



Republic
of Rwanda

RWANDA'S FOURTH NATIONAL COMMUNICATION REPORT

to the United Nations
Framework
Convention on
Climate Change

2026

Rwanda's Fourth National Communication Report

**To the United Nations Framework Convention on Climate
Change (UNFCCC)**

2026

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FOREWORD



On behalf of the Government of Rwanda, it is my honour to present Rwanda's Fourth National Communication (NC4) to the United Nations Framework Convention on Climate Change (UNFCCC). This report presents our nation's unwavering commitment to addressing the urgent challenges of climate change while advancing sustainable development for all Rwandans. Rwanda has long recognized that climate action is not just an environmental imperative but a cornerstone of economic resilience, social equity, and long-term prosperity.

Guided by Vision 2050 and the second National Strategy for Transformation 2024–2029 (NST-2), we have integrated climate considerations into every sector of our development agenda. This report reflects the progress we have made in reducing greenhouse gas emissions, strengthening climate resilience, and mobilizing the necessary finance and technology to achieve our climate action goals.

Since the Third National Communication (NC3), Rwanda has taken bold steps to enhance its climate policies, including the recently updated Nationally Determined Contribution (NDC 3.0) which set a target of 53% emissions reduction by 2035. We have expanded renewable energy, accelerated e-mobility, and promoted climate-smart agriculture demonstrating that economic growth and environmental sustainability can go hand in hand.

At the same time, we are acutely aware of the growing climate risks facing our communities. Rising temperatures, unpredictable rainfall, and extreme weather events threaten livelihoods, though their negative impacts on agriculture, water resources, and infrastructure. Rwanda continues to strengthen policies that promote equitable and resilient development in line with the global agenda on just transition, loss and damage, and ecosystem-based adaptation.

As we look ahead, Rwanda remains committed to transparency, accountability, and leadership in the global fight against climate change. We call upon the international community to honour its commitments on climate finance, technology transfer, and capacity-building to ensure that vulnerable nations like Rwanda can meet their climate goals.



**Digitally signed
by
MOE(Minister)**

**Dr. Bernadette Arakwiye
Minister of Environment
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I am pleased to express our gratitude to those who, in one way or another, have contributed to the preparation and publication of this Fourth National Communication report. Our appreciation goes particularly to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat, Global Environmental Facility (GEF) and UNEP in its quality as GEF Implementing Agency, for their financial and technical support and training in different methodological tools.

I would like to take this opportunity to thank all sectoral ministries, government departments, local government authorities, research and academic institutions, private sector, non-governmental organizations, civil society and other key institutions for participating in the development of this NC4.

I am thankful to all international and national experts who have conducted sector studies; and all those who took part in different validation workshops, which considered the thematic reports and the final report of the Rwanda Fourth National Communication under the United Nations Framework Convention on Climate Change (UNFCCC).

Juliet KABERA
Director General,
Rwanda Environment Management Authority

A handwritten signature in black ink, appearing to read 'Juliet Kabera'.

REMA(DG)1

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ABBREVIATIONS AND ACRONYMS

AFDB	African Development Bank	CPAs	Component project Activities
AFOLU	Agriculture, Forestry and other Land Use	CPCIC	Cleaner Production and Climate Innovation Center
AMEAMU	Advocacy and Multilateral Environment Agreements Unit	C-RATDC	China-Rwanda Agriculture Technology Demonstration Center
ANP	Akagera National Park	CSOs	Civil Society Organizations
AQI	Air Quality Index	CST	College of Science and Technology
ARCOS	Albertine Rift Conservation Society	CV	Coefficient of Variation
ARECO	Association Rwandaise Des Ecologistes	CWD	Consecutive Wet Days
a.s.l	above sea level	DEEM	Department of Environmental Education and Mainstreaming
ATADEC	Action Technique pour un Développement Communautaire	DFID	UK Department for International Development
BUR	Biennial Update Report	DFMP	District Forest Management Plan
CAVEM	College of Agriculture and Animal Sciences and Veterinary Medicine	DFO	District Forest Officer
CBCCA	Community-Based Climate Change Adaptation	DKRZ	German Climate Computing Centre
CBD	Convention on Biological Diversity	DRC	Democratic Republic of Congo
CBIT	Capacity Building Initiative for Transparency	DR	District Road
CBO	Community-Based Organization	DRR	Disaster Risk Reduction
CCAC	Climate and Clean Air Coalition	DTR	Diurnal Temperature Range
CCBS	Carbon Community and Biodiversity Standard	EAC	East African Community
CCGT	Combined Cycle Gas Turbine	EbA	Ecosystem-Based Adaptation
CCLM	Climate Limited-Area Modelling Community	ECC	Environment and Climate Change
CCS	Carbon Capture Storage and Sequestration	EDF	European Development Fund
CDD	Consecutive Dry Days	EIA	Environmental Impact Assessment
CDM	Clean Development Mechanism	EICV	Enquête Intégrale sur les Conditions de Vie des ménages
CERs	Certified Emission Reductions	EM	Ecosystems Market
CFL	Compact Fluorescent Light	ENACTS	Enhancing National Climate Services
CHIRPS	Climate Hazards Group Infrared Precipitation with Station Data	ENSO	El Niño-Southern Oscillation
CIF	Climate Investment Fund	EOF	Empirical Orthogonal Functions
CIP	Crop Intensification Program	ERIMEC	Efficient Low Emissions Cooking Solutions
CITES	Convention on International Trade In Endangered Species	ERs	Emission Reductions
CMIP	Coupled Model Intercomparison Project	ERUs	Emission Reduction Units
CMIP5	Coupled Model Intercomparison Project Phase 5	ESMF	Environmental and Social Management Framework
CoK	City of Kigali	EUCORD	European Cooperative for Rural Development
COMESA	Common Market for Eastern and Southern Africa	FAO	Food and Agriculture Organization
COMIFAC	Commission Des Forêts d'Afrique Centrale	FCDO	Foreign, Commonwealth and Development Office
COP	Conference of Parties		
CORDEX	Coordinated Regional Climate Downscaling Experiment		

FITs	Feed-in Tariffs	ITCZ	Inter-Tropical Convergence Zone
FLRP	Forest Landscape Restoration Programme	IUCN	International Union for Conservation of Nature
FMBE	Forest Management and Woody Biomass Energy	IWRM	Integrated Water Resource Management
FONERWA	Fond National de l'Environnement au Rwanda (Rwanda Green Fund)	JF	January-February
FREL	Forest Reference Emission Level	JJA	June-July-August
FRL	Forest Reference Level	JNR	Jurisdictional Nested Redd+
FSC	Forest Stewardship Council	JRA55	Japanese 55-Year Reanalysis Project
FSSP	Forest Sector Strategic Plan	KFW	Kreditanstalt für Wiederaufbau
GCF	Green Climate Fund	KOICA	Korea international Cooperation Agency
GCMs	Global Climate Models	KWH	Kilowatt-Hour
GCP	Rwanda Green City Pilot	LAIS	Land Administration Information System
GDP	Gross Domestic Products	LEAF	Lowering Emissions by Accelerating Forest Finance
GEF	Global Environment Facility	LED	Light-Emitting Diode
GGCRS	Green Growth Climate and Resilience Strategy	LDCF	Least Developed Countries Fund
GGGI	Global Green Growth Initiative	LODA	Local Administrative Entities Development Agency
GHG	Greenhouse Gas	LPG	Liquefied Petroleum Gas
GIS	Geographical Information System	LTRP	Land Tenure Regularization Process
GMNP	Gishwati-Mukura National Park	LWH	Land Husbandry, Water Harvesting and Hillside Irrigation
GOR	Government of Rwanda	MAM	March-April-May
GTS	Global Telecommunication System	MCA	Multi-criteria Analysis
HEC	Higher Education Council	MCM	Millions Cubic Meters
HFCs	Hydrofluorocarbons	MEAs	Multilateral Environmental Agreements
HFLD	High Forest Low Deforestation	MIGEPROF	Ministry of Gender and Family Promotion
HDI	Human Development Index	MINAGRI	Ministry of Agriculture and Animal Resources
HFO	Heavy Fuel Oil	MINALOC	Ministry of Local Government
HLIs	Higher Learning Institutions	MINECOFIN	Ministry of Finance and Economic Planning
ICHEC	Irish Centre for High-End Computing	MINEDUC	Ministry of Education
IDA	International Development Association	MINEMA	Ministry in charge of Emergency Management
IFC	International Finance Corporation	MINICOM	Ministry of Trade and Industry
IFPR	International Food Policy Research Institute	MININFRA	Ministry of Infrastructure
INADES	Institut Africain pour le Développement Economique et Social	MIT	Massachusetts Institute of Technology
INDC	Intended Nationally Determined Contributions	MoE	Ministry of Environment
INES	Institut d'Enseignement Supérieur	MoH	Ministry of Health
MOHC	Met Office Hadley Centre	R20mm	Very Heavy Precipitation Days
MPI	Max Planck Institute	RCMs	Regional Climate Models

MRV	Measurement Reporting and Verification	RCP	Representative Concentration Pathway
MT	Megatons	RCO	Rwanda Climate Observatory
MW	Megawatt	RCSA	Rwanda Climate Services for Agriculture
NAEB	National Agricultural Export Development Board	RDB	Rwanda Development Board
NAMA	Nationally Appropriate Mitigation Actions	RDO	Rwanda Development Organization
NAP	National Adaptation Plan	REB	Rwanda Basic Education Board
NBI	Nile Basin Initiative	RECOR	Rwanda Environmental Conservation Organization
Nbs	Nature-Based Solutions	REDD+	Reducing Emissions from Deforestation and Forest Degradation
NC3	Third National Communication	REF	Renewable Energy Fund
NC4	Fourth National Communication	REG	Rwanda Energy Group
NDC	Nationally Determined Contributions	REJ	Rwanda Environmental Journalists
NDF	Nordic Development Fund	REMO2009	Regional Model Version2009
ND-GAIN	Notre Dame Global Adaptation Initiative	REMA	Rwanda Environment Management Authority
NEPAD	New Partnership for Africa's Development	RFA	Rwanda Forestry Authority
NFI	National Forest Inventory	RHA	Rwanda Housing Authority
NFMES	National Forest Monitoring and Evaluation System	RICA	Rwanda Institute for Conservation Agriculture
NFMP	National Forest Management Plan	RMB	Rwanda Mines, Petroleum and Gas Board
NFMS	National Forest Monitoring System	RMP	Real-Time Multi Pollutant
NGOs	Non-Governmental Organizations	RNP	Rwanda National Police
NISR	National Institute of Statistics of Rwanda	RNRA	Rwanda Natural Resources Authority
NLUDMP	National Land Use Development Master Plan	RPHC5	Fifth Rwanda Population and Housing Census
NNP	Nyungwe National Park	RTB	Rwanda TVET Board
NR	National Road	RTC	Regional Telecommunication Centre
NST1	National Strategy for Transformation 1	RTDA	Rwanda Transport Development Agency
ODA	Official Development Assistance	RUDP	Rwanda Urban Development Project
ODK	Open Data Toolkit	RWARRI	Rwanda Rural Rehabilitation Initiative
PA	Paris Agreement	RWB	Rwanda Water Resources Board
PASTA-4	The Strategic Plan for Agricultural Transformation	RX1day	Maximum One-Day Precipitation
PBB	Performance-Based Budgeting	RX5day	Maximum Five-Day Precipitation
PEFA	Public Expenditure and Financial Accountability	Sig	Significance
PES	Payment for Ecosystem Services	SLCPs	Short-Lived Climate Pollutants
PHEV	Plug in Hybrid Electric Vehicles	SMEs	Small- and Medium-size Enterprises
PoAs	Programmes of Activities	SOND	September-October-November-December
PSTA	Plan Stratégique pour la Transformation Agricole	SPCR	Strategic Program for Climate Resilience
R25mm	Count of Days Where $RR \geq 25mm$	SREP	Scaling up Renewable Energy Program
R95PTOT	Precipitation Due to Very Wet Days	SSP	Sector Strategic Plan
R99Ptot	Precipitation Due to Extremely Wet Days	SSTs	Sea Surface Temperatures
RAB	Rwanda Agriculture and Animal Resources Development Board	Tmax	Maximum Temperature
Tmin	Minimum Temperature		
TN10p	Cold Nights		
TN90p	Warm Nights		

