiple stakeholder groups and used in national reporting.

Following receipt of removal permits and production registers, monthly submissions are made to the GFC's Management Information System section, where the data collection, recording, and quality control are performed. Data is entered in SQL databases custom-designed for production totals. This database has built-in programmatic QA/QC controls that allow automatic validation and red flagging of tags. These checks include tags being used by unauthorized operators or permits being incorrectly, incompletely or otherwise misused. The system also allows cross-checking of basic entry issues, including levels of production conversion rates, etc. The production data are disaggregated by types and declared volumes of primary products, including logs, lumber (chainsaw lumber), roundwood (piles, poles, posts, spars), splitwood (shingles, staves), and fuelwood (charcoal, firewood). These production data by type are then used to estimate the degradation emissions. Accounting for the impact of selective logging on carbon stocks involves the estimation of several different components:

- Biomass removed in the commercial tree felled – emission.
- Incidental dead wood created as a result of tree felling – emission.
- Damage from logging skid trails – emission.
- Carbon stored in wood products from extracted timber by product class – removal.
- Regrowth resulting from gaps created by tree felling - removal.

Illegal Logging

Though there is a robust system in place, the monitoring approach provides for continuous improvements – to capture illegal logging that may occur though the risk of this is quite low. To account for this possibility, areas and processes of illegal logging are monitored and documented as far as practicable. The measurement of these activity data is done by assessing the volumes of illegally harvested wood. In 2020, the rate of illegal logging was informed by a custom-designed database updated monthly and subject to routine internal audits. This database records infractions of unlawful logging in Guyana in all areas.

Reporting on illegal logging activities is done via the GFC's 36 forest stations located strategically countrywide and by field monitoring and audit teams through the execution of both routine and random monitoring exercises. The application of standard GFC procedures determines illegal logging activities. The infractions are recorded, verified and audited at several levels. All infractions are summarised in the illegal logging database and result in a total volume being reported as illegal logging annually.

Methodology in Deriving the Emission Factor

Guyana has, over the years, developed a number of country-specific emissions factors under the national REDD+ MRV system. These include emission factors associated with both deforestation and degradation. The emission factors related to deforestation are applied to the various drivers. In contrast, those associated with degradation are applied to those drivers, which include those developed for logging damage.

Emission Factors for Deforestation

The development of country-specific emissions factors for deforestation in Guyana was done through a combination of spatial data and those collected in the fields (Petrova, Goslee, Harris, & Brown, 2013). In 2010, methodologies were tested to determine the most appropriate emissions factor that allows for a confident estimation of Guyan's carbon stock, which ultimately contributed to the development of its emissions factors. Guyana's Forest Carbon Monitoring System (FCMS) for REDD+ activities developed by Winrock international provide the methodology used in developing the emissions factors by applying the following:

1. Stratification of the Country forest
2. Designing the sampling approach within the strata
3. Collecting and analyzing the data to achieve a set level of confidence

The emission factor for deforestation used by Guyana in Equation 1 is the sum of all carbon stocks from all live and dead biomass pools minus the post-deforestation carbon stocks and the change in stock for the soil carbon pool. Guyana applied the stratified sampling approach to assess the various carbon pools.

Equation 1 Emissions Factor for Deforestation

$$EF_{deforestation} = \{C_{AGB} + C_{BGB} + CWD + CLT + C_{sap} - C_{post} + [C_{Soil} * F_{LU} * F_{MG} * F_I]\} * \frac{44}{12}$$

Where:

$EF_{deforestation}$ = Emission factor for deforestation; t CO2 ha-1

CAGB = Carbon stock in aboveground biomass pool; t C ha-1

CBGB = Carbon stock in belowground biomass pool; t C ha-1

CDW = Carbon stock in dead wood pools (standing and lying); t C ha-1

CLT = Carbon stock in the litter pool; t C ha-1

Csap = Carbon stock in saplings; t C ha-1

Cpost = Biomass carbon stocks following deforestation; t C ha-1

Csoil = Carbon stock in soil organic matter pool (to 30 cm); t C ha-1

FLU = Stock change factor for land-use systems for a particular land-use, dimensionless

FMG = Stock change factor for management regime, dimensionless

FI = Stock change factor for the input of organic matter, dimensionless

Stratification of the Country Forest

Guyana's forested area was stratified using a Tier 2 approach, the method that was reported in the FREL. The first stratification stratified the country into high, medium and low potential for change. These potentials for change were driven by indicators that are driving changes in Guyana (see Figure 8). The indicators were the historical drivers of deforestation, such as roads, settlements, rivers, land under different management practices, elevation, etc., using heuristic and eMoPWrical approaches in a spatial modelling framework design. Using the heuristic approach, areas close to the factor feature were ranked with higher values for change than areas further away from the factor feature.

All maps of deforestation factors created using both approaches were evaluated against historical deforestation for the periods 2000-2005 and 2005-2009, using the statistic of Relative Operating Characteristic (ROC). ROC is a method that assesses how well a factor map portrays the location of forest change for both periods without estimating the exact quantity of the change. Factor maps that show high ROC statistics were combined in different combinations to create a Potential for Change (PC) map. The Potential for Future Change (PFC) map was created following the combination of identified factors from the historical analysis.

The idea is that areas close to factor features (roads, settlements, rivers, etc.) have a higher potential for future deforestation or forest degradation due to accessibility than areas further away from these factor features. This resulted in the second stratification of more accessible and less accessible, as illustrated in Figure 8. A large portion of Guyana's forestland is less accessible, and the purpose of the sampling stratification is to overcome this operational constraint while maintaining robust sampling results. As such, the factor of accessibility was introduced in the sampling stratification methodology to provide a forest carbon sampling framework that allows for the efficient collection of carbon sampling data. The more accessible stratum is defined as a 5 km straight distance from roads, a distance which will enable a field team to travel to the sampling point, establish the plots and return to the road within one day. The less accessible stratum is defined as all forestland outside the 5 km road buffer and will require additional travel that may entail caMoPWng or air travel for drop-off.

The more accessible stratum is defined as a 5 km straight distance from roads, a distance which will enable a field team to travel to the sampling point, establish the plots, and return to the road within one day. The less accessible stratum is defined as all forestland outside the 5 km road buffer and will require additional travel that may entail caMoPWng or air travel for drop-off.

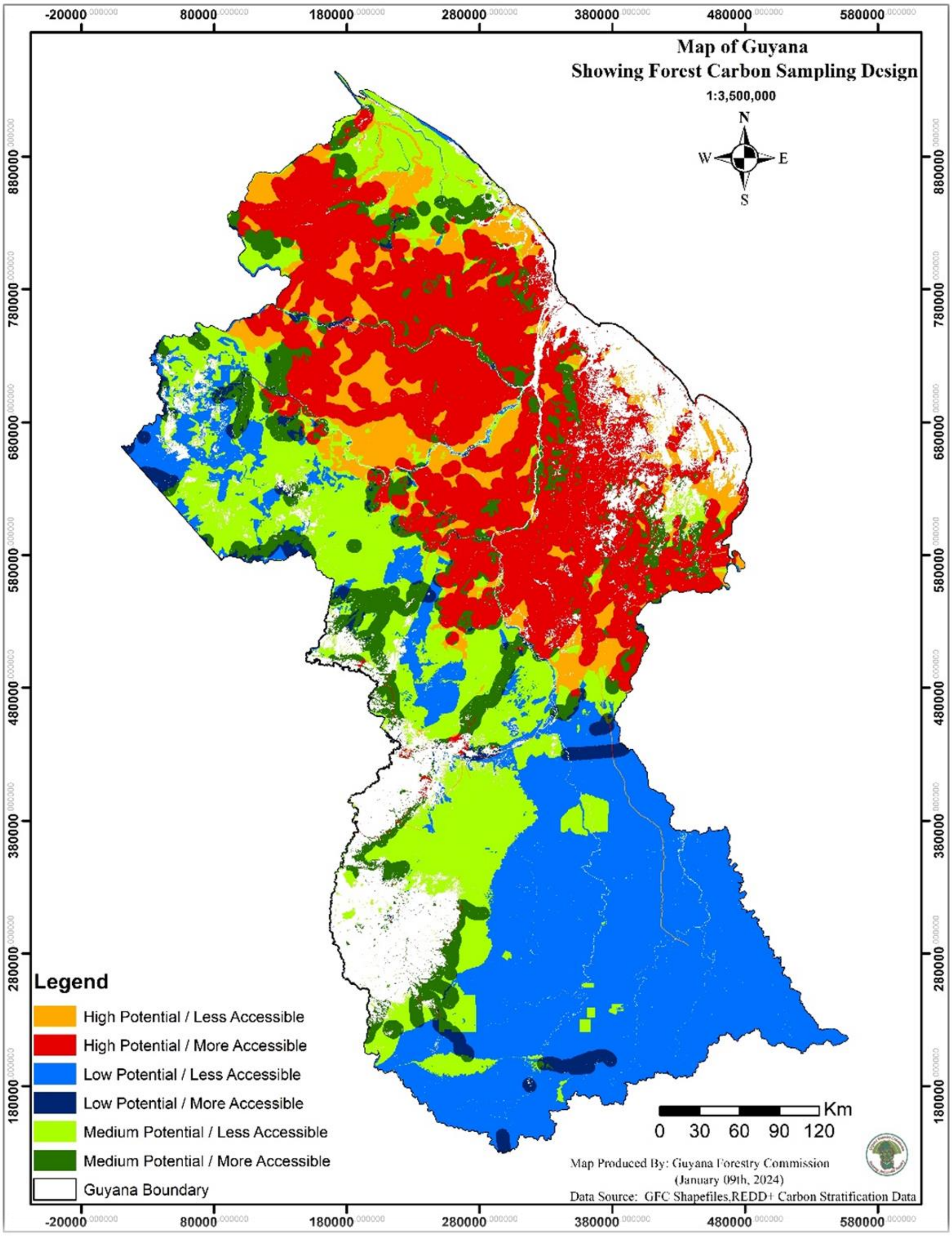


Figure 8 Guyana Forest Stratification Map

Designing the Sampling Approach Within the Stratum

Guyana's FCMS uses a stratified two-stage list sampling design with clustered plots for carbon stock assessment. Having established the six strata across the forested areas, subsets of primary sampling units (PSUs) are designed in which clustered plots of secondary sampling units (SSUs) are established. This allows field teams to achieve higher sample sizes at a relatively low cost. The number of PSUs to be sampled varies by stratum, with a greater sampling intensity (two-thirds) implemented in the more accessible strata and a lower sampling intensity (one-third) implemented in the less accessible strata. This follows the rational that areas with high accessibility have a higher chance of changing and should be sampled first.

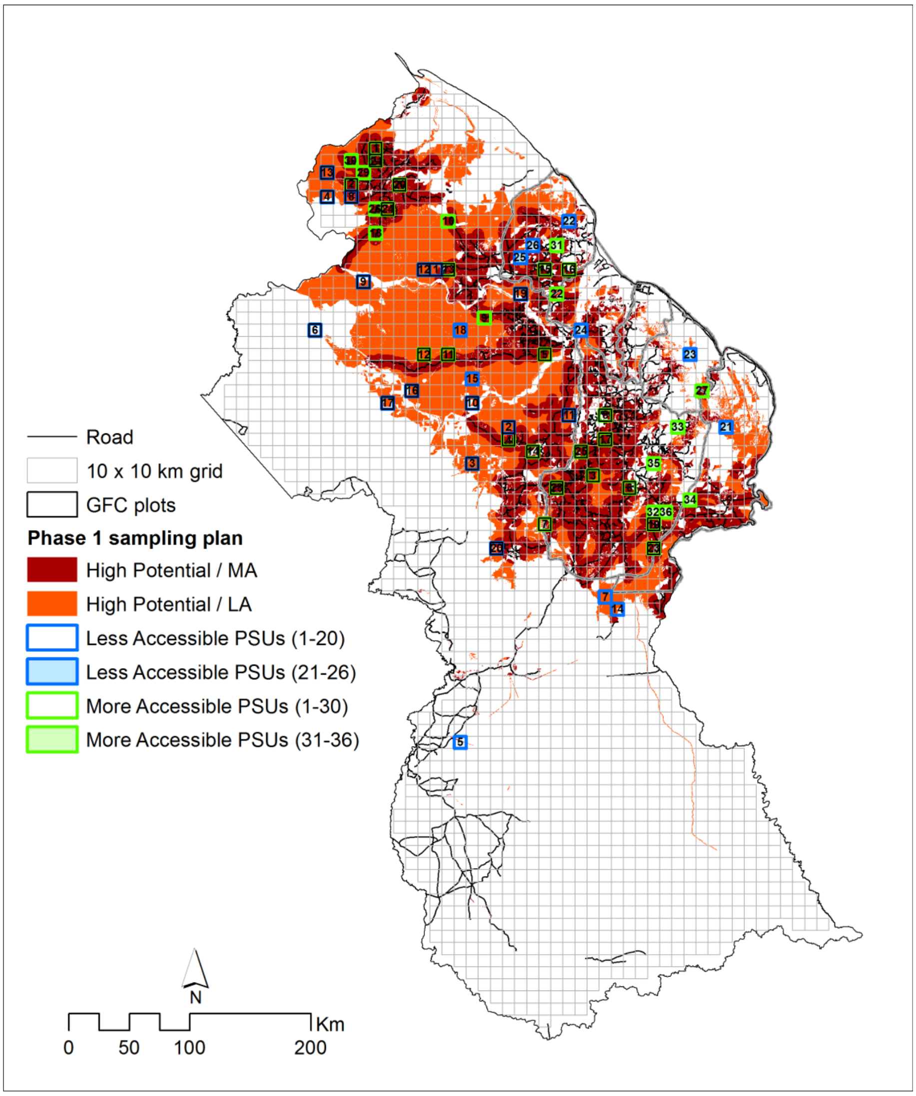


Figure 9 Guyana PSUs and SSUs by Two-tier Stratification

The PSUs are determined by laying a 10x10km grid across a map of Guyana, as illustrated in Figure 9 and identifying those grid cells which fall on the stratum of interest (for example, if data is being collected in the medium potential for change, then only those cells in orange and red will be targeted). Grid cells allow for the clustering of plots to aid in access and efficiency of data collection while focusing on the area of interest. The PSUs to be sampled are randomly selected with probability proportional to the area of a stratum of interest. The grid design of PSUs allows for systematic distribution of SSUs.

Secondary Sampling Units (SSU) are randomly located within each selected PSU with a minimum distance of 1 km from each other. By establishing three locations per SSU, the likelihood is increased that one of the SSU locations can be reached and data can be collected. The three SSU points are randomly numbered 1-3, and the field team collects data at point 1 first, failing that, point 2, and finally, point 3 if the other two are not reachable. SSU consists of a cluster of four (4) subplots established in an "L" shape intended to capture landscape variability, as shown in Figure 10. SSUs can be composed of fewer than four subplots in cases of safety concerns, or the subplot center is located in a different stratum than other subplots within SSU, in which case the subplot in different stratum shall also be sampled. Still, data from SSU will be disaggregated during the analysis. Each subplot of this SSU is further divided into nested plots from where different tree diameters are measured. This approach provides an efficient inventory distributed across the landscape.

Estimating the Biomass Carbon Stocks

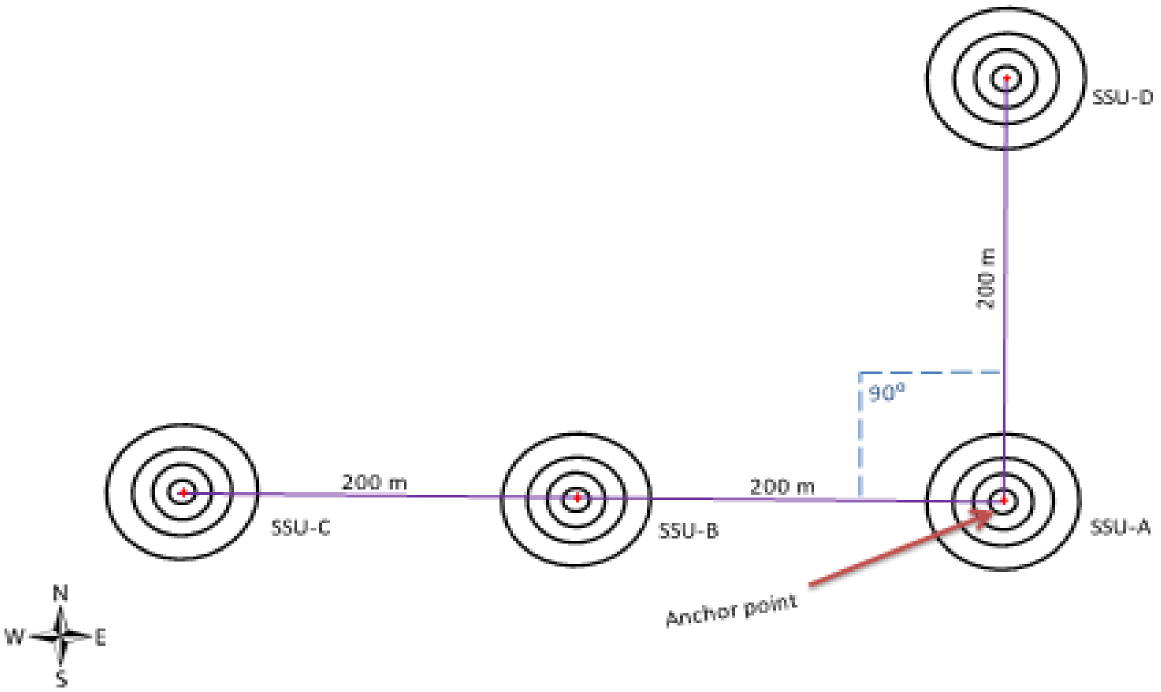


Figure 10 A Single SSU for Field Data Collection

Guyana estimated its forest carbon stocks to inform its national emissions factors for all five carbon pools (aboveground, belowground, deadwood, litter, and soils). Some of these estimates were done using field-tested allometric models (Chave, et al., 2005), others using IPCC-approved methods (Mokany, Raison, & Prokushkin, 2006), and field-collected data.

Aboveground Biomass Carbon Stock

When calculations are done, data and analyses at the plot level are extrapolated to the area of a whole hectare to produce carbon stock estimates. Extrapolation is done by the use of scaling factors that are calculated as the proportion of a hectare (10,000 m^2) that is occupied by a given nested plot by applying Equation 2. Under the methodology developed, Guyana collected information for all five carbon pools (ABG, BGB, Litter, Deadwood, and Soils).

Equation 2 Scaling Factor to Extrapolate to a hectare

$$Scaling\_factor = \frac{10{,}000m^2}{Area\_of\_nest\_(m^2)}$$

Chave et al. 2005 Equation 3 for tropical moist forest stands using diameter at breast height and wood density was used to estimate the aboveground carbon pool in Guyana (Chave, et al., 2005), as such data required for the application of this equation was collected, coMoPWled and generated.

Equation 3 Chave et al. 2005 Tropical Moist Forest

$$AGB_{est} = \rho \times \exp(-1.499 + 2.1481 \ln(D) + 0.207(\ln(D))2 – 0.0281(\ln(D))3)$$

Where:

AGB_{est} = aboveground biomass

ρ= species-specific wood density (when not available, an average value of 0.65 g/cm3 is used)

D = diameter at breast height

Belowground Biomass Carbon Stock

Belowground is one of the most challenging carbon pools to measure. It is even more complex and impractical to measure belowground biomass in tropical forests on a routine basis, making it complicated to develop country-specific allometric equations for root biomass. Instead, belowground biomass is estimated from a well-accepted ratio, an approach Guyana has taken to determine its belowground biomass for tropical moist forests, developed by Mokany (Mokany, Raison, & Prokushkin, 2006) and accepted by the 2006 IPCC Guidelines, which reliably estimates root biomass based on live aboveground biomass Equation 4.

Equation 4 Belowground Biomass Estimation

$$BGB = 0.235 * AGB \text{ if } AGB > 62.5 \text{ t C/ha}$$

$$BGB = 0.205 * AGB \text{ if } AGB \leq 62.5 \text{ t C/ha}$$

Where:

BGB = belowground biomass carbon

AGB = aboveground biomass carbon

Deadwood Biomass Carbon Stock

The estimation of the carbon stocks in dead wood, both lying and standing, is detailed in the Standard Operating Procedures (SOPs) for Guyana's forest carbon monitoring system (FCMS). The primary methods are:

(1) **For standing dead wood** - the volume of the main stem is estimated from measurements of base diameter and height, which is then multiplied by the density of the species.
(2) **For lying dead wood** - measurements are taken to estimate the volume and its density class (sound, intermediate, and rotten) according to the FCMS SOPs.

Biomass Carbon Stock from Sapling

Sapling data is also collected under Guyana's REDD+ MRV system in a 2 m radius plot in the centre of the nested plots. Saplings are defined as trees <5 cm DBH and >1.3 m tall. The number of samplings is multiplied by the average dry weight per sapling to derive the carbon stock.

Biomass Carbon Stock from Litter

Guyana defines the litter layer as all dead organic surface material on top of the mineral soil, including recognizable dead leaves, twigs, dead grasses, small branches and some unidentifiable decomposed fragments of organic material (fruits, flowers, and seeds). The dead wood with a diameter of less than 10 cm is included in the litter layer. Complete samples are weighed in "clip" plots of 1m^2, from which samples are taken to determine the dry weight, which is then extrapolated to estimate this carbon pool.

Biomass Carbon Stock from Soil

To account for changes to soil carbon, Guyana applied the stock change methods prescribed by the IPCC Guidelines (IPCC, 2006). The change in carbon stocks in the top 30 cm of soil is calculated as the difference between the soil carbon stocks before conversion and the soil carbon stocks after conversion. Soil carbon stocks after conversion were estimated based on land use, management, and input factors as derived from IPCC Guidelines. For simplicity in accounting, Guyana assumes the total emission of soil carbon in the year of clearing rather than spreading the emissions over 20 years (the default period suggested by IPCC 2006). This conservative approach was adopted by Guyana, owing to carbon stocks being highly variable, as shown by the high uncertainty. Soil carbon pool is not impacted equally or at all across all drivers of deforestation and degradation; as such, only those drivers in which this pool is affected include emissions from soils.

The methods described for estimating the carbon stock per carbon pools that inform the country-specific emissions factors are the same methods used for calculating the emissions by drivers in the FREL. However, not all emission factors developed by Guyana are used since in the FREL, only aboveground, belowground carbon and deadwood carbon pools are used.

Since the submission of the FREL in 2015, which is based on information up to 2012, a lot of significant improvements have been made. The most important improvement is the merging of the six strata presented in the FREL into a single national stratum. The time of the FREL submission, Guyana was still in the initial phase of collecting field data. It was working on the assumption that the biomass carbon stock varied significantly by forest type, the potential of an area for change and accessibility. The data used to inform the reference level in Guyana's FREL, therefore, were generated under this assumption, and only 66 plots of data were used to inform this assumption. After the submission of the FREL and as more information became available collected across all carbon pools spanning the six strata in which the country's national territory is divided, it was found that the initial assumption used to inform the FREL was incorrect. From 108 nested plots established across all the strata, when combined, it was found that no significant differences exist between them, and the overall uncertainty was reduced when combined (GFC W. I., 2019a). As such, Guyana, considering the increased accuracy of this based on verified data, chose to apply the single emission factor retroactively to ensure consistency in its reporting.

It was always Guyana's intention to submit a revised FREL in light of the many new developments and result-driven findings. The new FREL will be submitted before the first half of 2024 and will commence from reporting year 2022.

The emission factors presented in this REDD+ TA align with that of the latest GHG inventory, which applies the same emissions factors, thereby ensuring consistency in reporting. The final country-wide forest carbon stocks across all pools in Guyana are now estimated at 270.6 t C ha^{-1}. The findings of this study and the contribution of carbon pools are summarised in Table 8, which shows the single forest carbon stocks for the five carbon pools at a 95% confidence interval and the resulting sampling errors. These are the values that are used in estimating the various emissions across the drivers of deforestation. However, for comparability to the FREL and consistency, only carbon stocks from the aboveground and below-ground carbon pools are used in estimating the emissions in this report.

Table 8 Country-wide Forest Carbon Stocks by Pool for all Forests in Guyana.

AG Tree (t C/ha)	BG Tree (t C/ha)	Saplings (t C/ha)	Standing Dead Wood (t C/ha)		Lying Dead Wood (t C/ha)	Litter (t C/ha)	Sum Carbon Pools (t C/ha)	Number of plots	95% CI as a % of mean
205.8	48.3	3.7	2.6		8.6	1.6	270.6	118	5.1%

Source: (GFC W. I., 2019a)

Emissions Factors for Degradation Associated with Logging Damage

Guyana developed country-specific emissions factors for degradation resulting from logging. Forest degradation in Guyana is primarily attributed to timber harvest, which was the only degrading activity accounted for in Guyana's FREL; however, since the submission of the FREL, Guyana has developed emissions factors for its infrastructure drivers that are also contributing to forest degradation.