TNn	Monthly Minimum Value of Daily Minimum Temperature
TNx	Monthly Maximum Value of Daily Minimum Temperature
TOR	Terms of Reference
TREES	The REDD+ Environmental and Excellence Standard
TX10p	Cold Day-Times
TX90p	Warm Day-Times
TXn	Monthly Minimum Value of Daily Maximum Temperature
TXx	Monthly Maximum Value of Daily Maximum Temperature
UAE	United Arab Emirates
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNILAK	Université Laïque de Kigali
UR	University of Rwanda
USAID	United States Agency for International Development
USD	United States Dollars
UTAB	University of Technology and Arts of Byumba
VAA	Vulnerability & Adaptation Assessment
VCM	Voluntary Carbon Market
VNP	Volcanoes National Park
WASAC	Water and Sanitation Corporation
WCRP	World Climate Research Programme

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EXECUTIVE SUMMARY

ES.1. Introduction

Rwanda's Fourth National Communication (NC4) to the United Nations Framework Convention on Climate Change (UNFCCC) represents a significant milestone in the country's ongoing commitment to addressing climate change through comprehensive reporting and action. Building upon the foundation laid by previous National Communications, this document provides Rwanda's climate initiatives, policy developments, and implementation progress since the last reporting cycle. Prepared in accordance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and its guidelines, the NC4 incorporates substantial advancements in several key areas: enhanced climate change policy frameworks, updated greenhouse gas (GHG) emission inventories, detailed mitigation and adaptation measures, strengthened institutional arrangements, and innovative climate finance mechanisms.

ES. 2. National Circumstances and Institutional Arrangements

Rwanda's demographic and economic landscape is transforming rapidly, creating both opportunities and challenges for climate-compatible development. By 2025, Rwanda's population had grown to approximately 14.1 million, with urbanization rising to around 30%. At the same time, the economy grew strongly, with real GDP growth averaging 8.9% in 2024, from 8.3% in 2023, driven by manufacturing and services. The 2023 Human Development Index improved to 0.578, compared to 0.548 reported for 2022, though these gains remain vulnerable to the impacts of climate change.

In response, Rwanda has positioned climate resilience and green growth as national priorities. The Vision 2050 framework embeds these themes across all sectors, while the revised Green Growth and Climate Resilience Strategy (GGCRS) provide an integrated approach to adaptation and mitigation. Together, these policies aim to safeguard development progress, strengthen resilience, and align Rwanda's economic transformation with long-term sustainability goals.

Rwanda's climate is warming, with temperatures rising about 1.5°C since 1970, increasingly erratic rainfall, and more frequent floods and droughts already affecting agriculture, water, and livelihoods. Projections under the RCP4.5 scenario suggest further increases of 1.5 – 2.5°C by 2050, alongside with more variable rainfall marked by intense wet seasons and prolonged dry periods. These trends highlight the urgent need for adaptation and resilience measures across all sectors of society and the economy.

ES. 3. Greenhouse Gases Inventory (2006–2022)

ES. 3.1 Methodology and Coverage

Rwanda's Fourth National Communication presents a comprehensive greenhouse gas (GHG) inventory that represents a significant advancement in the country's climate reporting capabilities. The inventory has been prepared following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, utilizing the Fifth Assessment Report (AR5) Global Warming Potential (GWP) values to ensure alignment with international best practices and comparability with global datasets.

The inventory benefits from substantially improved Quality Assurance/Quality Control (QA/QC) protocols that have been institutionalized across government agencies. These include standardized data collection procedures, rigorous validation processes, and peer review mechanisms that have significantly enhanced the accuracy and reliability of emission estimates. The inventory covers all key sectors mandated by the UNFCCC, including energy, Industrial Processes and Product Use (IPPU), agriculture, Land Use, Land Use Change and Forestry (LULUCF), and waste, with particular attention to source categories most relevant to Rwanda's national circumstances. Notably, the current inventory represents the most complete time series to date, covering emissions and removals from 2006 through 2022, allowing for robust trend analysis and policy evaluation.

ES. 3.2 Key Findings

The 2022 greenhouse gas (GHG) inventory reveals that Rwanda's net total greenhouse gas emissions reached approximately 7,224 Gg of CO₂ equivalent (Gg CO₂e), with distinct variations across economic sectors:

The agriculture sector remains the largest contributor at 58% of total net emissions, dominated by three key sources: enteric fermentation in livestock (particularly dairy cattle), manure management systems, and agriculture soils. The Rwanda's NDC3.0 have clearly defined key measures to reduce these emissions and simultaneously, increasing the food security and improve the rural livelihoods.

The energy sector accounts for 22% of national total net emissions, with the majority from transportation fuels (47% of energy sector emissions), followed by energy used in residential and commercial (30%), electricity generation (14%) and the industrial energy use (9%), while still significant, the energy sector's share has remained relatively stable despite economic growth, reflecting early successes in renewable energy deployment and energy efficiency measures.

The waste sector contributes 18% of national net emissions, primarily from wastewater treatment (53%), solid waste disposal in landfills (35%), and biological treatment of solid waste (12%). Urbanization trends are increasing pressure on waste management systems, though new waste management initiatives are beginning to show promise.

A notable bright spot is the LULUCF sector, which serves as a net carbon sink (-34% of national emissions) thanks to Rwanda's ambitious afforestation programs and sustainable land management practices. The country's forest cover has increased to 30.4% of total land area, with community-based forest management proving particularly effective.

Analysis of emission trends reveals that total greenhouse gas (GHG) emissions have increased by 39.1% since 2015, largely tracking with economic expansion and population growth. However, the emission intensity of Rwanda's economy (emissions per unit of GDP) has declined by 12% over the same period, demonstrating that decoupling of economic growth from emissions is beginning to take hold. This encouraging trend reflects the cumulative impact of climate policies across sectors, particularly in energy efficiency, renewable energy deployment, and sustainable agriculture practices. The inventory results

provide critical baseline data for tracking progress toward Rwanda's Nationally Determined Contribution (NDC) targets and will inform the development of more ambitious mitigation actions in future planning cycles.

ES. 4. National Climate Change Mitigation Assessment

ES. 4.1 Business As usual Scenario

Under the Business as Usual (BAU) scenario, Rwanda's projected greenhouse gas emissions reveal a nation on a steep upward trajectory for the period 2022-2035. Over this period, total emissions excluding land-use changes are forecasted to more than double from 12,107.9 GgCO₂eq in 2022 to 31,712 GgCO₂eq by 2035. This acceleration will be primarily fuelled by explosive growth in transportation emissions, which will increase nearly fivefold from 1,247.3 to 6,002 GgCO₂eq as urbanisation intensifies. Meanwhile, agricultural activities, especially enteric fermentation from livestock and manure management, will maintain their dominance, rising from 3,381.6 to 7,450 GgCO₂eq and 2,255.2 to 5,418 GgCO₂eq, respectively. The waste sector also will emerge as a critical pressure point, with both solid waste and wastewater emissions doubling to exceed 2,234.1 GgCO₂eq each by 2035, reflecting rapid urban expansion.

ES. 4.2 Key Mitigation Actions

(i) Energy Sector Transformation

Rwanda is making substantial progress in decarbonizing its energy sector through multiple complementary initiatives. The country is aggressively pursuing its renewable energy expansion strategy, aiming to generate 60% of its electricity from renewable sources including solar and hydro by 2030.

In the transport sector, Rwanda's intend to transit to e-mobility, supported by the ongoing rollout of charging infrastructure across urban centres and along major transport corridors. The government has implemented fiscal incentives for EV imports and local assembly to accelerate adoption. For household energy use, Rwanda's clean cooking program has set an ambitious target of 80% adoption of improved cookstoves by 2030, through innovative financing mechanisms and community-based distribution networks.

(ii) Sustainable Transport Initiatives

Rwanda's transport sector mitigation efforts are centred on transforming urban mobility and reducing dependence on fossil fuels. The Kigali Bus Rapid Transit (BRT) system, currently under phased implementation, represents a \$200 million investment in sustainable urban transport that will serve over 150,000 daily commuters upon completion. Complementary investments in non-motorized transport (NMT) infrastructure include the construction of over 100 km of dedicated pedestrian and cycling pathways in Kigali, along with bike-sharing programs in secondary cities. These initiatives are supported by vehicle emission standards and complied through the motor vehicle emissions testing and the gradual phase-out of aging, and high-emission vehicles.

(iii) Agriculture and Forestry Solutions

The agriculture and forestry sectors are at the forefront of Rwanda's mitigation efforts. The Climate-Smart Agriculture (CSA) program has already trained over 500,000 farmers in sustainable practices such as agroforestry, conservation agriculture, and improved livestock management. These techniques simultaneously enhance productivity, resilience, and carbon sequestration. Rwanda's afforestation and reforestation initiatives have been remarkably successful, as by 2019, the forest cover standing at 30.4% of total land area exceeded the 30% target set for 2030. The country's innovative approach includes community-based forest management, commercial plantations, and the restoration of degraded ecosystems through the "Forest Landscape Restoration" program. These nature-based solutions not only contribute to carbon sequestration but also provide critical ecosystem services and livelihood opportunities for rural communities.

ES. 5. Adaptation Strategies and Resilience Building

ES. 5.1 Sectoral Adaptation Priorities

Rwanda has implemented comprehensive, sector-specific adaptation measures to address its unique climate vulnerabilities. In agriculture and food security, the government has prioritized three key interventions: widespread crop diversification programs by introducing climate resilient varieties of beans, maize and cassava; distribution of drought resistant seeds to over 300,000 smallholder farmers; and ambitious irrigation expansion targeting 50,000 hectares by 2030 through projects like the Eastern Province Rice Irrigation Scheme. These measures are reducing reliance on rain fed agriculture while improving yields by 25 - 40%.

For water resources management, Rwanda has adopted an integrated approach combining catchment restoration of 50 critical watersheds, installation of flood early warning systems covering 90% of flood prone areas, and promotion of rainwater harvesting through 15,000 new household and institutional storage systems annually.