To estimate emissions from logging, Guyana uses the approach that is based on estimating emissions per volume of timber harvested, including the timber tree, incidental tree damage, and development of skid trails needed for harvesting. The emission factors were developed to correlate the total biomass damaged (collateral damage and extraction infrastructure-skid trails) to the volume of timber extracted. This relationship allows for the estimation of the total emissions generated by selective logging for different concession sizes across Guyana. Selective logging clears forest for roads and decks, which are primarily large areas that can be identified spatially; hence, they are captured spatially, and their emissions are calculated through the stock-change method based on estimates of area deforested by logging infrastructure determined in the land cover change monitoring, provided that the area is more than 1ha. The emissions factor includes accounting for the impact of selective logging on carbon stocks, including the estimation of both emissions and removal components associated as following:

- Biomass removed in the commercial tree felled – emission.
- Incidental dead wood created as a result of tree felling – emission.
- Damage from logging skid trails – emission.
- Carbon stored in wood products from extracted timber by product class – removal.
- Regrowth resulting from gaps created by tree felling - removal.

The total emissions from selective logging are estimated using Equation 5, which incorporates the various emissions sources associated with log extraction.

Equation 5 Total Emissions from Selective Logging

$$Emissions = \{[Vol * WD * CF * (1 - LTP)] + [Vol * LDF] + [Lng * LIF]\} * 3.67$$

Where:

Emissions =Total emissions from Selective logging (t CO_2 Yr^{-1})

Vol = volume of timber over bark extracted (m^3)

WD = wood density (t/m^3)

CF = carbon fraction

LTP = proportion of extracted wood in long-term products still in use after 100 years (dimensionless)

LDF = logging damage factor—dead biomass left behind in the gap from the felled tree and incidental damage (t C/m^3 extracted)

Lng = total length of skid trails constructed to extract Vol (km)

LIF = logging infrastructure factor—dead biomass caused by construction of infrastructure (t C/km of skid trail to remove the Vol)

3.67 = conversion factor for t carbon to t carbon dioxide Wood in long-term products

Not all carbon is released at once since logs are converted into various items and put to different uses. Therefore, not all the carbon in harvested timber gets emitted into the atmosphere because a proportion of the wood removed may be stored in long-term wood products and must be accounted for. Total carbon stored in long-term wood products is estimated using Equation 6.

Equation 6 Carbon Stores in Long-term Wood Products

$$LTP = C * (1 - WW) * (1 - SLF) * (1 - OF)$$

Where:

LTP: = Carbon stock in long-term wood products pool (stock remaining in wood products after 100 years and assumed to be permanent); t C ha^{-1}

C = Mean stock of extracted biomass carbon by class of wood product; t C ha^{-1}

WW= Wood waste. The fraction immediately emitted through mill inefficiency by class of wood product.

SLF = Fraction of wood products with a short life that will be emitted to the atmosphere within 5 years of timber harvest by class of wood product.

OF = Fraction of wood products that will be emitted to the atmosphere between 5 and 100 years of timber harvest by class of wood product.

Calculation of Combined Uncertainties

Guyana's approach to calculating uncertainties reported in the FREL was the application of the error propagation method. The methods used follow the recommendations set out in the GOFC-GOLD guidelines to help identify and quantify uncertainty in the level and rate of deforestation and the amount of degraded forest area in Guyana. This uncertainty estimate reported in the FREL is based on the application of the error propagation equation in Ch.5 of the IPCC GPG (2003), which was applied to each stratum.

This change has been impacted by the updating of data analysis using the 2006 IPCC Guidelines and the evidence-based merging of the stratification. Like the situation that affected the stratification and the application of emission factors, the method for estimating uncertainty has also been updated after the submission of the FREL. Guyana has transitioned from using the error propagation method of the IPCC GPG (2003) to using the more advanced Monte Carlo simulation to estimate its uncertainty across all its data. This occurred because of the continued advancement in enhancing the assessment of all factors that affect the uncertainty level of reported results.

Activity Data Uncertainties

The uncertainties associated with the spatially generated activity data are catered to in the QA/QC mapping procedures that are outlined in the SOP, which provides strict mapping rules and is still guided by the IPCC Guidelines. The QC team operates independently of the mapping team and is responsible for reviewing each tile as it is completed. In addition to the QA/QC process performed by GFC, an independent accuracy assessment is carried out by the University of Durham by applying sampling techniques using higher-resolution imagery to assess the reporting accuracy. The assessment generates independent deforestation and degradation numbers using a stratified random sampling approach, which is reported in the country's annual MRV reports.

Emissions Factors Uncertainties

To estimate uncertainties associated with the various emissions factors developed, Guyana considers the multiple sources and applies the Monte Carlo analysis (Hagen, Goslee, Pearson, & Brown, 2017). Sources of uncertainty include measurement, allometric model parameterization, allometric model structure, factor, and sampling. The simulation is designed so that sources of uncertainty can be turned off or on as needed, enabling estimates of the contribution to total uncertainty from each source.

A Monte Carlo simulation, or stochastic simulation, uses repeated sampling to determine the properties of a modeled system and is often used to estimate uncertainty. An implementation of a randomized Monte Carlo resampling technique can reduce the reliance on incorrect assumptions about the distribution of the underlying data sets while combining the individual uncertainties from many different sources. The uncertainty generation involves the construction of a large number of scenarios, each generated from randomized alternative data sets and each providing a realistic set of parameters for each model component.

A variant of the residual bootstrap sampling algorithm was applied to estimate uncertainty in the model parameters. With this algorithm, uncertainty in model coefficients is estimated by a) sampling the residuals generated from the model fit (e.g. Chave et al. 2005), with replacement, b) adding these "bootstrapped" residuals to the model estimates to generate a pseudo sample, c) fitting the model to the pseudo sample, d) saving these fit parameters to a file, and e) repeating steps (a) through (d) 10,000 times. The Monte Carlo analysis for emission factors is a distribution of total change in carbon stocks in each stratum and from each activity type. By including large numbers of runs (~10,000), the results generated from the Monte Carlo simulation are statistically robust.

Guyana developed a comprehensive accounting of uncertainty, represented by 95% uncertainty limits. The results represent the following: if the entire stratum was destructively sampled and the actual carbon in each pool measured, including the separate effects from conversion to agriculture, mining, and roads, there is a 95% chance that the value measured would fall between the upper and lower limits if the assumptions about component level uncertainty are realistic. Table 9 lists the emission factors by deforestation drivers and their respective uncertainties, which are applied to the combined stratum covering all of Guyana's forest. In Table 9, the emissions per driver for aboveground and belowground carbon are presented, with an uncertainty of 4.9%. In contrast, when compared to the increased emissions when all carbon pools are included in the estimation, the uncertainty decreased to 4.8%.

Table 9 Uncertainty for EF of Deforestation Drivers

Stratum	Drivers	Emissions Factors ABG and BGB (t CO_2e ha^{-1})	Uncertainty ABG and BGB (IPCC approach 1)	Emissions Factors all C pools (t CO_2e ha^{-1})	Uncertainty all C pools (IPCC approach 1)
Combined Stratum	Forestry infrastructure	**984.8**	**4.9%**	1,051.3	4.8%
	Agriculture	**1,043.9**	**4.9%**	1,110.4*	4.8%
	Mining (medium and large scale)	**984.8**	**4.9%**	1,051.3	4.8%
	Infrastructure	**984.8**	**4.9%**	1,051.3	4.8%

* Includes an additional 30.53 t C/ha for soils accounting for the change in carbon stocks owing to the conversion to permanent agriculture.

The same Monte Carlo approach was used to estimate the uncertainties for the data associated with the selective logging listed in

Table 10, where all parameters were used, including the allometric model, measurement, structure, and factor.

Table 10 Logging Emissions Factors

Logging Emission Factors							
Component	Unit	Factor (tC)	*Std Dev (tC)*	*90% CI (tC)*	t CO2	*Std Dev (tCO2)*	*90% CI (tCO2)*
LDF	per m^3	1.05	*0.68*	*0.08*	3.85	*2.49*	*0.29*
Wood Density of timber harvested	per m^3	0.40	*0.03*	*0.00*	1.47	*0.11*	*0.01*
LIF (Skid Trails)	per km	46.87	*8.08*	*1.60*	171.84	*29.63*	*5.87*

Combined Uncertainties

The combined uncertainties for the REDD+ results are calculated using the Monte Carlo Simulation, combining all activity data and emissions facts to generate the emissions estimates and reduction results for Guyana. This is done via the SimVoi add-in, which is applied to the emission factors and the activity data. This approach was taken as a necessary improvement measure because the uncertainty calculations performed did not capture all sources of uncertainty and thus underestimates the total uncertainty. As the MRVS further developed in Guyana, this step was possible and Monte Carlo analysis was integrated into the MRVS reporting.

DESCRIPTION OF THE NATIONAL FOREST MONITORING SYSTEM AND INSTITUTIONAL ROLES AND RESPONSIBILITIES FOR MRV RESULTS

The national forest monitoring system is being implemented by the Guyana Forestry Commission (GFC). In 2009, Guyana and Norway collaborated on emission reduction goals under UNFCCC-REDD+, leading to the development of a Measurement Reporting Verification (REDD+ MRV) system for assessing forest area change. The system used satellite data, which at the time was slowed owing to capacity and technological constraints. Since then, GFC has made incremental gains by including new sources of satellite data and refining mapping and reporting processes while building its capacity to manage and monitor its forest, boosting its reporting capability and enhancing accuracy. Simultaneously, field data was being collected to establish verified emissions factors.

National Forest Monitoring System (NFMS)

The building block of Guyana's national forest monitoring system (NFMS) used for REDD+ is built on spatial and temporal change, including satellite imagery and a way to process the satellite imagery to provide layers of change over time. Additionally, data collected from the field allows for the verification of spatial information as well as monitoring of forest activities. A combination of spatial information and field-based monitoring data provides the annual snapshot of forest change and production data.

Central to the system are satellite data and the datasets provided by Guyana's agencies. GFC's Forest Area Assessment Unit interprets and analyses these data and generates maps and associated spatial layers required to meet annual reporting requirements. Two external audits are included in the process, as illustrated in Figure 11, which provides an overview of Guyana's REDD+ MRV system. The first is the accuracy assessment; since inception, this analysis has been conducted externally by a team from Durham University and external auditors who review and verify methods and analytical processes that meet specified reporting requirements.

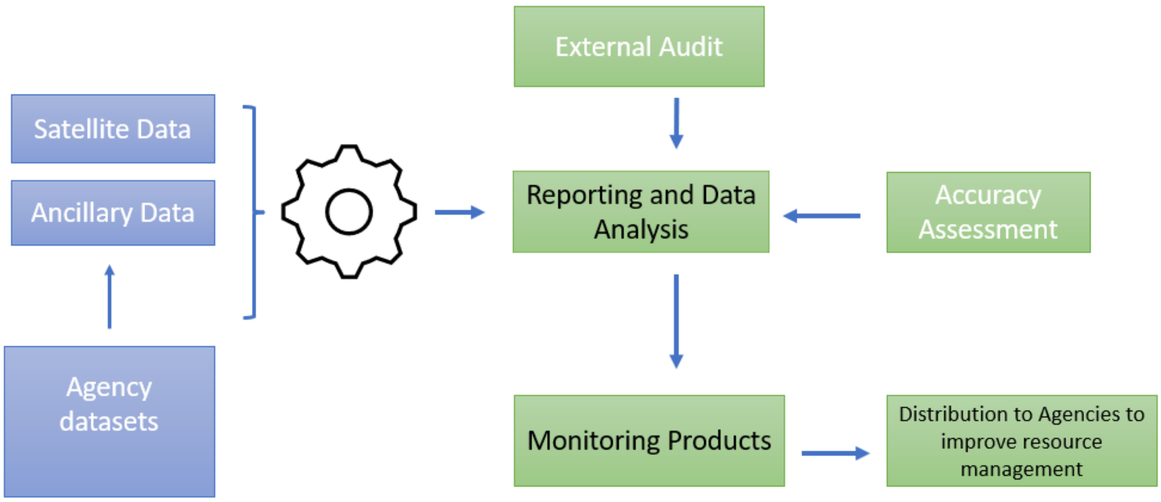


Figure 11 Overview of Guyana REDD+ MRV System within the GFC. Source, (GFC, 2023)

The schematic in Figure 12 shows the various departments/units within the Government of Guyana that provide the data used in measuring, estimating, and reporting for various purposes and the reporting flow. The data generated are used to inform national policies and strategies, access carbon finance, and for international reporting purposes such as to the UNFCCC. As such, information flows from the GFC to other government departments, depending on their use upon request.

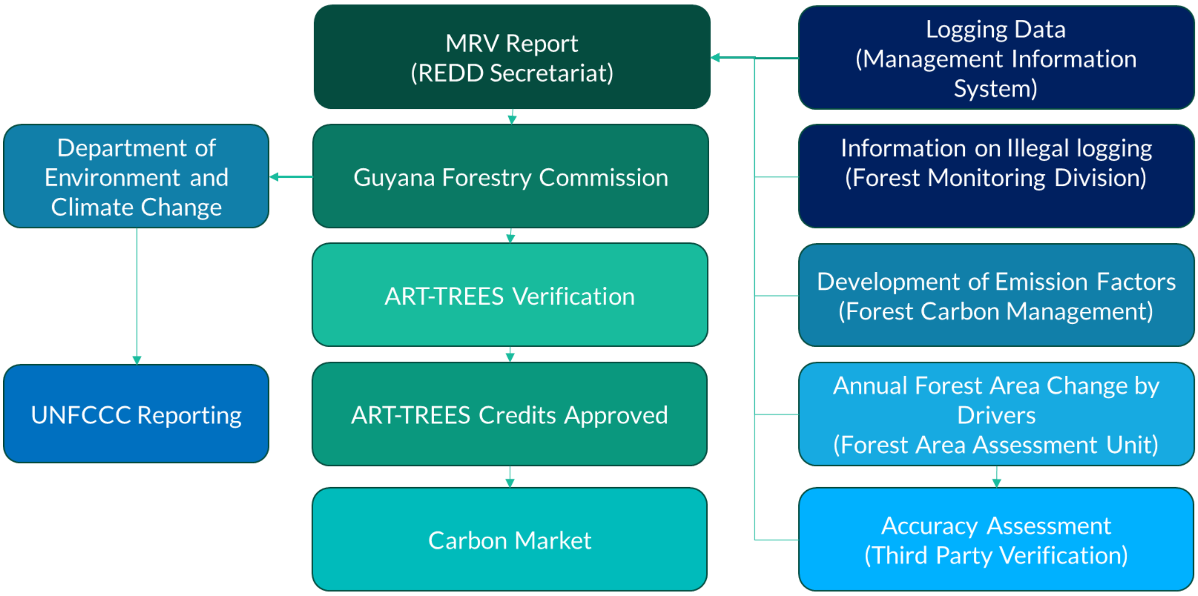


Figure 12 Guyana National REDD+ MRV System

Data storage is an integral part of the national MRV system. All data generated is stored on the Network Attached Storage (NAS) at GFC and is managed by the IT team, who routinely backed it up and stored it off-site. The relevant datasets that are used during the analyses are documented and archived. This includes metadata on the dataset, its location on the network and anticipated/or update frequency. Several datasets are actively used and reside on the GFC's Forest Resource Information Unit (FRIU) network drives. The FAAU (Forest Area Assessment Unit) undertakes the mapping and has access to these drives as well. Additionally, the data gathered and analyzed by the GFC includes some collected from various government agencies that have different roles and responsibilities, as illustrated in Figure 12.

In 2018, the GFC facilitated consultations with several agencies to identify options for further use of MRVS data beyond the use for forest monitoring and management, thereby establishing the Continuous Resource Monitoring System (CRMS), a prototype system designed to allow more frequent monitoring of Guyana's natural resources and reducing reliance on commercial satellite imagery and software. The system aims to streamline existing image processing workflows by recording them for use within the Google Earth Engine (GEE) platform, which provides access to cloud processing capability, satellite images, and other open-source datasets. The CRMS design incorporates low-cost satellite data and generates monitoring products that support compliance processes, awareness promotion, improved information flows between agencies, enforcement policies, and regulations (GFC, 2020).

Role and responsibilities

In Guyana, several government agencies are involved in managing and allocating land resources that also contribute data to the national REDD+ MRV systems and national forest management system. The Ministry of Public Works is overseeing the development of the Amalia Hydropower Project. This planned hydroelectric project includes road construction and site clearance. A newly established Protected Areas Commission (PAC) holds spatial representations of all protected areas. Each of the agencies has its data management systems and only provides relevant requested information to the GFC for the coMoPWlation of annual reports.

Guyana Forestry Commission (GFC)

The GFC[25] is responsible for advising the subject Minister on issues relating to forest policy, forestry laws and regulations, guided by the Forests Act 2009 and the Guyana Forestry Commission Act 2007. Under these Acts, the GFC is responsible for administrating and managing all State Forest land, and the work is guided by Guyana's National Forest Plan and the National Forest Policy of 2018, among various other regulations put in place by the Commission. The Commission develops and monitors standards for forest sector operations, implements forest protection and conservation strategies, oversees forest research and provides support and guidance to forest education and training. The agency is currently responsible for implementing the National REDD+ MRV through the REDD Secretariat.

The REDD Secretariat was formed in 2009 and, housed within the GFC, is responsible for developing the national REDD+ MRV systems to generate the results and report on the country's REDD+ performance. This secretariat produces the annual MRV reports, which comprise the data for the FOLU sector in Guyana, generated by the spatial mapping developed by the Forest Area Assessment Unit and the Forest Carbon Monitoring Unit. Additionally, the secretariat and the GFC are responsible for contracting independent verifiers to verify the results reported by the country independently, enhancing reporting transparency.

The Forest Monitoring Division of the GFC is responsible for the enforcement of forest laws and regulations, monitoring and controlling the environmental and social impact of operations within the state forest, and collecting revenue in accordance with the various actions and regulations in place. This division is also responsible for processing export documents (with forest produce), quality control and promoting forest products, reviewing and assisting in inquiries in relation to lumber and logs, and therefore recording the annual forest productions by product types. Additionally, this department reports on illegal logging and provides this information to the REDD Secretariat to generate the results for the yearly MRV report.

The Management Information Systems of the GFC is responsible for improved data communication between both internal and external stakeholders and ensuring that technological advancements are captured. The main function of this unit is to maintain reliability, security and availability of information that is accessed throughout GFC. It also overlooks the data accuracy, productivity and processing speed/capabilities as it is responsible for developing end-user reporting on the GFC activities data, which are shared with the REDD Secretariat to generate the results for the annual MRV report.

The Forest Resource Management Division of the GFC is responsible for data collection on national forest resources, conducting surveys and inventories, researching and making recommendations on forest dynamics and silviculture, planning and recommending the allocation of concession areas, preparing operational guidelines for forest management planning, evaluating management and operational plans, prescribing standards for forest management and providing support for forestry extensions. This division is also responsible for building a GIS capacity, developing a database of digital geographical data and providing a service to both external & internal stakeholders. This division is currently conducting the national forest inventory.

Guyana Geology and Mines Commission (GGMC)

The Guyana Geology and Mines Commission (GGMC[26]) was created in 1979. It was previously the Department of Geological Surveys and Mines and is guided by the Mining Act 1989. It has in place various regulations that guide the work of the commission, including its own MRV system for its

[25] GFC: Guyana Forestry Commission – Ensuring Sustainable Forestry
[26] GGMC: Who We Are | Guyana Geology and Mines Commission (ggmc.gov.gy)

operation. The GGMC's mission is to promote, facilitate, monitor, and regulate the sustainable utilization of Guyana's mineral resources (including petroleum) and to provide effective stewardship of Guyana's mineral resources through deploying competent human resources employing innovative tools and methods, research, and analysis. The GGMC collaborates with the GFC in providing information affecting the forests, which it monitors on the ground and spatially. Together, the GGMC and the GFC provide enhanced ground verification for the various drivers of deforestation and forest degradation in Guyana. Additionally, the GGMC is responsible for piloting the reforestation of mined-out areas in collaboration with the GFC.

Guyana Lands and Survey Commission (GL&SC)

The Guyana Lands and Surveys Commission (GL&SC[27]), which falls under the Office of the President, is responsible for the overall management of the national territory. The work of the GL&SC is guided by the Guyana Lands and Survey Commission Act 1999, Lands Department Act 1903, State Lands Act 1903, Land and Surveyors Act 1891, and various other regulations. The GL&SC's mandate includes providing land policy recommendations and drafting land use plans to ensure orderly and efficient utilization of public land resources, advice on land surveying matters, and effective and efficient land administration. This is the agency that provides land-use zoning and allocations of titles and lease lands. Most of the information collected by this agency is reported under land use, for example, the area allocated for mining, agriculture, settlement, infrastructure development such as Hydroelectric projects, and title Amerindian areas. This agency provides the various land use changes to the GFC used to generate and report data for the FOLU sector.

Protected Areas Commission

The Protected Area Commission (PAC[28]) is a government agency under the Office of the President mandated to manage Guyana's National Protected Areas, guided by the Protected Area Act 2011. This Act provided for the establishment, management, maintenance, promotion and expansion of the protected area system in Guyana. The main objectives of the PA Act are to assist in combating climate change, assist the state in meeting international obligations, recognize the value of biological diversity, conserve biodiversity, and conserve ecosystem services and ecosystems representative of Guyana's natural land and seascapes. Additionally, guiding the work of the PAC are the Iwokrama Act 1996, the Kaieteur National Park Act 1929 and amended Act 2002, and other regulations put in place by the PAC.

Prior to becoming a commission, there was a national Protected Area System that was in existence for over 90 years and under which the Kaieteur National Park (KNP) was established in 1929, the first national park created in the Amazon region and only one of three countries in South America to have a protected area. Guyana has taken a measured approach to the development of protected areas, with the country's second protected area, The Iwokrama Rainforest Reserve, being formally established in 1996. Two new protected areas, the Kanuku Mountains Protected Area (KMPA) and Shell Beach Protected Area (SBPA), were declared following decades of preparatory work with local communities and other stakeholders in 2011. The largest and first-ever indigenous-owned PA, Kanashen Amerindian Protected Area (KAPA), was added to the NPAS in 2017. Also included in the system are four urban parks: the Botanical Gardens, Zoological Park, National Park, and Joe Vieira Park. The PAs, together with the urban parks, account for approximately 8.4% of the country's land area. The PAC provides this information to the GFC to be included in the annual MRV reports as these land use types impact the forest uses and, consequently, the emissions.

[27] GL&SC: GLSC – Administer Land. Promoting Development

[28] PAC: https://www.pac.gov.gy/

Department of Environment and Climate Change

The Department of Environment and Climate Change (DECC) was formed by merging the Office of Climate Change and The Department of Environment in 2020. This department is the National Focal Point of the UNFCCC on climate change issues and is responsible for coordinating Guyana's reporting requirements and other international agreements. The role of the DECC continues to evolve as it advises government partners to participate in international climate negotiations representing Guyana's best interests and leads on national climate actions and policies. It also leads dialogues with multilateral agencies on behalf of the Government of Guyana (GoG) to establish partnerships and facilitate access to technical and financial support for low-carbon initiatives and national development. The DECC activities span policy-level intervention and advisory as well as program and project management and execution, with engagements directly with sectoral GoG partners to provide advice and recommendations to sector-level planning and strategies where they intersect with climate change adaptation and mitigation. Additionally, the DECC is responsible for leading and coordinating national adaptation and mitigation efforts in collaboration with multiple GoG sector agencies and other stakeholders.

Together, these agencies are responsible for the development and testing of methodologies, conducting the data analysis, and reporting under the various conventions and national agencies that require this information for the fulfilment of multiple purposes.

INFORMATION NECESSARY FOR THE RECONSTRUCTION OF THE RESULTS.

For the reconstructions of the results presented in this REDD+ Technical Annex, information extracted from Guyana's national REDD+ MRV System is presented disaggregated by activity data and emission factors.

Activity Data for Deforestation and Forest Degradation by Drivers

The average of the various activity data generated and used in deriving the results presented by Guyana in establishing its REDD+ results are listed in Table 11. The results cover the period 2011-2022 and exclude natural events that are considered non-anthropogenic change.

Table 11 Annual Average of Forest and Forest Loss by Deforestation Drivers

Variable	Description	
Coverage	National	
Period	2013-2022	
Satellite Image Resolution (m)	Variations of 5m, 10, and 15 m	
Average Deforestation by Driver (ha)	Forestry Infrastructure	255
	Agriculture	422
	Mining	7,494
	Infrastructure	156
Average Logging extraction (m^{-3})		585,620
Average Logging - skid trail (km yr^{-1}		2,214

While the system initially measured and reported on forest area change in its inception, over the years, it has evolved as more data are collected, and the system's data uses changes to satisfy multiple purposes, including reporting to the UNFCCC. As such, while methods remain largely the same, many improvements occurred to improve estimates' accuracy and reporting transparency. As such, the carbon pools, as per the FREL remain constant for this reporting period. However, new drivers have been added. As such presents, all the drivers associated with the FREL while all currently measured drivers' activity data are listed in Table 12. Of the drivers listed in Table 12, settlements, fire, and shifting cultivation do not form part of the emissions estimates for reporting, according to the FREL, since these are additional drivers. Still, they are included here for completeness purposes.