In infrastructure and urban resilience, Rwanda has enacted revised building codes mandating climate-proof designs for all new construction, including elevated foundations in flood zones and reinforced structures for high wind areas. In addition, environmental and engineering guidelines were developed for climate resilient road infrastructure. Rwanda is also working to mainstream climate-proofing considerations across broader infrastructure development by integrating climate resilience requirements into the Environmental and Social Impact Assessment (ESIA) guidelines. This approach aims to ensure that infrastructure investments are designed, constructed, and managed in a manner that enhances resilience to current and future climate risks.

The health and ecosystems sector have seen innovative adaptation solutions, including malaria early warning systems that use climate data to predict outbreaks 8-12 weeks in advance, and heatwave alert systems protecting vulnerable urban populations. Rwanda has restored 60% of its critical wetlands since

2020, enhancing both biodiversity and flood regulation capacity through projects like the Rugezi Wetland Rehabilitation Initiative, and the Second Rwanda Urban Development Project (RUDP II).

ES. 6. Climate Finance, Technology Transfer, and Capacity Building

ES. 6.1 Climate Finance Mobilization

Rwanda has established itself as a leader in innovative climate finance mobilization. The Rwanda Green Fund, as a dedicated national climate investment vehicle, has mobilized \$ 364 million by May 2026 from \$250 million that were mobilized in 2022. Rwanda Green Fund has created funding vehicles to drive climate actions from private sector and public institutions. This include Intego Facility, as Rwanda's Nationally Determined Contributions (NDC) Facility, is a climate finance program that provides funding and technical support to public institutions at central and local levels to implement climate change adaptation and mitigation projects. To support the private sector, the Ireme invest was launched at COP27, with two components,

- **Credit Facility:** Hosted at the Development Bank of Rwanda (BRD), it provides concessional loans and credit guarantees to make green investments more affordable.
- **Project Preparatory Facility:** Hosted at the Rwanda Green Fund, offers grants, equity, and incubator programmes to help startups refine their business ideas and develop bankable projects.

International support has been strategically directed toward high impact initiatives: such as the Rwanda's Green Climate Fund's portfolio reached \$255.3 million by May 2026, includes the landmark projects such as "Strengthening Climate Resilience of Rural Communities in Northern Rwanda", and Green City Kigali: a new model for urban development in Rwanda". On other hand, the Rwanda's profile under the Global Environment Facility (GEF) Trust Fund (GET), funded 11 national projects for \$46.3 million in GEF financing, with a strong co-financing ratio of 16.19, while through the Least Developed Countries Fund (LDCF), 5 projects were funded, with US\$52.1 million at 3.25 co-financing ratio.

ES. 6.2 Technology and Capacity Development

Rwanda's climate change capacity building efforts focused on strengthening transparency (NDC tracking, and GHG inventory), policy and planning processes. Rwanda has enhanced its Measurement, Reporting and Verification (MRV) System, where it has established its national GHG activity data Platform. To advance the capacity building, a combined national-level training for professionals in climate related sectors were trained under the long-term programme called Evidence based for Climate Reporting Initiative (ECRI). Other training programme were delivered to sectoral and district focal points, all aimed at mainstreaming climate change, strengthening adaptation, and improving readiness to access international finance.

To enhance its adaptive capacity through technology, the government has developed 2 pilot early warning systems (EWS) and established 8 district emergency command posts. To understand the technology needed, 2 Technology Need Assessment (TNA) have been developed covering 4 sectors, which are energy, agriculture, urbanization and industry for both mitigation and adaptation.

ES. 7 Innovative Projects and Initiatives Driving Climate Action from 2022-2025

Since 2022, (the latest inventory year for this report), Rwanda has advanced climate action through a range of innovative projects, ideas, and initiatives across multiple strategic areas. A summary of these actions is presented in the table below, organized by policy and strategic interventions as well as sector-specific actions.

Areas	Innovative projects and Initiatives
Policy and Strategy	- Rwanda Revised its Green Growth and Climate Resilience Strategy (GGCRS) in 2023, to better reflect the new sector strategic plans - Rwanda has established its Second National Strategy for Transformation 2 that will be implemented from 2024–2029. The NST2 highly integrated climate resilience in its economic transformation pillars and key actions. - Rwanda has updated and revised its NDC under the Paris Agreement, which is referred as Rwanda's NDC3.0 targeting 53% emissions reduction by 2035 - Rwanda has developed its National Biodiversity Strategy and Action Plan with Rwf 399.8 billion finance requirement from 2025–2030
Climate Finance and Investment Vehicles	- Ireme Invest was established and launched at COP27 in 2022 targeting the private sector green investment facility - Intego facility which is Rwanda's NDC Facility was established to support government institutions to deliver to the NDC implementation - Rwanda Green Taxonomy was put in place and launched at COP28 with implementation roadmap launched in 2025, to guide the green investment - Green Exchange Window was established under the Rwanda Stock Exchange platform for green/sustainability bonds in 2025 - To enhance the fund mobilization for Biodiversity, Rwanda Green Fund has created the Biodiversity window for ecosystem protection - To enable the environment for climate finance mobilization, Rwanda has established its Climate and Nature Finance Strategy with the period of 2024 to 2030
Energy	- Rwanda has developed its new Energy Policy for Rwanda in 2025, updating the 2015 policy, to reflect climate issues - Developed the Least Cost Power Development Plan 2024–2050, which indicate the need for solar scale-up - Rwanda's renewable energy have increased with the share of 51% in the energy mix

Forest, Land and Ecosystem Restoration	Forest, land and ecosystem restoration has marked key initiatives and projects such as: • Congo-Nile Divide Restoration Project with \$39.1M funding from GCF started in 2024 • Nyungwe–Ruhango Corridor Climate Resilience Project with \$9M funding started in 2025 • Green Amayaga Project with \$18M GEF grant for ecosystem restoration, Southern Province started in 2025 • Eastern Province landscape restoration cluster (TREPA, COMBIO, DeSIRA, AREECA projects)
Urban	To green and sustain the urban areas, Rwanda initiated the following key projects and initiatives • Green City Kigali (GCK) Project with \$28M financing from GCF grant; target 600-hectare carbon-neutral city on Kinyinya Hill in City of Kigali • Five wetlands rehabilitation projects in Kigali to reduce flood risk, and enhance biodiversity, and support recreation
Transport and Energy	• Rwanda has established a mandatory motor vehicle emissions testing since July 2025, to enhance the control of vehicle emissions • IMOBIS Green Mobility Project started in 2025, to enhance real-time bus systems, and electric buses • Following the Electric vehicle incentives, Rwanda is running the E-mobility rollout, by increasing the electric buses in Kigali public transport • Initiated the rolled out of Dedicated Bus Lane (DBL) across major Kigali corridors since 2025
Circular Economy and Waste Management	• National Circular Economy Action Plan and Roadmap was established in 2022, with 17 policy interventions • Waste to Resources Project was implemented to valorize facilities at Nduba Dumpsite operational since 2024
Carbon Markets and International Cooperation	• To enable the implementation of the Carbon market, Rwanda has established its National Carbon Market Framework, that guide its institutional arrangements, and the manual of procedures • Rwanda and Singapore are implementing the Article 6 Implementation Agreement • GGGI and REMA are implementing the Article 6 readiness project since 2025
Agriculture	• Climate-Smart Agriculture Investment Plan was launched at COP30, that guide the private investment opportunities

	- Rwanda has developed its 5-year agricultural and food systems strategy running from 2024 to 2029 which referred as PSTA 5 (Plan Stratégique pour la Transformation Agricole). It aims to build climate resilience, boost domestic food production, reduce post-harvest losses, and connect farmers to profitable markets - For climate resilient, area of land under radical terraces reached 142,318, while progressive terraces reached 1,032,282ha by 2024
Water Resource	- Lake Water Use Master Plan (Kivu, Muhazi, Mugesera, Ruhondo, Burera) was launched in 2025, to enhance the resilience of water bodies - Area of land at high risk of soil erosion restored reached 332,861 ha by 2024 - Approved Nature-based flood adaptation project (\$9.4M) to be supported by AfDB, aimed at strengthening climate resilience in the western Rwandan districts of Karongi and Rusizi.

ES.8. Climate Change Reporting Challenges/Gaps and Areas of Improvement

Despite Rwanda's significant progress in climate change reporting, several critical challenges persist that indicate the needed areas of improvement. The country face substantial data gaps, for GHG inventory particularly related to activity data such as the lack of detailed fuel consumption by activity, limited transport data (vehicle kilometres travelled per type of vehicles), data on wastewater from various activities (Households, industries such brewery, coffee, dairy, malt, meat etc), technical capacity in developing emission factors and assessing mitigation potentials and tracking the emission reductions from the NDC policies and measures. In addition, for finance there are challenges in tracking the support channelled to the private sector and NGOs which are important finance reporting elements.

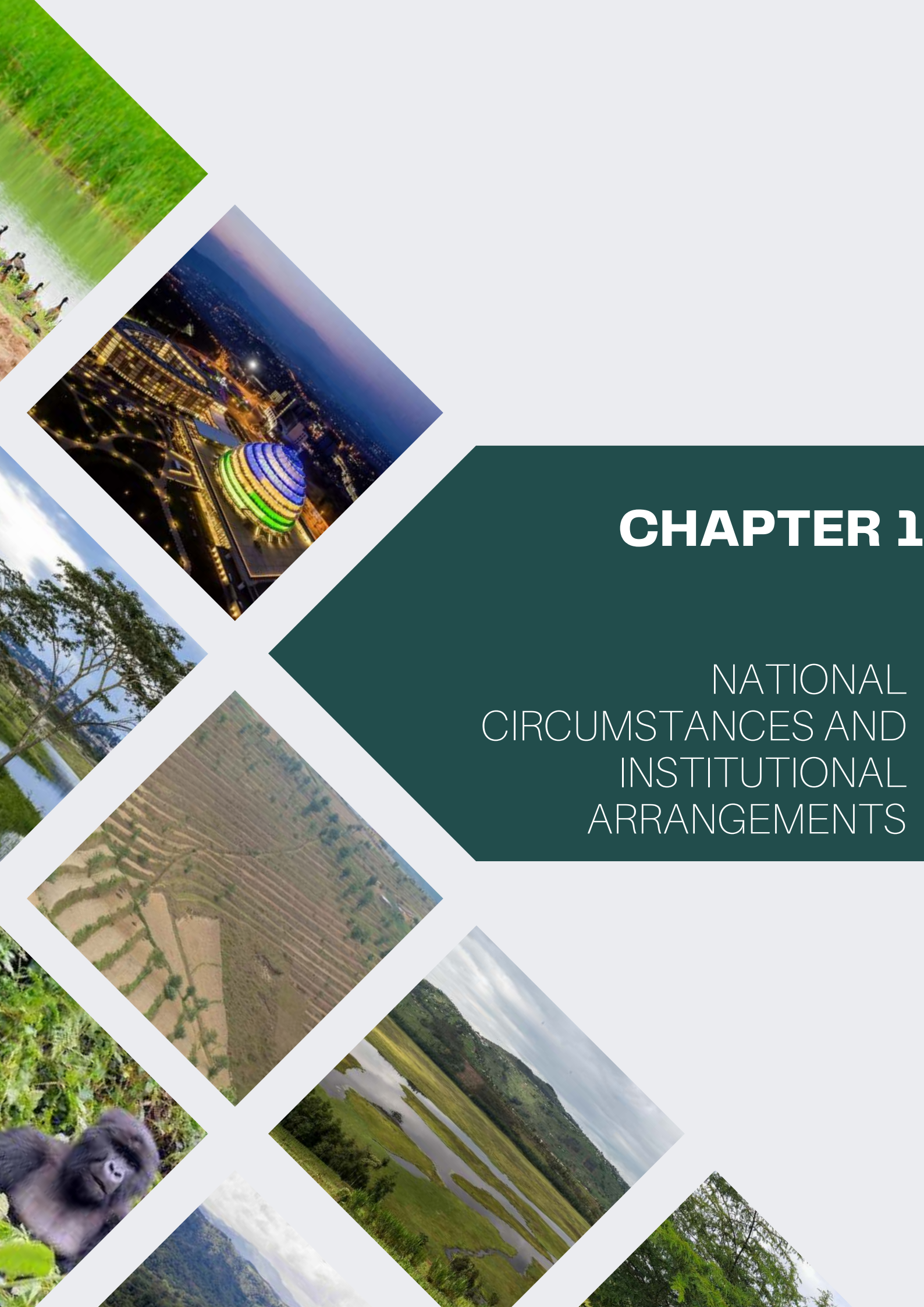
As part of improvement, specific studies have been conducted to develop the eight key national emissions factors, which has allowed to improve the GHG inventories and reduce uncertainty. MRV process is under improvement process whereby the activity data platform has been developed for activity data collection, and support to archive the data. To enhance the capacity, Ministry of Environment through REMA has run the long-term course on Evidence Based Climate Reporting programme, to enhance the capacity of professional on climate change reporting (Data analysis, greenhouse gas inventory, and mitigation).