Table 12 Area Deforestation by Drivers

	Forestry Infrastructure	Agriculture	Mining	Infrastructure	Settlements	Fire	Shifting Cultivation
	(ha)						
2013	330	424	1,518	342	23	96	-
2014	204	817	10,434	141	71	259	-
2015	313	379	6,782	217	8	1,509	-
2016	313	379	6,782	217	8	1,509	-
2018	356	512	7,624	67	7	661	436
2019	226	246	5,821	52	22	6,371	431
2020	195	489	6,452	102	60	2,933	554
2021	228	216	6,825	117	105	139	393
2022	156	282	5,264	111	169	333	156

Emission Factors for Deforestation and Forest Degradation

Guyana applied the emission factors listed in Table 9 to generate the REDD+ results by drivers of deforestation and those listed in Table 10 for forest degradation. These country-specific emission factors are used in developing the GHG emissions for the sector reported in the national GHG inventory submitted as part of the country's Biennial Update Report, to which this REDD+ annex is attached. Additionally, emission factors were generated for degradation attributed to mining and infrastructure and logging activities linked to the volume extracted. These are captured in the GHG inventory estimates but are excluded from this report along with emissions from degradation resulting from settlements, biomass burning and shifting cultivation for consistency purposes to the FREL.

Calculation of Emission Reductions Resulting from REDD+

Guyana's annual emissions and reduction from REDD+ are estimated using the systems outlined in the methodology section of this report, which is guided by the country's national REDD+ MRV system that is compliant with the IPCC Guidelines (IPCC, 2006). Since this REDD+ technical annex covers the period from 2013- 2022, Table 13 lists the country's performance in relation to its annual emissions and reductions, only accounting for the drivers and carbon pools covered in the FREL.

Table 13 Annual REDD+ Performance

Year	Total Deforestation (tCO_2e)	Total Degradation (tCO_2e)	Total emission (tCO_2e)	Total emission reductions as per FREL (tCO_2e)
2013	12,447,415	3,724,737	16,172,152	30,129,099
2014	11,468,094	4,532,569	16,000,663	30,300,588
2015	7,596,547	3,910,404	11,506,951	34,794,300
2016	7,596,547	2,987,896	10,584,442	35,716,809
2017	8,242,461	3,180,717	11,423,177	34,878,074
2018	8,459,216	3,259,093	11,718,309	34,582,942
2019	6,263,139	3,109,512	9,372,650	36,928,601
2020	7,157,941	3,253,797	10,411,739	35,889,512
2021	7,286,552	3,266,693	10,553,245	35,748,006
2022	5,740,349	3,714,932	9,455,281	36,845,970

Since submitting the FREL, Guyana has improved its data collection and expanded the drivers covered to enhance the completeness and accurate reporting of the country's REDD+ Performance, which has allowed access to carbon finance. The new drivers that are included in the country's REDD+ performance for deforestation and degradation. Additionally, Guyana developed country-specific emissions factors for additional drivers. These new sources of emissions have been incorporated into the GHG inventory reported in the BUR but excluded from this report. The inclusion of these sources increased the country's emissions, as expected. However, despite the inclusion of these new drivers, the country's emissions have remained well below the reference level of the FREL, as seen in Table 14.

Table 14 Total emissions, including all drivers of deforestation and forest degradation

Year	Total Deforestation (tCO_2e)	Total Degradation (tCO_2e)	Total emission (tCO_2e)	Total emission reductions as per FREL (tCO_2e)
2013	12,564,342	3,724,737	16,289,078	30,012,173

2014	11,792,364	4,532,569	16,324,933	29,976,318
2015	9,086,325	3,910,404	12,996,729	33,304,522
2016	9,086,325	3,283,518	12,369,843	33,931,408
2017	9,253,505	3,438,197	12,691,702	33,609,549
2018	9,566,572	3,486,455	13,053,027	33,248,224
2019	12,987,717	3,295,268	16,282,984	30,018,267
2020	10,671,069	3,437,674	14,108,743	32,192,508
2021	7,912,787	3,481,675	11,394,463	34,906,788
2022	6,387,743	3,863,498	10,251,241	36,050,010

These results generated from the inclusion of the sources of emissions that contributed to an increase in the country's emissions have been used to inform a new baseline that Guyana will be setting in the revised FREL. Additionally, these combined emissions have been used by Guyana to transition from bilateral results-based payments to a voluntary carbon market, which was a first phase towards implementing Article 6 of the Paris Agreement. Even with the additional drivers of emissions being added, Guyana is well below its FREL baseline.

Guyana intends that the submission of its BUR and REDD+ Technical Annex will ensure alignment with implementing the enhanced transparency framework that is the next step of reporting in the form of the upcoming Biennial Transparency Report (BTR) submission.

DESCRIPTION OF HOW THE ELEMENTS IN 4/CP.15 PARA. 1(C) AND (D) HAVE BEEN TAKEN INTO ACCOUNT

Use of the most recent IPCC Guidance and Guidelines

In developing this REDD+ technical annex, Guyana utilised the 2006 IPCC Guidelines, as encouraged by the Conference of the Parties, for estimating its anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes. The same guidelines were used to develop the national GHG inventory reported in the BUR and the FREL, which was submitted to the UNFCCC. The changes are reported for both deforestation and forest degradation and are divided into two parts applying different methods as prescribed by the 2006 IPCC Guidelines.

To calculate the net change in carbon stocks resulting from deforestation, Guyana used the Stock-Difference method, which estimates the difference in total carbon stock between two time periods following Equation 2.5, Chapter 2, Volume 4, 2006 IPCC Guidelines. Additionally, the emissions resulting from fire, which is also a driver of deforestation, are estimated using Equation 2.27, Chapter 2, Volume 4, 2006 IPCC Guidelines.

To estimate the emissions from forest degradation attributed to logging activities, the Gain-Loss Method based on estimates of annual change in biomass was used by applying Equation 2.4, Chapter 2, Volume 4, 2006 IPCC Guidelines.

Following the Good Practice Guidance and uncertainty, Guyana applied the Monte Carlo uncertainty simulation. The Monte Carlo estimation of uncertainties was done by source as well as using the techniques to estimate overall uncertainty annually as well as trends.

Establish, According to National Circumstances and Capabilities, Robust and Transparent National Forest Monitoring System

As stated in Guyana FREL, the forest MRV system in place is at a national scale and will remain as such (described in Chapter 4). Additionally, there is a community MRV system in place, and both systems provide information to each other. As mentioned in Chapter 3, Guyana employed the use of a combination of remote sensing and ground-based forest carbon inventory approaches for estimating its anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes. The spatial estimates include the use of high-resolution imagery of various types, tested to determine the appropriateness and applicability for the country’s needs. The field data used were also tested to ensure its suitability and applicability, including the uncertainty associated with the data collected and analysis.

Since submitting the FREL, Guyana has made significant improvements in sustained capacity building, data collection and analysis, revised country-specific emission factors, and revised its emissions accounting to improve its reporting accuracy. Some of these changes include the revision of the stratification of the country’s forest; the addition of three new deforestation drivers: settlement, biomass burning, and shifting cultivation to its monitoring; the addition of a new driver for degradation: mining and infrastructure, the development of additional country-specific emission factors, and the move to a higher more complete form of uncertainty assessments.

Guyana's reporting on its methods and uncertainties demonstrates the openness to transparently reporting on its emissions and removals as far as practical, utilizing its national capacity and capabilities. The rigorous accuracy assessment built into the REDD+ MRV system illustrates the confidence in the accuracy of the estimates generated by the country, which is proven by the various international verifications. Additionally, the generating and publishing of the annual MRV reports is an indication of Guyana’s openness and confidence in its transparent system, which is no different to this report being submitted to the UNFCCC, which is also subjected to review, which Guyana welcomes.

Guyana considered its improvements, which resulted in an overall increase in accuracy and consistency, to be a significant milestone achieved and can illustrate the country's commitment to improving its national systems and reporting capabilities

CONCLUSIONS

Guyana intends to continue improving its national REDD+ MRV systems as more information and data become available. The country will continue to build on the existing systems and adopt changes as necessary to ensure its sustainability. One of the key improvements is the planned implementation of the Continuous Resource Monitoring System (CRMS), which is currently being tested and aims to reduce the reliance on commercial satellite imagery and software. Guyana will continue to put systems in place to implement the modalities and procedures required for the ETF implementation with an effort to implement Article 6 of the Paris Agreement. However, in the interim, Guyana intends to pursue the voluntary carbon markets to continue accessing carbon financing for national development and putting in place the necessary systems and institutional arrangements, including capacity-building to fulfil its commitment to the UNFCCC and pledges made under the Paris Agreement.

Since the submission of Guyana’s FREL in 2015, many improvements have been made owing to data availability and changing national circumstances. Guyana will be submitting a revised FREL, which will then align with the improved MRV system.

In the future, Guyana will continue to participate in the jurisdiction approach to REDD+ accessing voluntary and compliance markets (and once operational, full UNFCCC mechanisms for REDD+) and has outlined a benefit-sharing mechanism to ensure that the climate finance benefits will be shared in a way that is fair and equitable, recognizing the contribution of stakeholders.

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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**

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: Common reporting tables for the electronic reporting of the national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

1. GHG Inventory
2. Mitigation Database
3. Support Database

Annex III: Common tabular formats for the electronic reporting of:

- Information necessary to track progress in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement
- Information on financial, technology development and transfer and capacity-building support provided and mobilized under Articles 9–11 of the Paris Agreement
- Information on financial, technology development and transfer and capacity-building support needed and received under Articles 9–11 of the Paris Agreement

Please refer to areas of flexibility that have been identified.

A. Annex IV: Agreed Electronic Format (AEF) – Annual Reporting for Article 6.2 (Paris Agreement – UNFCCC)

AEF Guyana 2024 - Guyana revised.xlsx

Table 1: Heading

Party	Guyana
Reported year[a]	2024

[a] The annual period from 1 January to 31 December during which actions occurred.

Table 2: Actions

		ITMO																	*Actions*						
		Unique identifier				*Metric and quantity*				*ITMO details*				*Authorization*					*Action details*						
Article 6 database record ID	***Cooperative approach*** [a]	***First unique identifier*** [b]	***Last unique identifier*** [c]	*Underlying unit block start ID* [d]	*Underlying unit last block end* [e]	***Metric*** [f]	*Quantity (expressed in metric)* [g]	***Quantity ($t\ CO_2\ eq$)***	*factor (reporting Party)* [h]	***First transferring participating Party*** [i]	***Vintage*** [j]	***Sector(s)*** [k]	***Activity type(s)*** [l]	*Date of authorization* [m]	***Authorization ID*** [n]	***Purposes for authorization***	***authorized by the Party*** [o]	***First transfer definition*** [p]	***Action date*** [q]	***Action type*** [r]	***Transferring participating Party*** [s]	***Acquiring participating Party*** [t]	***Purposes for cancellation*** [u]	***Using participating Party or authorized entity or entities***	***First transfer*** [v]
	CA0005	CA0005-ART-GY-1-2021	CA0005-ART-GY-1-2021	ART-GY-102-2021-11-1	ART-GY-102-2021-11 - 7,144,362	GHG		7,144,362		Guyana	2021	AFOLU	REDD+	2/12/2024	*GUY 2024-CA1*	NDC and OIMP		Authorization	1/1/2024	Authorization					Yes
	CA0005	CA0005-ART-GY-1-2022	CA0005-ART-GY-1-2022	From ART Registry	From ART Registry	GHG		8,732,929		Guyana	2022	AFOLU	REDD+	2/12/2024	*GUY 2024-CA2*	NDC and OIMP		Authorization	1/1/2024	Authorization					Yes

[a] Name/ID of the cooperative approach as per common nomenclatures.*

[b] First ITMO unique identifier.

[c] Last ITMO unique identifier.

[d] Underlying unit block start ID for ITMOs recorded on the basis of cooperative approach units tracked in an underlying cooperative approach registry.

[e] Underlying unit block end ID for ITMOs recorded on the basis of cooperative approach units tracked in a an underlying cooperative approach registry.

[f] GHG or non-GHG.

[g] For non-GHG, the metric in which the ITMO was generated as per common nomenclatures.

[h] The conversion method or factor of the non-GHG units in the reporting Party's as per decision 2/CMA.3, annex, para. 22(d).

[i] Participating Party in which the mitigation outcome was generated as per common nomenclatures.