To engage the private sector, the Ministry of Environment is planning to raise the capacity of key industries in enhancing their Environment, Social and Governance Framework, that will support the data availability and sharing mechanisms.

ES. 8. Conclusion and Way Forward

Rwanda's Fourth National Communication demonstrates the country's strong climate leadership and its successful integration of climate action into national development priorities. The report showcases how Rwanda is balancing economic growth with environmental sustainability. Rwanda is envisaging to enhance its finance mobilization, and implementation of climate action. This target key areas such as finance mobilization, carbon market, renewable energy, data and governance, specifically the key target among other include:

- Reduce 53% of its emissions by 2035 comparing to the business as usual scenario
- Mobilize the \$12 Billion, as indicated in its NDC 3.0 package in ten years period (2025–2035);
- Implementation and Operationalize Article 6 bilateral agreements
- Reach 60% renewables in the generation mix by 2029
- Accelerate e-mobility ecosystem (charging infrastructure, local EV assembly, battery end-life management)
- Implement the National Biodiversity Strategy (2025–2030) and operationalize the Biodiversity Finance Window
- Strengthen climate change related data through REMA, Meteo Rwanda, and Rwanda Space Agency (RSA)
- Improve activity data collection for GHG inventory for key categories



CHAPTER 1

NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

CHAP 1. NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

1.1. NATIONAL CIRCUMSTANCES

1.1.1. Geographical Profile

Rwanda is located in East Central Africa between 1°04' and 2°51' south latitude, and between 28°53' and 30°53' East Longitude. Rwanda is a land-locked country, bordered by Burundi in the South; Tanzania in the East; Uganda in the North, and the Democratic Republic of Congo in the West.

1.1.2. Administrative Structure

The country's administrative division counts for four provinces (Northern Province, Western Province, Southern Province, Eastern Province) and City of Kigali. The country is also subdivided into 30 districts further subdivided into 416 sectors, 2,148 cells and 14,837 villages.

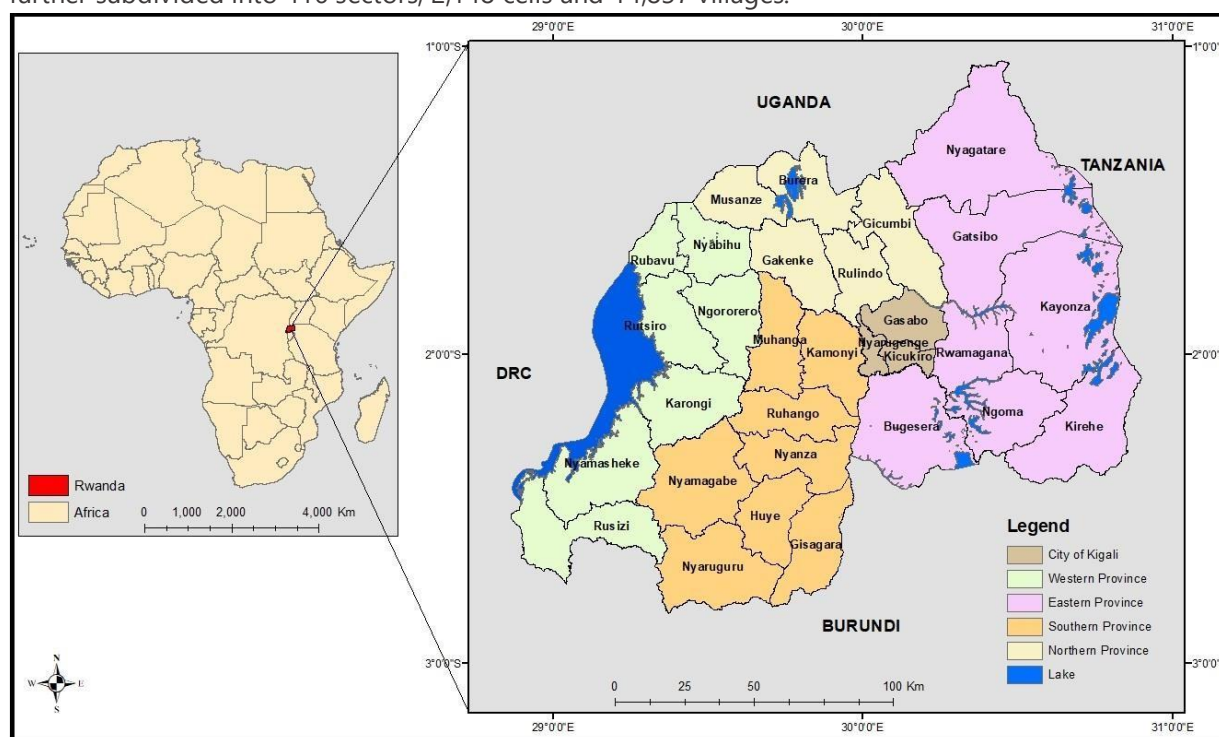


Figure 1: Administrative Map of Rwanda

Source: REMA, 2021

1.1.3. Population Profile

From the national census conducted in 2022, Rwanda's population was 13,246,394 (51.5% women, 48.5% men), 72% are under 30 years old: 44.7% children (<16) and 27.3% youth (16–30), with adults over 30 making up 28%. Young females (16–30) account for 13.6% and males 12.9% of the population (NISR, 2023). By 2025, Rwanda's population had grown to an estimated 14.1 million, reflecting a sustained annual growth rate of approximately 2.2% (NISR, 2025)

Rwanda's population has tripled since 1978 from 4.8M to 13.2M, but the annual growth rate declined from 3.1% (1978–1991) to 2.3% (2012–2022), with a sharp drop to 1.2% (1991–2002, (NISR, 2023; World Bank, 2022)). In addition, it is important to highlight the following population characteristics obtained from National Census (NISR, 2023):

- **Life expectancy:** 69.6 years, projected to reach 80.9 years by 2052 under low mortality scenarios. Infant mortality is expected to fall from 32.5/1000 in 2023 to 11/1000 in 2025.
- **Population density:** Increased from 183/km² (1978) to 503/km² (2022), with a temporary decline during 1990–1995. Kigali has the highest density (2,401/km²), with Kicukiro District reaching 2,944/km².
- **Regional population:** Eastern Province is most populous (3,563,145), while Gasabo District leads in population (879,505).
- **Urbanization:** Grew from 2.6% (1960) to 27.9% (2022). The Vision 2050 plan targets 70% urbanization; NST1 aims for 35% by 2024.

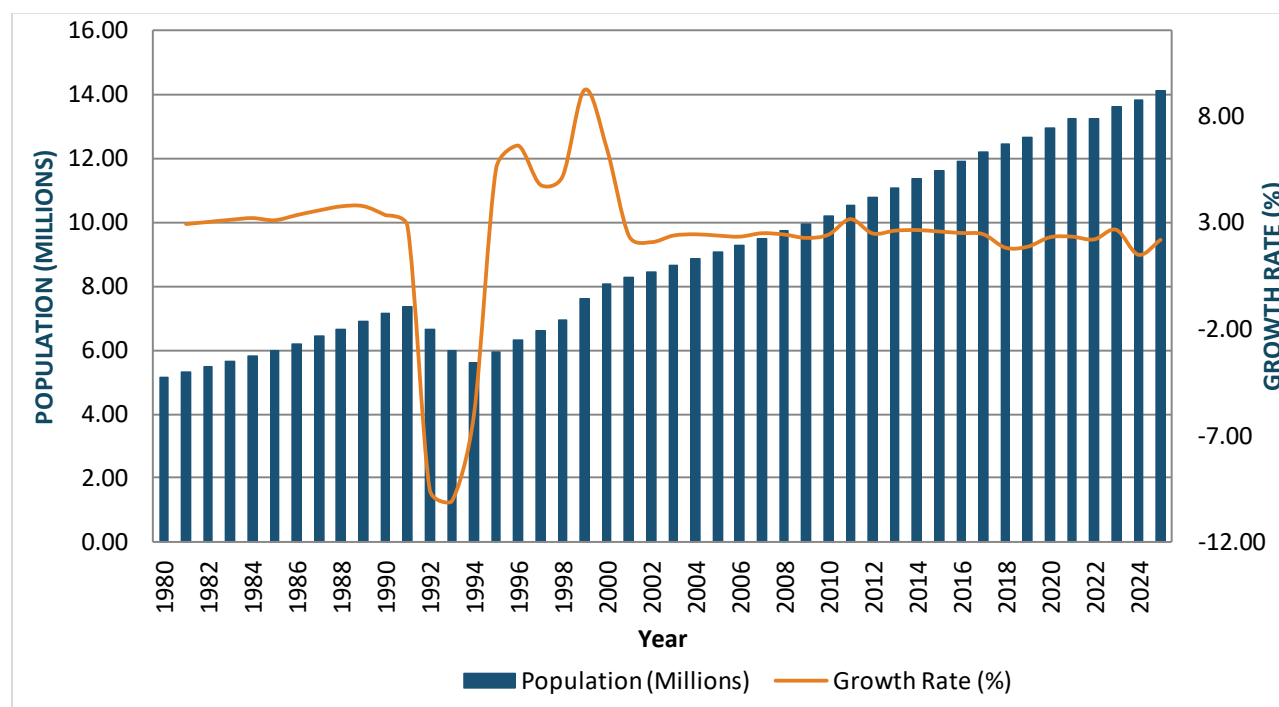


Figure 2: Rwandan Population Growth

Source: (NISR, 2022)

1.1.4. Climate Profile and Climate Variability

Rwanda has a tropical climate moderated by hilly topography stretching from east to west. The country is divided into four main climatic regions: **the eastern plains, central plateau, highlands, and regions around Lake Kivu**. The eastern plains receive an annual rainfall of between 700 mm and 1,100 mm, with mean annual temperature oscillating between 20°C and 22°C. The central plateau region enjoys rainfall of between 1,100 mm and 1,300 mm, with an annual mean temperature of between 18°C and 20°C (Republic

of Rwanda, 2020). The seasonal distributions in Rwanda comprises of two rainy seasons (March-May, September-December), and a two dry seasons (January-February, June-August) (Ntwali et al., 2016; Siebert et al., 2019; Kazora et al., 2021). Due to varied elevation, Rwanda has 11 agro-ecological zones grouped into highlands (> 1,900 m), midlands (1,600-1,900 m), and lowlands below 1,600 m (Rushemuka, 2014)).

Increasing rainfall variability intensifies the risk of droughts predominantly in the eastern region and increased occurrence of floods and landslides, especially in the western and northern areas. These events lead to infrastructure damage, reduced agricultural productivity, and impacts health outcomes. In addition, greater climatic variability increases the incidence of climate-sensitive diseases such as malaria, meningitis, and cholera. A rise in temperature is predicted across Rwanda in the coming years up to 2050, especially during the dry seasons. An additional seasonal increase of between 0.1 °C and 0.3 °C is projected on top of the annual mean temperature throughout the country, except for the northern region where a decrease of 0.06°C is expected (Republic of Rwanda, 2018; 2020).

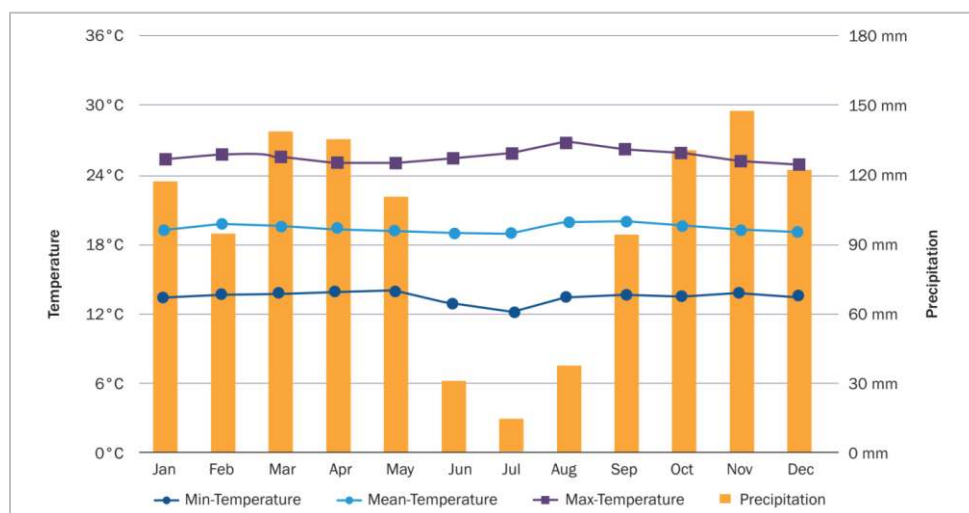


Figure 3: Observed Average Monthly Mean, Max and Min Temperature and Precipitation for 1991-2021

Source: (World Bank, 2022)

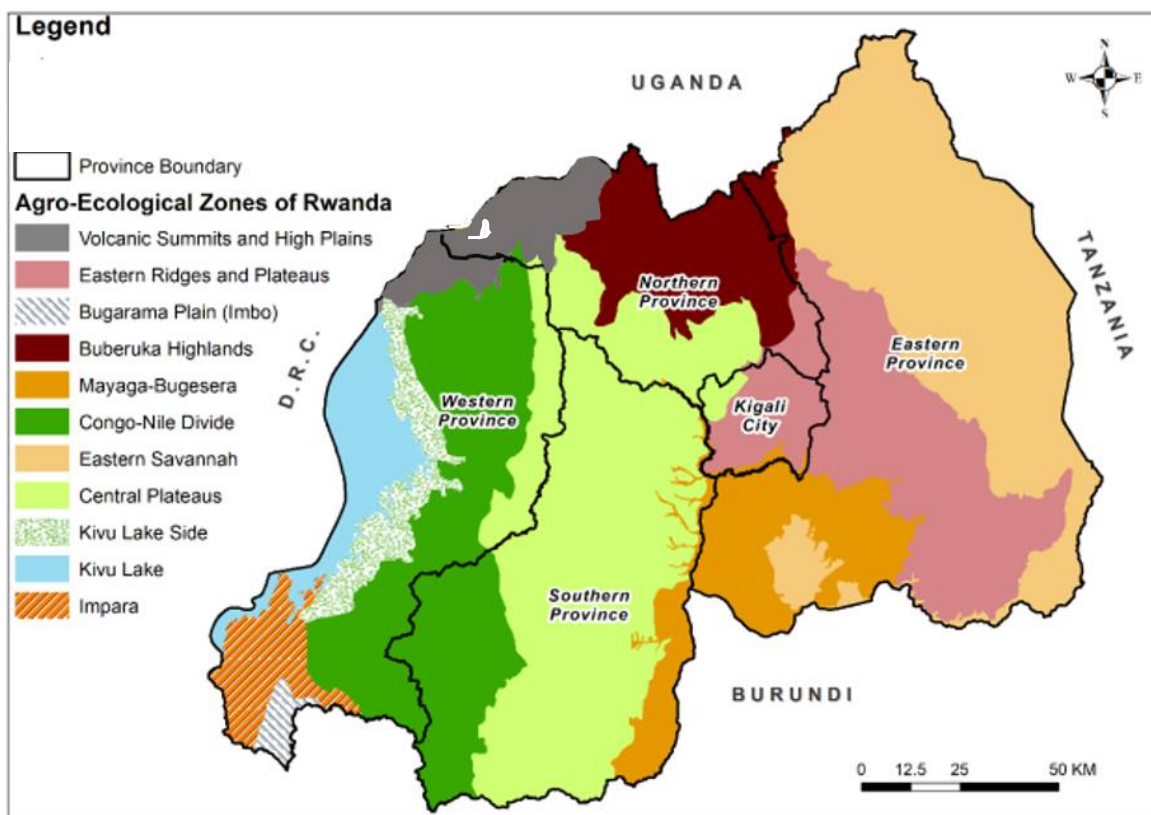


Figure 4: Agro-Ecological Zones of Rwanda

Source: (RDB, 2020)

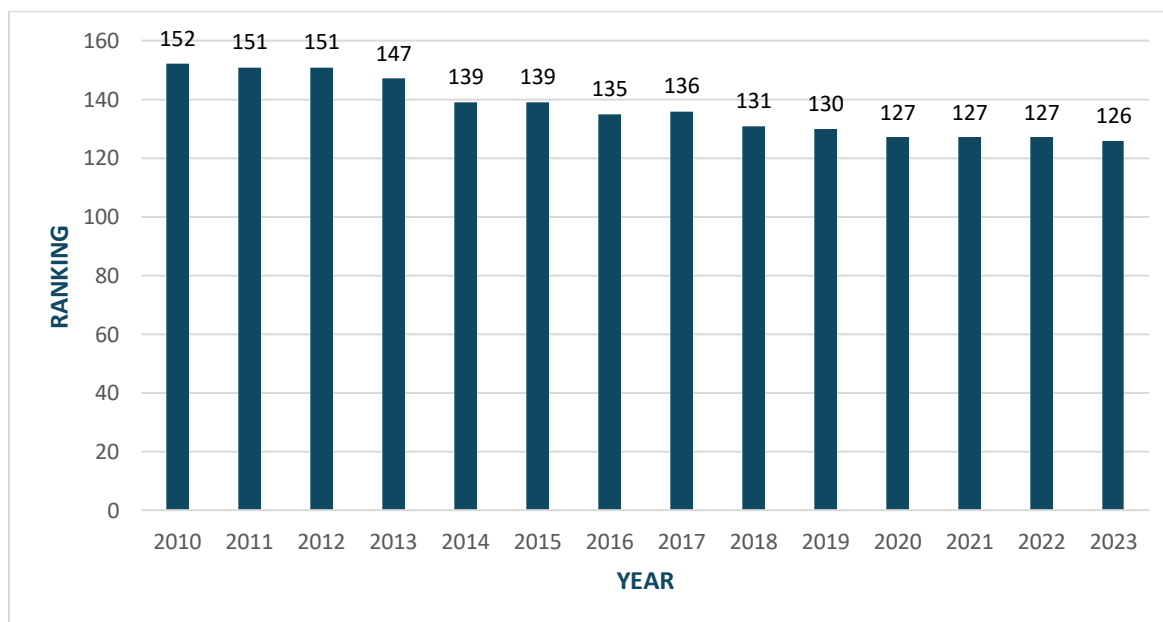


Figure 5: ND-GAIN Index Ranking for Rwanda

Source : (Notre Dame Global Adaptation Initiative, 2023)

The ND-GAIN Index (2023) ranked Rwanda 126/182 globally, 19th in vulnerability and 71st in readiness, while vulnerability has decreased and readiness improved over 20 years, the country remains highly susceptible to climate change impacts. At the subnational level, Southern Province is the most vulnerable, while out of 30 districts, 11 of them have low vulnerability (REMA, 2019).

1.1.5. Geology Profile

The geology of Rwanda comprises Mesoproterozoic metasediments, largely quartzites, sandstones, and shales of the Burundian Supergroup which are locally intruded by granite (RDB, 2020). There are four types of granite in the Kibaran Belt while in eastern Rwanda are the "older granites" along with granitic-gneisses and migmatites of Paleoproterozoic age. In the northwest and southwest are Neogene volcanic, ranging in age from cenozoic to recent (RDB, 2020). Some of the volcanoes in the area are highly alkaline. Alluvium and lake sediments of Quaternary age occur in parts of the Western Rift and along rivers and lakes.