[j] Year in which the mitigation outcome occurred.

[k] Sector(s) where the mitigation outcome occurred as per common nomenclatures based on IPCC guidelines.

[l] Description of the mitigation activity type(s) as per common nomenclatures.

[m] Date of authorization by first transferring Party.

[n] Authorization ID as assigned by the first transferring Party, may include a link to the public evidence of authorization by the first transferring Party.

[o] Fill when "Purposes for authorization" is "OIMP" or "NDC and OIMP".

[p] If OIMP is authorized, the first transferring participating Party definition of "first transfer" as per decision 2/CMA.3, annex, para. 2(b).

[q] Date on which the action was executed in the registry of the reporting Party.

[r] Action type as per decision 2/CMA.3, annex, paragraph 20(a) and any further relevant guidance.

[s] Initiating participating Party, including for cancellations and uses.

[t] Participating Party receiving the ITMOs.

[u] For relevant actions, the specific purposes for cancellation towards which ITMOs can be or were used.

[v] Approach for first transfer as per decision 2/CMA.3, annex, paragraph 2 to be clarified, subject to defining the list of actions as per note "r" above.

[*] Common nomenclature to be established as per decision -/CMA.4

AEF Guyana 2024 - Guyana revised.xlsx

Table3: Holdings

		ITMO												Authorization				
		Unique identifier				Metric and quantity				ITMO details								
Article 6 database record ID	**Cooperative approach [a]**	**First unique identifier [b]**	**Last unique identifier [c]**	*Underlying unit block start ID [d]*	*Underlying unit last block end [e]*	**Metric [f]**	*Quantity (expressed in metric) [g]*	**Quantity ($t\ CO_2$ eq)**	*factor (reporting Party) [h]*	**First transferring participating Party [i]**	**Vintage [j]**	**Sector(s) [k]**	**Activity type(s) [l]**	*Date of authorization [m]*	**Authorization ID [n]**	**Purposes for authorization**	**authorized by the Party [o]**	**First transfer definition [p]**
	CA0005	CA0005-ART-GY-1-2021	CA0005-ART-GY-1-2021	ART-GY-102-2021-11-1	ART-GY-102-2021-11 - 7,144,362	GHG		7,144,362		Guyana	2021	AFOLU	REDD+	2/12/2024	*GUY 2024-CA1*	NDC and OIMP		Authorization
	CA0005	CA0005-ART-GY-1-2022	CA0005-ART-GY-1-2022	From ART Registry	From ART Registry	GHG		8,732,929		Guyana	2022	AFOLU	REDD+	2/12/2024	*GUY 2024-CA2*	NDC and OIMP		Authorization

[a] Name/ID of the cooperative approach as per common nomenclatures.*

[b] First ITMO unique identifier.

[c] Last ITMO unique identifier.

[d] Underlying unit block start ID for ITMOs recorded on the basis of cooperative approach units tracked in an underlying cooperative approach registry.

[e] Underlying unit block end ID for ITMOs recorded on the basis of cooperative approach units tracked in a an underlying cooperative approach registry.

[f] GHG or non-GHG.

[g] For non-GHG, the metric in which the ITMO was generated as per common nomenclatures.

[h] The conversion method or factor of the non-GHG units in the reporting Party's as per decision 2/CMA.3, annex, para. 22(d).

[i] Participating Party in which the mitigation outcome was generated as per common nomenclatures.

[j] Year in which the mitigation outcome occurred.

[k] Sector(s) where the mitigation outcome occurred as per common nomenclatures based on IPCC guidelines.

[l] Description of the mitigation activity type(s) as per common nomenclatures.

[m] Date of authorization by first transferring Party.

[n] Authorization ID as assigned by the first transferring Party, may include a link to the public evidence of authorization by the first transferring Party.

[o] Fill when "Purposes for authorization" is "OIMP" or "NDC and OIMP".

[p] If OIMP is authorized, the first transferring participating Party definition of "first transfer" as per decision 2/CMA.3, annex, para. 2(b).

Article 6, Paragraph 2 Initial Report (AIR) Referred to in Decision 2/CMA.3, Annex, Chapter IV.A (Initial Report) in Respect of Authorisation of ITMOs

1. General Information

Name of Party	Cooperative Republic of Guyana
Report Mandate	Decision 2/CMA.3, Annex, Chapter IV.A (Initial Report)
Report Type	Initial Report
NDC Submission	20 May 2016
NDC Implementation Period	2016-2025
Air Reference Number	AIR1
Date	February 12, 2024
Cooperative Approach Name	Emissions Reductions from Sustainable Management of Forests
Submitted by	Government of Guyana
Contact information	Pradeepa Goberdhan, National Focal Point UNFCCC, Guyana

2. Participation Responsibilities (para. 18(a))

A. Information on how the Party ensures that it is a Party to the Paris Agreement (para. 18(a), para. 4(a), to be updated by para. 21(a))

Guyana signed the Paris Agreement on April 22, 2016 and ratified on May 20, 2016 and is a Party to the Paris Agreement thereupon.

B. Information on how the Party ensures that it has prepared, communicated, and is maintaining an NDC in accordance with Article 4, paragraph 2 (para. 18(a), para. 4(b), to be updated by para. 21(a))

Guyana submitted its NDC to the UNFCCC Secretariat on May 20, 2016. This NDC will be revised by 2025.

C. Information on how the Party ensures it has arrangements in place for authorizing the use of ITMOs towards achievement of NDCs pursuant to Article 6, paragraph 3 (para. 18(a), para. 4(c), to be updated by para. 21(b))

The Office of the President is the designated authority within Guyana, tasked with authorizing the use of ITMOs. Guyana's national institutional arrangements for the issuance of correspondingly adjusted carbon credits are designed to align with UNFCCC standards and ensure transparency, accountability, and effectiveness. They are also designed to facilitate ongoing sales within the voluntary and compliance carbon markets.

1. Designated Authority:

Guyana's UNFCCC Focal Point serves as the designated authority responsible for overseeing the issuance of correspondingly adjusted carbon credits. The Focal Point collaborates with relevant government agencies and international bodies to ensure CAs remain aligned with national and UNFCCC guidance. The Focal Point also liaises, where applicable, with standards bodies and compliance market authorities.

The Focal Point ensures that:

- Guyana's approach to CAs, supports the relevant commitments made in the country's Nationally Determined Contribution (NDC) and, given the importance of the forest sector to the issuance of carbon credits, its Forest Reference Emissions Level (FREL).
- Pending the full operationalisation of Article 6 within the UNFCCC, Guyana will continue to articulate how it integrates with voluntary and compliance markets in a manner which remains in line with Guyana's UNFCCC contributions.
- Credits that are available for CAs are tagged as such, and mechanisms are in place to ensure that the adjustments are irrevocable.
- All submissions to the UNFCCC that relate to CAs are made, and these submissions are communicated.

2. Decisions on Corresponding Adjustments

The UNCCC Focal Point for Guyana, is authorized to oversee the issuance of carbon credits, which may be correspondingly adjusted, within the framework of commitments of the Guyana's NDC and FREL. The Focal Point is authorized to issue Guyana's Host Country Letters of Assurance and Authorization, related to REDD+ and any REDD+ programme activities.

D. Information on how the Party ensures it has arrangements in place that are consistent with Article 6, paragraph 2, guidance, and relevant decisions of the CMA for tracking ITMOs (para. 18(a), para. 4(d), to be updated by para. 21(b))

Guyana will generate credits to be traded on the carbon market, with independent verification of the quality of those credits and their adherence to the rules of the marketplace. Credits will adhere to UNFCCC guidance on REDD+, pending the launch of a full REDD+ mechanism. Currently all credits generated by Guyana are listed on the ART TREES Registry. All ITMOs will be issued under the ART TREES Registry.

At the national level, Guyana is establishing a national carbon registry, integrated with international markets and with any future REDD+ mechanism under the UNFCCC. This will be done in accordance with the rules of all relevant international agreements on markets and carbon trading.

E. Information on whether the most recent national inventory report required in accordance with decision 18/CMA.1 has been provided (para. 18(a), para. 4(e), to be updated by para. 21(b))

Guyana submitted its Second National Communication in 2012.

Guyana's BUR with updated GhG inventory information was submitted in February, 2024.

Guyana's Forest Reference Emissions Level was submitted in December 2014. The duration of the FREL is 2015 to 2022.

F. Information on how the Party ensures participation contributes to the implementation of its NDC and long-term low-emission development strategy, if it has submitted one, and the long-term goals of the Paris Agreement (para. 18(a), para. 4(f), to be updated by para. 21(b))

Guyana's NDC (2016-2025) was developed to initially focus on the forest and energy sectors, where the majority of current and historic emissions have been produced. It seeks to pursue a resilient, low-carbon, socially-inclusive economy that provides a better quality of life for all within the ecological limits of the planet. The approach is a utilization of a combination of conservation and sustainable management of Guyana's forests in the fight against climate change. The greenhouse gas taken into account in the NDC is CO_2.

Guyana's nationally determined contribution is articulated in a set of unconditional commitments in both the energy and forest sectors. Guyana's target is to make a contribution beyond this NDC by achieving up to 46.3 MtCO2e annually to global mitigation efforts through emissions credits from its forests. This is set out as a conditional commitment within the NDC document.

Guyana intends to expand the focus of its NDC and align this to the national Low Carbon Development Strategy 2030, and will move towards inclusion of other sectors.

Guyana recognises registries managed by international carbon mechanisms for the tracking of ITMOs, such as that of the Architecture for REDD+ Transactions (ART), through which Guyana has been issued 33.47 million TREES credits to date, for the period 2016-2020. With the development of its domestic registry, Guyana will seek to ensure synergies and interconnectivity with this and other relevant registries as that becomes necessary.

3. Description of the Party's nationally determined contribution, as referred to in decision 18/CMA.1, annexe, paragraph 64, where a participating Party has not yet submitted a biennial transparency report (para. 18(b), to be updated by para. 21(b))

A. Target(s) and description, including target type(s) (decision 18/CMA.1, annex, para. 64(a))

Guyana's target for enabling ITMOs is an emissions reductions target set against maintaining forest cover. This target type is described in Guyana's NDC under the conditional commitments within the forest sector.

B. Target year(s) or period(s), and whether they are single-year or multi-year target(s) (decision 18/CMA.1, annex, para. 64(b))

Guyana has adopted an absolute single-year target approach, with 2016-2020 being the base period and 2030 the target year. The single year target is to maintain emissions levels in the forest sector below the baseline set by Guyana's FREL as submitted to the UNFCCC – 46.3 MTCO2eq.

However, market acceptance to date is based on standards that are considerably more conservative than the UNFCCC FREL. While continuing to adhere to UNFCCC methodological guidance, Guyana will seek to build market confidence and cap its available ITMOS at the level allowed by the ART-TREES methodology. This cap will stay in place until there is greater convergence between ART-TREES and Guyana's FREL (there will be a new FREL from 2023), and will not be lifted before 2025 at the earliest. In sum,
Guyana will only issue Correspondingly Adjusted credits to the level of ART TREES verified and validated credit issuance.

C. Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s) (decision 18/CMA.1, annex, para. 64(c))

Base Period: 2016-2020

Annual emissions target for ITMOs in the forest sector is 46.3MTCO2eq. Guyana will only issue Correspondingly Adjusted credits to the level of ART TREES verified and validated credit issuance.

D. Time frame(s) and/or periods for implementation (decision 18/CMA.1, annex, para. 64(d))

Period for Implementation: 2021 to 2030

E. Scope and coverage, including, as relevant, sectors, categories, activities, sources and sinks, pools and gases (decision 18/CMA.1, annex, para. 64(e))

Gases Covered: CO_2

Sectors: Forestry /LULUCF

LULUCF:

- Pools- All five IPCC recognized carbon pools are included
- All data are at Tiers 2 and 3 for the following reasons:
    - Wall-to-wall coverage of satellite imagery is used to obtain the AD related to conversion of forest lands to other uses and such data are combined and co-registered with other key spatial databases in a GIS such as roads, rivers, settlements, vegetation class, location of logging concessions, location of mining concessions, and topography.
    - A comprehensive, peer-reviewed, field sampling system was designed and implemented to attain a required precision target of a 95% confidence interval of <+/-15% of the mean total carbon stock of forests.

F. Intention to use cooperative approaches that involve the use of internationally transferred mitigation outcomes under Article 6 towards NDCs under Article 4 of the Paris Agreement (decision 18/CMA.1, annex, para. 64(f))

Guyana ITMOs will be achieved against a target based on the current FREL submitted in 2015, of 46.3 MTCO2eq – but with a temporary cap in place so as to limit ITMOs to those allowed through the ART TREES methodology for verified and validated credit issuance. At present (2024), this would be a maximum of 21 MTCO2eq. per year.

G. Any updates or clarifications of previously reported information (e.g., recalculation of previously reported inventory data, or greater detail on methodologies or use of cooperative approaches) (decision 18/CMA.1, annex, para. 64(g))

None

4. Information on ITMO metrics, method for applying corresponding adjustments and method for quantification of the NDC (para. 18(c–f))

A. ITMO metrics (para. 18(c))

Guyana will apply and report ITMOs only in carbon dioxide equivalent (CO2e), whereby one ITMO equals one tonne of CO2e (1tCO2e).

B. Method for applying corresponding adjustments as per chapter III.B (Application of corresponding adjustments) (para. 18(c))

i. Description of the method for applying corresponding adjustment for multi- or single-year NDCs that will be applied consistently throughout the period of NDC implementation, if applicable (para. 18(c))

Guyana will apply corresponding adjustments based on a single year target. This will be applied consistently throughout the period of the NDC implementation. CAs will be issued only on ART approved credits (post verification and validation by independent process as per TREES V2) as issued in the ART TREES Registry. Though Guyana's FREL concludes on a reference level of 46.3 MTCO2eq, Guyana will only issue CAs for ART TREES verified, validated and issued credits which will be to a maximum (based on TREES methodology computed for Guyana): 21 MTCO2eq annually.

ii. Description of the method for applying corresponding adjustments where the method is a multi-year emissions trajectory, trajectories or budget, if applicable (para. 18(c))

Not Applicable.

C. Quantification of the Party's mitigation information in its NDC in tCO_2e, including the sectors, sources, GHGs and time periods covered by the NDC, the reference level of emissions and removals for the relevant year or period, and the target level for its NDC or, where this is not possible, the methodology for the quantification of the NDC in $t\ CO_2e$ (para. 18(d))

Guyana's mitigation sources are from the forest and land use sectors. It covers the period 2021 to 2030. Guyana's reference level is 46.3 MtCO2eq annually of which CA will only be issued for those certified by ART-TREES (currently this equates to 21 MTCO2eq annually).

D. Quantification of the Party's NDC, or the portion in the relevant non-GHG indicator, in a non-GHG metric determined by each participating Party, if applicable (para. 18(e))

Not Applicable

E. For a first or first updated NDC consisting of policies and measures that are not quantified, information on the quantification of the Party's emission level resulting from the policies and measures that are relevant to the implementation of the cooperative approach and its mitigation activities for the categories of anthropogenic emissions by sources and removalsby sinks, as identified by the first transferring Party pursuant to paragraph 10, and the time periods covered by the NDC (para. 18(f))

Not Applicable

5. Information on each cooperative approach (para. 18(g–i), para. 19)

A. Copy of the authorization by the participating Party (para. 18(g))

Copy of LoAA attached to this Report and submitted to the UFFCCC.

B. Description of the cooperative approach (para. 18(g))

Cooperative Approaches

The cooperative approach promotes programmes in the forestry sector across a range of REDD+ actions including EU Forest Law Enforcement Governance and Trade (FLEGT), Sustainable Forest Management with a focus on Reduced Impact Logging, Development of a National Forest Management and Chain of Custody Standard and the MRV System for REDD+.

The Cooperative Approach promotes the maintenance of approx. 18 million hectares of forest cover that stores 19.5 GTCO2eq. **This will enable a net emissions reductions level of 46.3 MtCO2eq.** of which **Guyana will issue corresponding adjustments to a maximum of those allowed by ART-TREES (currently 21MtCO2eq).**

Development and implementation of codes of practice to inform effective forest resources management in forest harvesting activities to maintain low rates of deforestation and forest degradation - Given the multiple use nature of Guyana's forests, forest harvesting activities is but one aspect of economic activities undertaken. To this end, sustainable forest management and the accompanying codes of practices are absolutely necessary to ensure the efficient management of the resources. Codes of practice are designed to take into account the various Acts and Legislations that are directly related to forest management. They provide guidelines for best practices in order to ensure that continuing economic returns can be obtained over the long term, while simultaneously fostering overall sustainable utilisation and management of Guyana's forest resources.

Implementation of forest monitoring activities to ensure conformance with sustainable forest management (SFM) guidelines and EU FLEGT requirements- REDD+ encapsulates all aspects of sustainable forest management, including forest monitoring and enforcement. Legality and the activities that accompany attaining same are critical to achieving good governance in the forest sector, in that, principles of sustainable forest management as well as activities under a REDD + agenda cannot be accomplished without this. Forest Monitoring is a critical support component of any REDD+ programme, especially to ensure forest degradation and deforestation is contained and or minimized. Guyana has been implementing a number of forest monitoring schemes, including its Legality Assurance System. Additionally, in 2009, the GoG engaged the European Union (EU) to better understand the requirements of the European Union Forest Law Enforcement Governance & Trade (EU FLEGT) Programme. EU FLEGT is also part of Guyana's REDD+ Programme.

Guyana – EU FLEGT Process
Guyana's early commitment to REDD+ implementation under the Guyana-Norway partnership (Phase I), led to Guyana's national process to join the European Union's Forest Law Enforcement, Governance and Trade (FLEGT) initiative towards achieving a Voluntary Partnership Agreement (VPA). This national REDD+ governance indicator aims to raise the profile of Guyana's timber industry and make it more sustainable.

Reduced Impact Logging (RIL)
As a key pillar for sustainable forest management, Reduced Impact Logging (RIL) will result in improved harvesting practices through the implementation of planned activities which includes directional felling of trees which reduces damage to the residual stand. These activities will support Guyana's REDD+ initiatives through the maintenance of its low deforestation rate during logging activities, as well as to continue to build capacities and improve practices within the sector.

Development of a National Forest Management and Chain of Custody Standard
Starting in 2021 and continuing through 2022, the Guyana Forestry Commission commenced preliminary activities on the development of a National Forest Management and Chain of Custody Standard. The National Forest Management and Legality Standard for Guyana will cover forest management on all land tenures where forest management for commercial purposes is permitted by law and is intended to be available to both individual forest management organisations and potential group schemes involving multiple forest management entities. Certification will cover both timber and non-timber forest products and will facilitate chain of custody certification for entities purchasing, processing and/or trading in forest products.

Monitoring, Reporting and Verification System (MRVS)

Building on Guyana's reporting commitments under the Guyana Norway Bilateral Agreement to measure and report on the country's performance against the REDD+ Performance Indicators[29], the country is committed to continuing to develop and maintain the MRVS as a platform through which the country can report on forest change and associated emissions. The MRVS was designed to underpin results-based REDD+ compensation and is integral to Guyana's engagement with the ART. It is a key component of the Low Carbon Development Strategy 2030, whereby the Strategy seeks to build on the platform provided by the MRVS to embark on a more inclusive and comprehensive path to a low-carbon economy. **Advance the promotion of value added initiatives within the sector to assist in creating higher potential for carbon storage in long term wood products-** Market research and promotion are integral to supporting REDD+, as the country seeks to minimise the pressure on its forest by finding the most suitable and economic use for the forest resources. Guyana's NDC points out that the use of value added "could also potentially reduce the pressure on forest resources as derivation of a higher value may result in reduced harvest levels."

C. Duration of the cooperative approach (para. 18(g))

January 1, 2021 to 31st December, 2030

D. Expected mitigation for each year of the duration of the cooperative approach (para. 18(g))

Mitigation per Year: net emissions reductions level of 46.3 MtCO2eq. of which Guyana will issue corresponding adjustments to a maximum of those allowed by ART-TREES (currently 21MtCO2eq.)

E. Participating Parties involved in the cooperative approach (para. 18(g))

Cooperative Republic of Guyana – transferring participating Party.

F. Authorized entities (para. 18(g))

Cooperative Republic of Guyana

G. Description of how the cooperative approach ensures environmental integrity (para. 18(h), to be updated by para. 22(b))

i. Description of how the cooperative approach ensures that there is no net increase in global emissions within and between NDC implementation periods (para. 18(h)(i), tobe updated by para. 22(b)(i))

Guyana's Low Carbon Development Strategy (LCDS) was first formulated in 2008 and aimed to support the country in the pursuit of a '*resilient, low-carbon, socially-inclusive economy'*, paving the way for national efforts to reduce emissions in the forest and land use sector. This initiative is led by the Office of the President of Guyana and continues to be the cornerstone for REDD+ strategic development in Guyana. Guyana's legal framework provides a comprehensive suite of laws governing conservation and the protection of biodiversity consistent with national forest programmes that are applicable to the REDD+ Implementation Plan[30]. The National Forest Policy Statement 2018 (NFPS) and National Forest Plan 2018 (NFP) have been developed within the framework of the Guyana Constitution. The policy framework developed for REDD+ implementation in Guyana has resulted in greater levels of sectoral coordination and more efficient policy formulation and implementation, and Guyana has been able to align effort to further develop REDD+ actions and strengthened its institutional capacities for REDD+ implementation.

[29] Joint Concept Note, 2012

[30] The Constitution of Guyana 1980 – Principles and Bases of the Political, Economic and Social System recognises by virtue of section 36- the wellbeing of the nation requires inter alia the preservation of the rich diversity of plants and eco-systems. This is a general aspiration of the nation expressed by the drafters of the Constitution and represent the broad objectives which can be viewed as the foundation for all the subordinate legislation, regulations and policies.

In recognition that the bulk of Guyana's forest emissions emanate from mining and logging activities, Guyana's efforts will therefore focus on ensuring that such activities align with sustainable and efficient operations in line with the country's objectives stated in the NDC.
Guyana's national commitments were made that targeted the forest and energy sectors, which have produced the majority of emissions, both current and historic. Importantly, sustainable forest management and conservation are highlighted as key to Guyana's fight against climate change and are in keeping with the national implementation of REDD+ in Guyana. These activities all form the basis for Guyana's contribution to efforts to mitigate climate change up to 2025.
Unconditional contributions for forestry activities have been identified as follows:

- Ensure compliance with the various Codes of Practice to realise sustainable forest management (SFM);
- Forest monitoring will maintain a high level of timber legality. These efforts will maintain a low rate of illegal logging (at less than 2% of production).
- Forest monitoring to maintain a high level of timber legality, including the finalisation and implementation of the Voluntary Partnership Agreement (VPA) under the EU Forest Law Enforcement Governance and Trade (EU FLEGT);
- Improve added- value activities locally to assist in creating higher potential for carbon storage in long term wood products and to support linkages to the FLEGT process.
- Strengthen support for indigenous communities as they continue the stewardship of their lands and inter alia the benefits that accrue from any REDD+ activities from these lands

Conditional contributions include:

- Conservation of an additional 2 million hectares through Guyana's National Protected Area System and other effective area-based conservation measures as per Guyana's commitment under the UNCBD, including the protection of conservancies and reservoirs and their watersheds and the watersheds upstream of new hydro-power sites. Existing mangrove forests will be counted in this target and the mangrove restoration programme along the vulnerable coast will be expanded.
- Avoided deforestation through the development of an Emissions Reduction Programme that will target:
  - Use of Reduced Impact Logging (RIL) with the potential to reduce annual emissions by 13.5%
- Completion and maintenance of building the national MRVS, provided that adequate financial resources are available to do so.

Guyana's MRVS has verified that small scale gold mining resulted in 89% of the national deforestation recorded over the past three years. To address this, the ERP will include actions by the Guyana Geology and Mines Commission (GGMC) to implement policies, education programmes, and incentives for integrated planning and management of the mining sector. This will support the transformation of the mining sector and include actions to:

- Implement mineral mapping in the mining districts to identify economically exploitable deposits. This will significantly reduce deforestation by avoiding clearing of forest cover from lands which contain only marginal mineral deposits.
- Implement awareness and incentive programmes to improve the efficiency of technologies and practices in the mining industry.
- Implement policies to institute reclamation and reforestation of mined areas.

Guyana has continued to pursue efforts to have in place all requirements and methodological guidance to support REDD+ implementation as agreed under the Warsaw Framework for REDD+ (WFR), including ensuring the implementation of REDD+ in accordance to Cancun Safeguards and meeting all safeguards-related requirements.
The NDC acknowledges Guyana's robust MRVS as one that can ensure the integrity of emission reduction efforts as the country engages with carbon-neutral markets as a means of maximizing the

value of national exports and providing internationally attractive, verifiable low carbon products. The MRVS will continue to be strengthened and improved as new international guidance and technologies become available. Further the role of the MRVS will be expanded to inform forest management policy and practice.