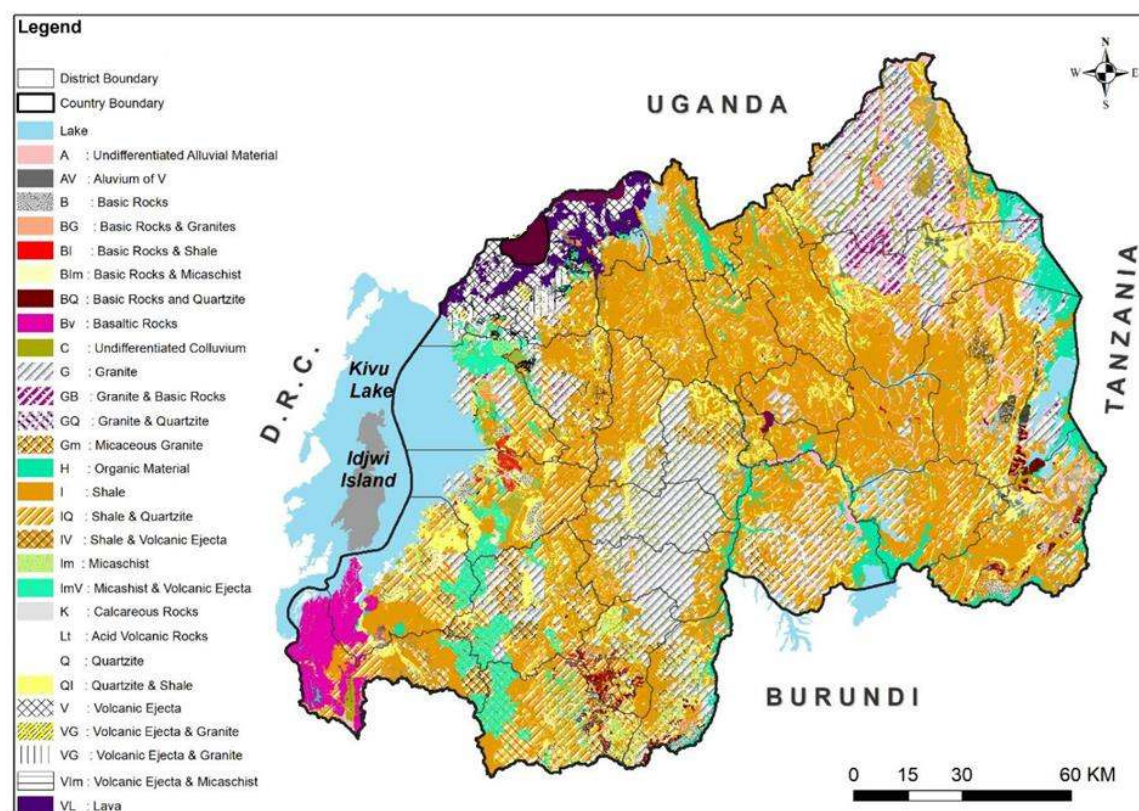


Figure 6: Geology of Rwanda

Source: (RDB, 2020)

1.1.6. Topography Profile

Rwanda's topography is hilly and mountainous with altitude ranging between 900 m and 4,707 m with an average of 1,700 m (MIDIMAR, 2015). The highest point is on Mount Karisimbi at 4,507 meters above sea level. Rwanda has volcanic mountains at the northern fringe and undulating hills in most of the central plateau. However, the eastern part of the country is relatively flat with altitudes well below 1,500 m (MIDIMAR, 2015). The lowlands of the southwest in Bugarama plain with an altitude of 900 m are part of the tectonic depression of the African Rift Valley (REMA, 2009). This type of relief covers almost half of the country and has earned Rwanda the nickname of the "Land of a Thousand Hills".

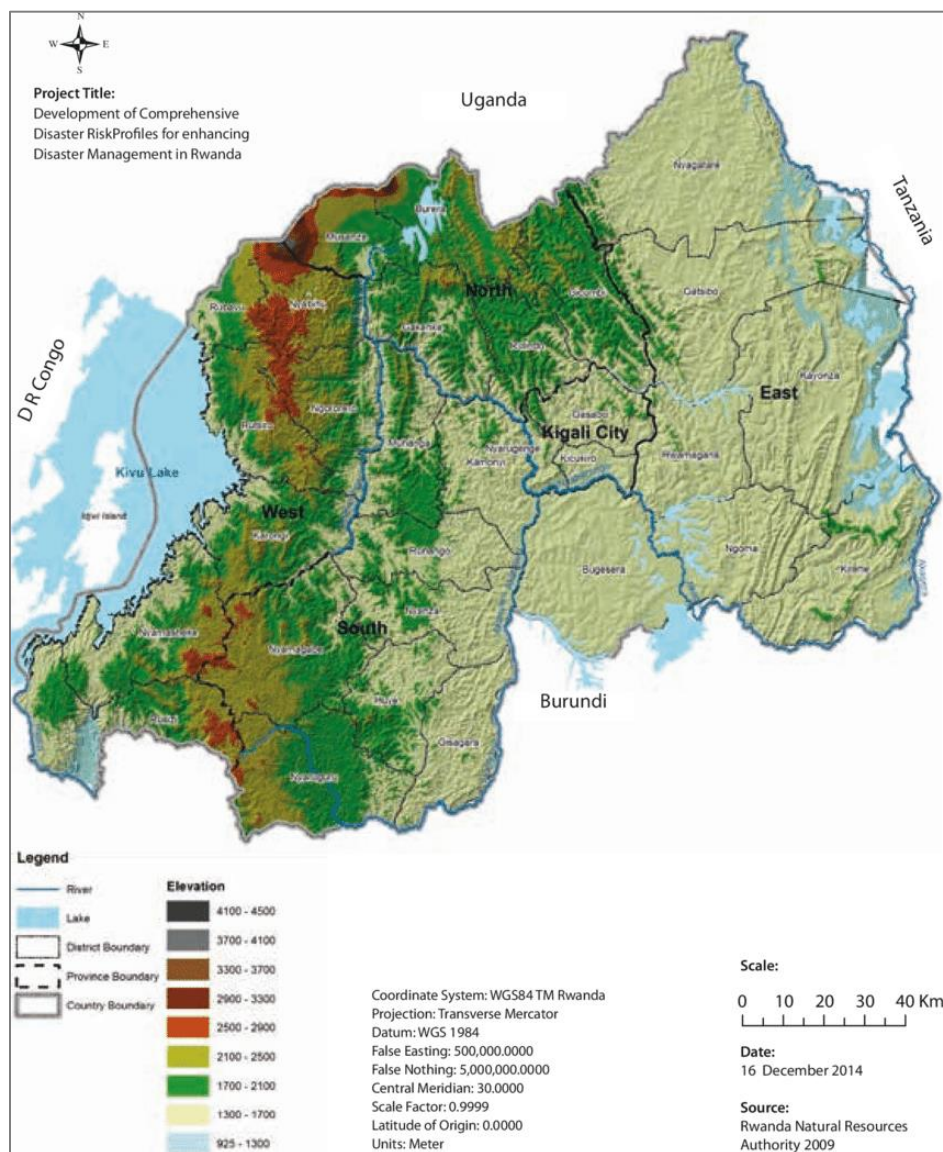


Figure 7: Elevation Map of Rwanda

Source: (MIDIMAR, 2015)

1.1.7. Soil Profile

Rwanda's soil is naturally fragile. They are a result of the physical and chemical alteration of schistose, quartzite, gneiss, granite, and volcanic rocks which form the surface geology of the country (Nzeyimana, Hartemink, & Geissen, 2014)). The soil map of Rwanda, shows six sources of soil types of Rwanda (Birasa, et al., 1992):

- I. Soil derived from schistose, sandstone and quartzite which cover almost 50% of the national territory
- II. Soil derived from granite and gneiss which make up about 20% of the national territory
- III. Soil originating from intrusive basic rocks that hardly cover 10% of the national territory
- IV. Soil originating from recent volcanic materials that cover 10% of the national territory
- V. Soil originating from ancient volcanic materials that cover 4% of the national territory
- VI. Alluvial and colluvial soils which are typical of Rwanda's swamps occupy 6% of the national territory

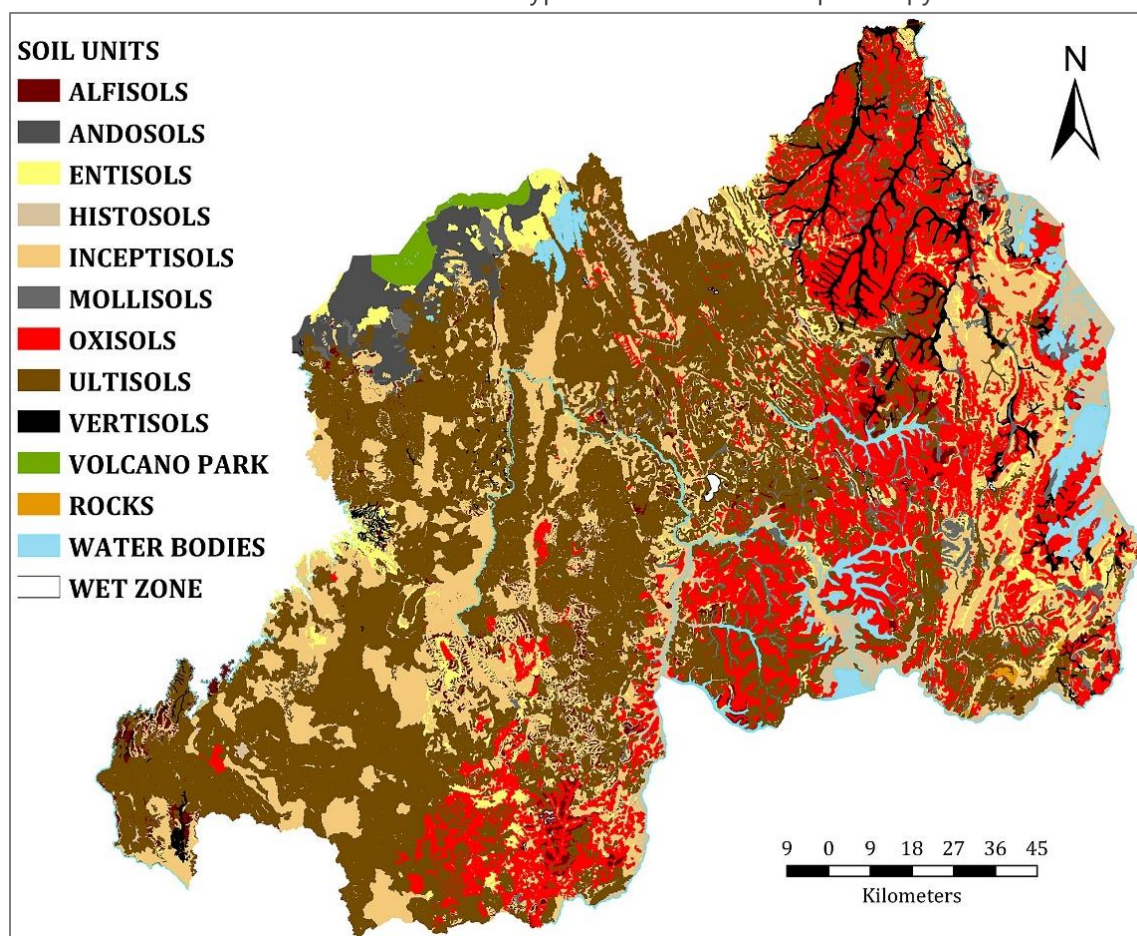


Figure 8: Soil Map of Rwanda

Source: (Nzeyimana, Hartemink, & Geissen, 2014)

1.1.8. Environment and Natural Resources

Rwanda covers 26,338 sq. km, with 23,038 sq. km of land excluding 3,300 sq. km of water bodies and 24,801 sq. km of dry land excluding only lakes and rivers (Republic of Rwanda, 2020). The 2019 distribution of land cover between 1990–2016, indicated the major land-use change with forest loss of 7,090 sq. km (64.5%), grassland loss of 1,715 sq. km (32.1%), cropland increase: +135.3% (8,504 sq. km) and built-up areas increase: +304.3% (Karamage, Zhang, Liu, & Kayiranga, 2017).