The MRVS was developed as performance measurement mechanism for REDD+ with focus initially placed on the development of two primary components: (i) a framework for forest area change assessment and monitoring; and (ii) forest carbon stock measurement and monitoring. The national-scale MRVS is identified as a national priority of Guyana's REDD+ program. Guyana's MRVS Roadmap, developed in 2009, aimed to build a comprehensive national system to monitor, report and verify forest carbon emissions resulting from deforestation as well as forest degradation. Since 2010, there have been twelve national-level assessments done on an annual basis. MRVS uses a combination of GIS and field-based data to report on activity and emissions data. Satellite imagery technology used include Landsat, Planet Scope and Sentinel 2. The range of deforestation rates is between the reference period of this report (2016 to 2020) is 0.048% and 0.073% which is at a maintained low level and for the period under monitoring of year 2022, the rate is 0.036%. The repeated, systematic assessments under the Guyana MRVS, integrates the risk of reversals in its approach.

Additionally, the Guyana Forestry Commission Act[31] and the State Lands Act (SLA)[32] with their corresponding NFPS[33] and NFP[34], the Code of Practice for Timber Harvesting[35], the Guidelines for Conducting Management-level Inventory and 100%-level Inventory, and the Guidelines for the Preparation of Forest Management Plans and Annual Operational Plans additionally the Code of Practice for Timber Harvesting prescribes inter alia internationally accepted standards for exclusion areas and buffer zones, pre-harvest inventory, road construction and felling.

ii. Description of how the cooperative approach ensures environmental integrity through robust, transparent governance and the quality of mitigation outcomes, including through conservative reference levels and baselines set in a conservative way and below 'business as usual emission projections (including by considering all existing policies and addressing uncertainties in quantification and potential leakage) (para. 18 (h)(ii), to be updated by para. 22(b)(ii))

The REDD+ Environmental Excellence Standard (TREES) sets out ART requirements for the quantification, monitoring, and reporting of GHG emissions and removals; demonstrating the implementation of the Cancún Safeguards; and verification, registration, and issuance of TREES credits. TREES has been designed to ensure that all TREES credits issued are real, measured, permanent, additional, net of leakage, verified by an accredited independent third party, and are not double-counted. As a result, TREES credits will represent high quality while still allowing flexibility for implementing REDD+ programmes at a national level or subnational as an interim measure.

ART's standard TREES 2.0 includes approaches for the full range of necessary actions needed for a broad range of forest countries and communities to contribute to Paris Agreement targets. This includes reducing emissions from deforestation and forest degradation, the most urgent priority for the forest sector, and protecting intact forests and restoring forest landscapes.

By ensuring the continuum of climate action is eligible for participation in carbon markets, ART offers an incentive for jurisdictions to reduce deforestation, restore forests and ultimately become High Forest – Low Deforestation (HFLD). Intact forests contribute both climate mitigation and adaptation benefits by storing carbon, regulating local and regional climate, supplying critical moisture to agricultural lands, and resisting wildfire. Also, providing incentives to HFLD jurisdictions

[31] Guyana Forestry Commission Act No 20 of 2007.
[32] State Lands Act 1903.
[33] Guyana National Forest Policy Statement 2018.
[34] Guyana National Forest Plan 2018.
[35] Code of Practice for Forest Operations 2018

lowers the risk of cross-boundary shifting of deforestation emissions (i.e., leakage).

iii. Description of how the cooperative approach is minimizing the risk of non-permanenceof mitigation across several NDC periods and how, when reversals of emission reductions or removals occur, the cooperative approach will ensure that these are addressed in full (para. 18(h)(iii), to be updated by para. 22(b)(iii))

Annual MRV reporting will be conducted by Guyana and subject to the independent verification and validation steps under TREES V2.

Guyana is a country with very low rates of deforestation (not exceeding 0.079% between 2005 and 2014) and as such a 15% variation in rate from a mean value is not a reflection of a high risk of reversal. Over a 5-year period the variation about the mean is 16%.

Given the very low areas of annual deforestation and low annual fluctuation in deforestation area (16% of the 5-year average deforestation rate is less than 2000 ha), there is very low risk of non-permanence of mitigation across the NDC period.

The programmes described in 5(B) maintains forest cover and prevents risk of non-permanence.

In the unlikely instance of reversal, ART TREES V2 provides for reversal at a level of 5% that results for period 2021 in an amount reversal buffer account of 446,714 tCO2eq being provided for. Over the period 2016 to 2022, Guyana' reversal buffer account within ART TREES holds a total of 3MtCO2eq.

H. Additional description of the cooperative approach (para. 18(i))

i. Description of how the cooperative approach minimizes and, where possible, avoids negative environmental, economic and social impacts (para. 18(i)(i), to be updated bypara. 22(f))

The cooperative approach ensures that the application of sustainable forest management and conservation are result in maintained low levels of emissions through the national implementation of REDD+ in Guyana. Annual MRV assessments are conducted to monitor and measure impacts of the approach and the programmes are all oriented towards effective management and strong governance of the forest sector.

Guyana has reported in two Summary of Information on REDD+ Safeguards to the UNFCCC and has reported on monitoring systems and progress across each Cancun Safeguard. This is part of the required reporting under ART TREES and is independently validated and verified before credits are issued to Guyana.

ii. Description of how the cooperative approach reflects the eleventh preambular paragraph of the Paris Agreement, acknowledging that climate change is a common concern of humankind, Parties should when taking action to address climate change, respect, promote and consider their respective obligations to human rights, the right tohealth, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity (para. 18(i)(ii), to be updated by para. 22(g))

Guyana's institutional and legal framework supports the implementation of its cooperative approach, and includes the enactment of forest regulations under the national Parliament which aim to ensure the continued maintenance of the low rates of deforestation and forest degradation,

including the provision of necessary platforms for the implementation of updated forest legislation.
Guyana's legal framework provides a comprehensive suite of laws governing conservation and the protection of biodiversity consistent with national forest programmes. Among them are the National Forest Policy Statement 2018 (NFPS) and National Forest Plan 2018 (NFP), which were developed within the framework of Guyana's Constitution. These present a set of policies and plans that address the economic, conservation, governance and capacity facets of forest management, while seeking to value the forest for more than the price of the timber.
Guyana's Constitution includes provisions protecting individuals from discrimination including on the grounds of gender, stating that (a) no law shall make any provision that is discriminatory either of itself or in its effect; and (b) no person shall be treated in a discriminatory manner by any person acting by virtue of any written law or in the performance of the functions of any public office or any public authority. Further protections are provided specifically to women and children.
Guyana's legal framework guards against all forms of discrimination, including discrimination on the grounds of gender. The Guyana Constitution established the Women and Gender Equality Commission to promote national recognition and acceptance that women's rights are human rights, respect for gender equality and the protection, development and attainment of gender equality.
Guyana has a suite of legislation such as the Amerindian Act (AA), the Protected Areas Act (PAA), the Forest Act (FA) and other sectoral policies recognise the rights, statutory and customary ownership and use rights. This suite of forest legislation provides clear legal rules recognizing land and forest land tenure rights.
The Amerindian Act in its opening paragraph states that it is: An Act to provide for the recognition and protection of the collective rights of Amerindian Villages and Communities, the granting of land to Amerindian Villages and Communities and the promotion of good governance within Amerindian Villages and Communities.
Guyana's LCDS 2030 recognises that for global climate, health and other challenges to be met, nature-based solutions and eco-system services must be valued. It further posits that for Guyana, the long-term future for eco-system services should include market-based mechanisms, with the most realistic entry point for building an eco-system services economy being based on carbon through integration of Guyana's forest climate services into global carbon markets.

iii. Description of how the cooperative approach is consistent with the sustainable development objectives of the Party, noting national prerogatives (para. 18(i)(iii), to beupdated by para. 22(h))

Guyana's cooperative approach is outlined as part of the country's national development strategy – Guyana's Low Carbon Development Strategy 2030.
Guyana's Low Carbon Development Strategy (LCDS) was first formulated in 2008 and aimed to support the country in the pursuit of a *'resilient, low-carbon, socially-inclusive economy',* paving the way for national efforts to reduce emissions in the forest and land use sector.
The Low Carbon Development Strategy set out a vision through which economic development and climate change mitigation will be reconciled through the generation of payments for "forest climate services" in a mechanism of sustainable utilization and development (i.e. REDD+). The result is intended to be the transformation of Guyana's economy whilst combating climate change. Guyana's LCDS was updated in 2011 and 2013, and expanded in 2021, when a draft LCDS 2030 was launched for national consultation. After seven months of national consultation, overseen by a Multi-Stakeholder Steering Committee (MSSC), the LCDS 2030 was finalised in July 2022.
LCDS 2030 seeks to build on the progress made in implementation of LCDS 2009 and to further create a new low-carbon economy in Guyana by establishing incentives which value the world's ecosystem services, and promoting these as an essential component of a new model of global development with sustainability at its core. The three objectives set out in 2009 continue to provide a guiding framework and have been enhanced based on knowledge gained since then, as well as new opportunities created by international progress. This LCDS 2030 addresses these objectives:

- **Forest Climate Services and other Ecosystem Services:** Guyana can access market-based mechanisms for forest climate services that includes private, as well as international public sector financing that will enable a pathway to build on the successes of the Guyana-

Norway partnership as Guyana moves to a market based mechanism, and starts Phase II of Guyana's vision for REDD+.

- **Stimulate future growth through clean energy and sustainable economic activities:** Guyana can undergo one of the world's most ambitious energy transitions and grow the economy up to five-fold, while keeping greenhouse gas emissions from energy generation at around 2019 levels. The development of the Ocean Economy is a further priority - to bridge the land-ocean nexus via low-carbon growth. This will include areas such as fishing, ocean biodiversity and mangroves, and shipping and transport.
- **Protect against climate change:** Global wellbeing continues to be damaged by climate change, including in Guyana where extreme weather events are destroying livelihoods and damaging the economy.

The LCDS 2030 recognizes that for global climate, health and other challenges to be met, nature-based solutions and eco-system services must be valued. It further posits that for Guyana, the long-term future for eco-system services should include market-based mechanisms, with the most realistic entry point for building an eco-system services economy being based on forest carbon through integration of Guyana's forest climate services into global carbon markets.

iv. Description of how the cooperative approach applies any safeguards and limits set outin further guidance from the CMA pursuant to chapter III.D (para. 18(i)(iv), to be updated by para. 22(i))

Not Applicable.

v. Description of how the cooperative approach contributes resources for adaptation pursuant to chapter VII (Ambition in mitigation and adaptation actions), if applicable (para. 18(i)(v), to be updated by para. 22(j))

No Applicable.

vi. Description of how the cooperative approach delivers overall mitigation in global emissions pursuant to chapter VII (Ambition in mitigation and adaptation actions), if applicable (para. 18(i)(vi), to be updated by para. 22(k))

Implementing LCDS 2030 will advance progress towards the UN Sustainable Development Goals, and Guyana's multilateral, regional and bilateral agreements within the thematic areas of each programme. In fact, the LCDS is aligned to all SDGs to varying degrees. This alignment will feed into sector level planning and will be integrated within institutional programming at Governmental level. Where existing sector plans already exist, and in instances of new requirements stemming from global, bilateral and regional agreements/conventions, these will be aligned with LCDS programme areas and future revisions of the LCDS will also take these developments on board. Implementation will be advanced, where relevant, in collaboration with NGO and development partners.

As part of Guyana's LCDS 2030, Guyana commits to following a development pathway that aims to simultaneously progress national and global solutions around development, climate change and ecosystem services. While national policies and plans are set through national processes, at the same time, Guyana is committed to a wide array of international treaties, conventions on pledges on climate, biodiversity and other broader sustainability.
Through the Cooperative Approach, which centres on maintaining and reducing impact on forests, Guyana's ecosystems will contribute to the world's health and economy, through:

• maintaining the second highest percentage of forest cover on earth, with more than 99% of the forest's 18 million hectares remaining.
• safeguarding approximately 19.5 billion tons of carbon dioxide equivalent stored in Guyana's forests
• Ensure that Guyana's deforestation rates are among the lowest in the world and Guyana is one of only four countries in the world (and one of only two in the Amazon Basin) verified to have sustained a High Forest Low Deforestation (HFLD) state.

• Maintain Guyana's contribution as one of six countries which host the Guiana Shield, one of the most pristine rainforest landscapes in the world. The Guiana Shield stores around 18% of the world's tropical forest carbon and 20% of the world's fresh water. Guyana will authorise the use of ITMOs for NDC reporting, and other mitigation purposes, including voluntary and compliance offsetting. All ITMOs issued by Guyana will be ART TREES certified credits and will see a buffer provision of 5% being set aside in keeping with TREES requirements. This protects against the risk of reversal. Only TREES issued credits will be offered as ITMOs upon issuance.	
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