By 2019, forest cover accounted for 30.4% of land, mainly forest plantations (53.5%), followed by wooded savanna (22.3%), natural mountain rain forests (18.1%), shrubs (6.1%), and bamboo (<0.1%) (Republic of Rwanda, 2019).

Over 55% of production forests are private smallholder plantations, harvested with short rotations (2–3 years), with low productivity, and high vulnerability to agricultural expansion. Public forest policy has prioritized increasing forest cover to 30% of dry land, while the Forest Sector Strategic Plan (2018–2024) seeks to improve sustainable forest management, biodiversity conservation, and climate resilience (MINILAF, 2018).

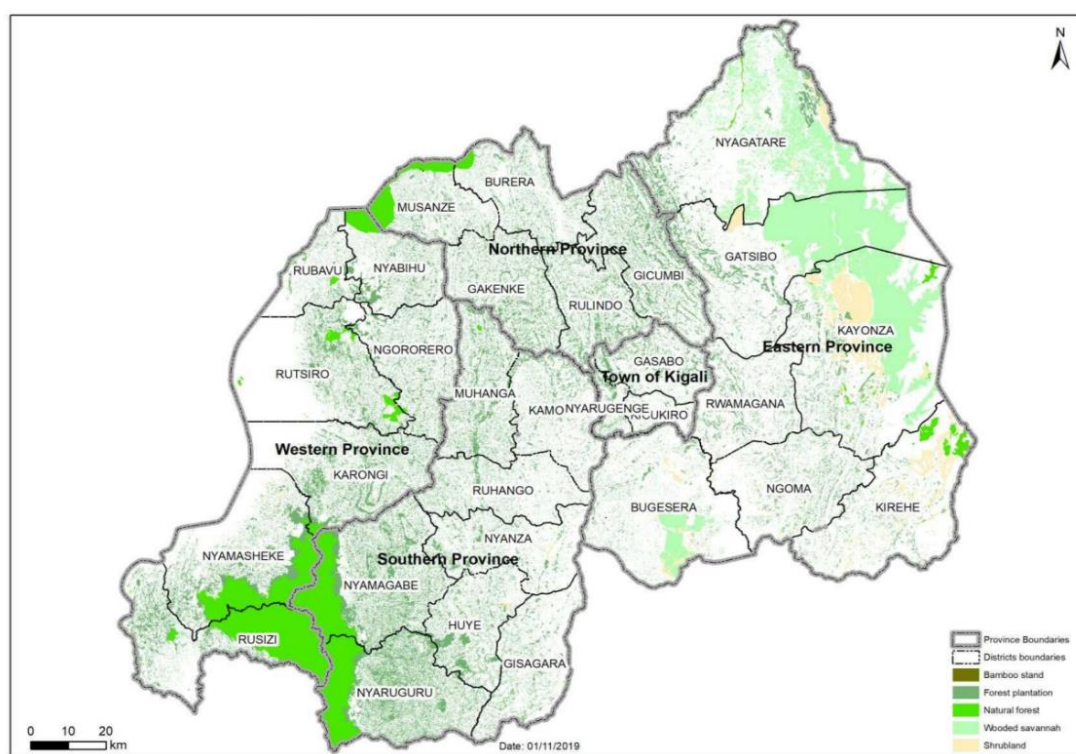


Figure 9: Rwanda Forest Cover in 2019

Source: (Republic of Rwanda, 2019)

1.1.9. Biodiversity Profile

Rwanda, located in the Albertine Rift biodiversity hotspot, hosts diverse ecosystems including mountain rainforests, savannas, wetlands, gallery forests, and aquatic habitats. Its biodiversity is spread both inside and outside protected areas, notably in four national parks:

- **Akagera National Park** (1934): Originally 245,000 ha, and it is 112,193 ha due to farmland conversion. This is a savannah park with >525 bird species, more than 50 large mammals, and more than 900 plant species (Vande Weghe & Vande Weghe, 2011).
- **Gishwati-Mukura National Park** (2016): The newest park, comprising Gishwati (1,450 ha) and Mukura (1,980 ha) forests, and it is a home to about 340 birds, 22 mammals, and 490 plants (REMA, 2017).
- **Nyungwe National Park** (2004): This is the largest park with 101,659 ha, on altitude ranging between 1,600–2,950 m. It is a tropical montane forest shared with Burundi and contains about 275 birds, 85 mammals, and 1,068 plants (REMA, 2015)
- **Volcanoes National Park** (1925): This is the oldest Park (160 sq. km) encompassing five volcanoes with the highest being Kalisimbi, with 4,507 m altitude. Part of the Virunga Massif, famed for mountain gorillas, golden monkeys, more than 290 bird species, and 1,200 plants (Tuyisingize, 2010; Owiunji, et al., 2005).

Beyond parks, natural forests (e.g., Mashyuza, Sanza, Ibanda-Makera) have rich biodiversity but face threats from deforestation, climate hazards such as fires and landslide (REMA, 2015). Rwanda has 38 threatened plant species, 26 threatened birds, 42 threatened mammals, and 4 threatened reptiles/amphibians, indicating ongoing biodiversity pressures (REMA, 2015).

1.1.10. Water Resources Profile

In Rwanda, two major drainage basins constitute the main sources of surface water supply: the Nile Basin to the East (covering 67% of the surface area and delivering 90% of the national waters), and the Congo basin to the West (covering 33% of surface area and 10% of all national waters). Surface water bodies in the country occupy a total of 135,000 ha or about 8% of the country's surface area. The country counts 935 wetlands, covering a total area of 176,337 ha (REMA, 2021). Rwanda recognizes the importance of wetlands and the need to manage the wetlands. For example, current legislation classifies wetlands into total protected wetlands, or non-protected wetlands. This category is further divided into those with status of use under specific conditions, and those with a status of use without conditions according to the Prime Minister's Order No 006/03 of 30/01/2017 on drawing up a list of swamp lands, their characteristics and boundaries and determining modalities of their use, development and management.

Data estimates on ground water and aquifers in Rwanda indicate that the discharge for the available resource is 66 m³/sec and there are about 22,000 recognized sources which have a discharge of 9.0 m³/second (REMA, 2009). Within the Nile and Congo Basins in Rwanda, nine 'Level 1' surface water catchments have been classified for management purposes. Upper Nyabarongo holds the biggest ground water volume storage of 25,110 MCM (Republic of Rwanda, 2015).

Table 1: Rwanda Water Catchments

No	Code	Name	Surface area (km2) in Rwanda	Ground water volume storage (MCM)
1	NNYU	Upper Nyabarongo	3,348	25,110
2	NNYL	Lower Nyabarongo	3,305	8,673
3	NAKN	Akanyaru	3,402	5,103
4	CRUS	Rusizi	1,005	5,025
5	NMUK	Mukungwa	1,887	4,870
6	NAKL	Lower Akagera	4,288	4,820
7	NAKU	Upper Akagera	3,053	4,580
8	CKIV	Lake Kivu	2,425	2,425
9	NMUV	Muvumba	1,565	1,570

Source: (Republic of Rwanda, 2015)

1.1.11. Energy

Rwanda's energy sector is central to its development, with goals of providing reliable, efficient, and affordable power (REMA, 2021). The country relies on imported fuels but has built seven fuel depots with 118.4 million liters of storage capacity to ensure supply security, and the petroleum consumption is 23 million liters /month, growing at 12% annually (NISR, 2022).

Electricity installed capacity reached 467.142 MW in 2025, from 276.068 MW in 2022 (REG, 2022). In the mix, the share of renewable energy reached 51%. While the access to electricity rose to 85.4% in 2025, from 61% in 2022 (REG, 2022). Rural households consume 11.3 KWh, while urban consume 28.6 KWh (World Bank, 2022). Carbon intensity from power generation was projected to drop from 10% in 2018 to 25% in 2025 (REG, 2019).

Rwandan households rely on traditional biomass for cooking of which is dominated by wood fuel making up 76.1% of total energy consumption followed by charcoal with 17.3% and gas with 4.6% (NISR, 2022). According to the biomass energy strategy between 2019-2030 (MININFRA 2019), the target was to reduce biomass usage to 42% by 2024 and to achieve the set target different approach, programs and solutions were proposed such as:

- Adoption of LPG, Electricity, Combined Woody pellet ICS or Green charcoal in urban areas
- Use of firewood ICS, briquette ICS, Combined Woody pellets ICS, Biogas and LPG in rural areas
- Use of LPG, Combined Woody pellet/briquette ICS, electricity, green charcoal in commercial food industry
- Adoption use of cooking with gas, electricity, improved institutional stove and biogas in Public Institution
- Use of gasifier, cogeneration options including peat and renewable energies in processing and production sector.

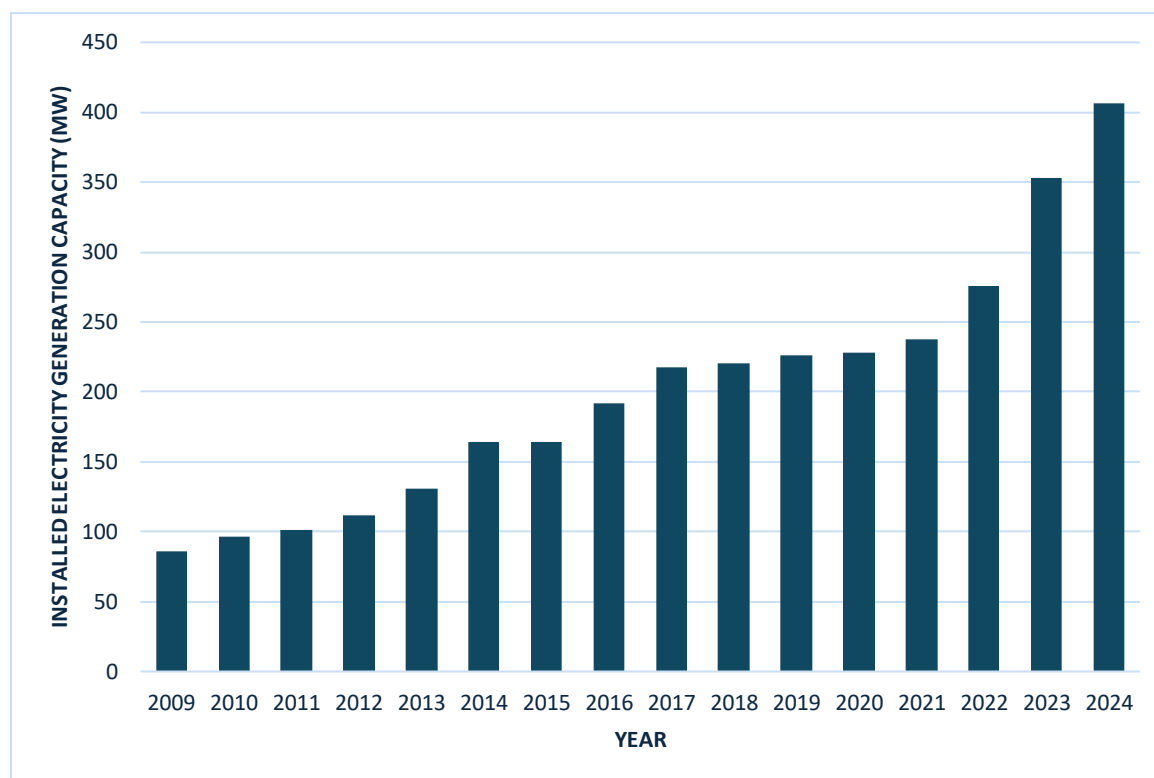


Figure 10: Installed Electricity Generation Capacity in Mega Watt (MW)

Source: (REG, 2022)

1.1.12. Transport

The road network covers 44,671 km, with only 2.4% (1701.91 km) paved; 97.2% of paved national roads are in good condition (MININFRA, 2021, RTDA 2022-2023). Roads are classified into five categories;

- I. National Road;
- II. District and City of Kigali roads of Class 1;
- III. District and City of Kigali roads of class 2;
- IV. Specific Road; and
- V. Local Road

Public transport use in 2016 - 2017 was 77% in urban areas (down from 82%) and 51% in rural areas (up from 43.5%) and private car ownership remains low at 1% of households (NISR, 2018).

To improve road safety, a Motor Vehicle Inspection Centre and mobile emission testing were introduced. Taxes on old, high-emission cars, were increased and tax exemption on electric vehicles (EVs) were introduced in 2019 to reduce GHG emissions. As of 2024/25, Rwanda had 394,157 registered vehicles, up from 297,987 vehicles in 2022, representing an increase of about 32% over three years. The vehicle fleet has continued to grow at an average annual rate of approximately 10–11%, raising concerns about traffic congestion, air pollution, greenhouse gas emissions, and the need for sustainable urban mobility solutions (NISR, 2024).

The electric vehicles registered number increasing, whereby in 2025, there were around 33,123 e-motorcycle, 30 e-buses, and 295 e-cars, while by 2022, there were 632 e-motorcycles, 146 e-cars, and 160 EV charging/swapping stations in operation in (MININFRA, 2022).

For air transport, Kigali International Airport is the main hub, while Kamembe Airport provides domestic and regional connectivity, serving Cyangugu and the Rusizi area with cross-border potential. RwandAir served 25 destinations, including domestic, regional and international destinations, carrying 850,000 passengers in 2019/20 before dropping to 278,000 in 2020/21 due to COVID-19 (MININFRA, 2021).

Furthermore, water transport in Rwanda is primarily centered on Lake Kivu, which borders the Western Province and supports passenger movement, small-scale cargo transport, and cross-border connectivity with the Democratic Republic of Congo, using motorboats and canoes for passenger and fishing activities. Services operate between key lakeside towns such as Rubavu, Karongi, and Rusizi, providing an alternative to road travel in a region with challenging terrain. In addition, other lakes in Rwanda including Twin Lakes of Burera and Ruhondo, Muhazi, Ihema, Rweru, Mugesera, and Cyohoha serve as water transport modes.

While the sector plays an important role in local, regional and international mobility, trade and access to markets and social services, this transport sector relies mostly on petroleum products including Petrol/Gasoline, Diesel/Gasoil and Jet A1 for aviation (REG, 2022). Ongoing government efforts aim to improve safety standards, upgrade landing sites and encourage investment in modern vessels to strengthen the reliability and efficiency of lake transport.

Transport relies mostly on petroleum products: Petrol/Gasoline, Diesel/Gasoil, and Jet A1 for aviation (NISR, 2022).

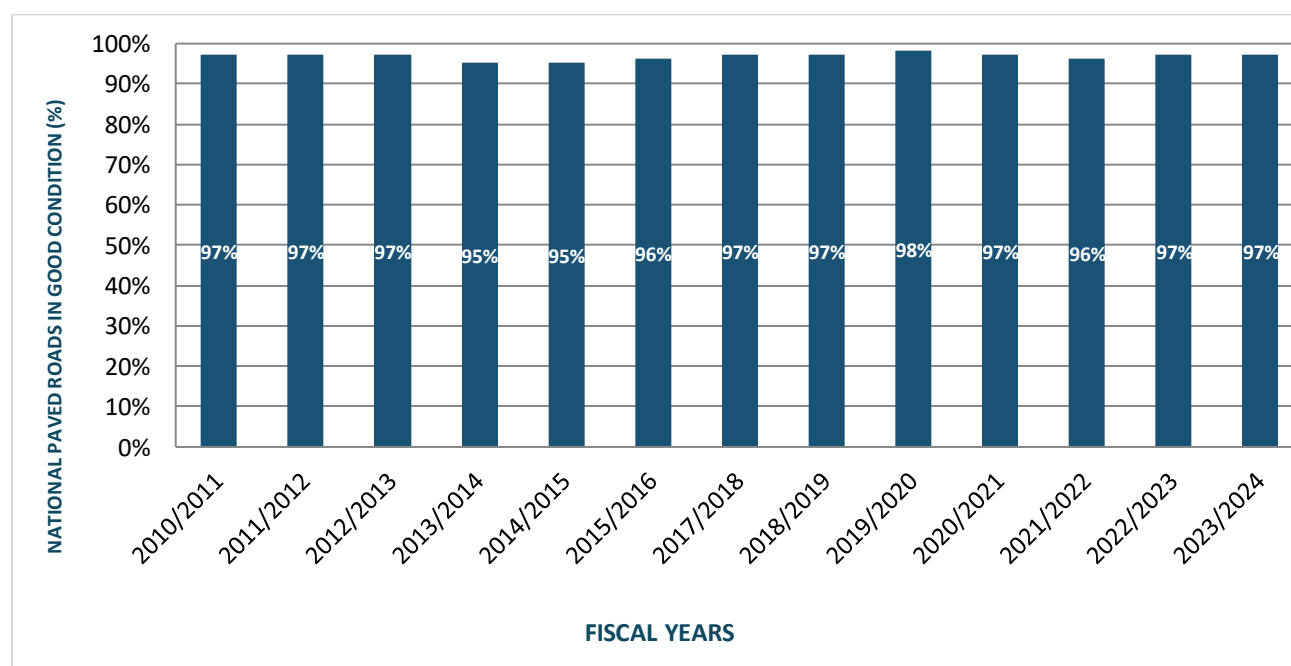


Figure 11: Chronological Evolution of Paved Roads

Source: (MININFRA, 2022)

Rwanda has maintained its road quality, and this has been reported in the Transport Sector Strategic Plan 2024–2029 that confirmed that Rwanda achieved a 97% target of national paved roads maintained in good condition as of the end of NST1 (2023/24).

1.1.13. Housing

In 2024, Rwanda has achieved significant strides in human settlements development, with 68% of households living in planned settlements. Housing tenure analysis reveals that nationally, 72% of the 3.31 million private households are owner-occupied, while about 22% are rented and 4% are occupied under free lodging arrangements. A clear urban-rural divide exists: in urban areas, tenant-occupied households (50%) slightly exceed owner-occupied ones (45%), whereas in rural areas, owner-occupancy rises sharply to about 83%, well above the national average, and tenancy falls to about 11% roughly half the national figure (NISR, 2023).

Concurrently, Rwanda has reduced the share of its population living in informal settlements from 62.6% in 2016/2017 underscoring tangible improvements in housing quality, security, and living conditions.

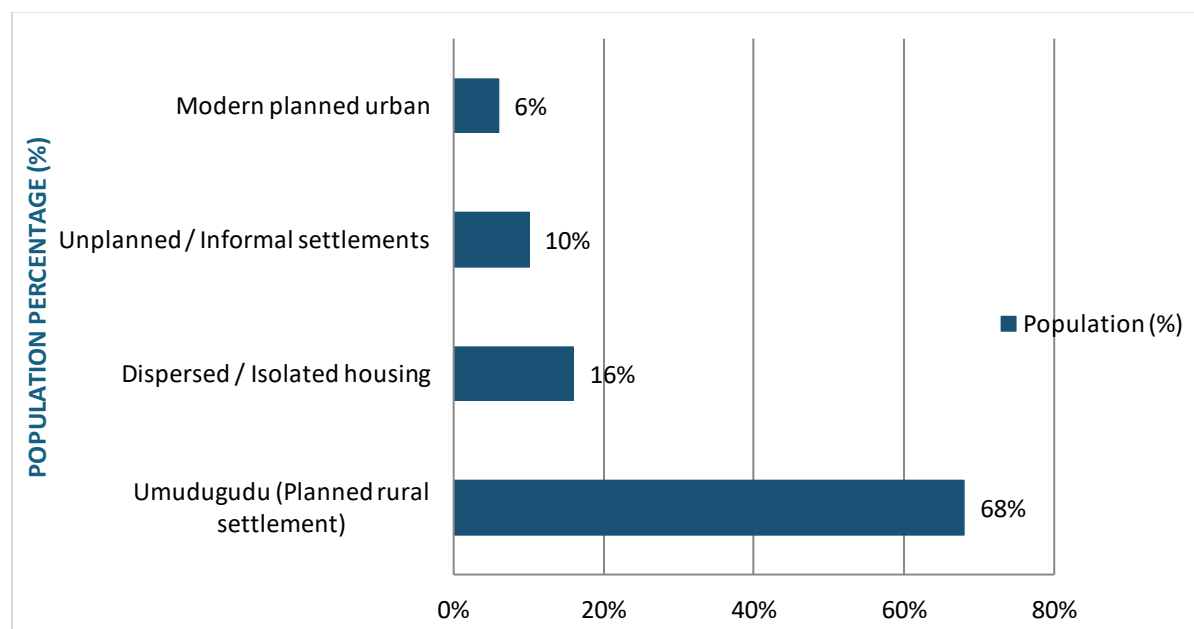


Figure 12: Settlements Status in Rwanda

Source:

1.1.14. Economic Profile

Gross Domestic Product

Over the last 20 years, Rwanda's economy has significantly recovered, achieving an average GDP growth of 7.8% per year (NISR, 2022). By 2025, GDP had grown to RWF 23,387 Billion at a rate of 9.4% with services leading at 52% of GDP, reflecting sustained structural transformation. Reforms in the financial and business sectors improved the investment climate, enabling Rwanda to climb over 100 places in the World Bank Doing Business Index, ranking 38th globally and 2nd in Africa (2021).

Domestic tax revenues have increased 20-fold since 2000, and the national budget grew 14 times. After a 3.4% GDP contraction in 2020 due to COVID-19, the economy rebounded with 10% growth in 2021, reaching a GDP of 10,279 billion RWF, with projections of 7.9% growth in 2023 (NISR, 2021). By comparison actual GDP reached RWF 23,387 billion in 2025 (9.4% growth).

Sector contributions from 2000 to 2022 and 2025 comparison (NISR, 2022):

- **Services moved from 47% in 2020 to 52% in 2025:** Main GDP driver, led by wholesale & retail trade, financial services, tourism and technical services.
- **Agriculture, forestry and fishing moved from 27 % in 2020 to 20% in 2025:** Driven mainly by food crop production.
- **Industry moved from 21% in 2022 to 22% in 2025:** Mining, construction, and manufacturing contribute steadily.

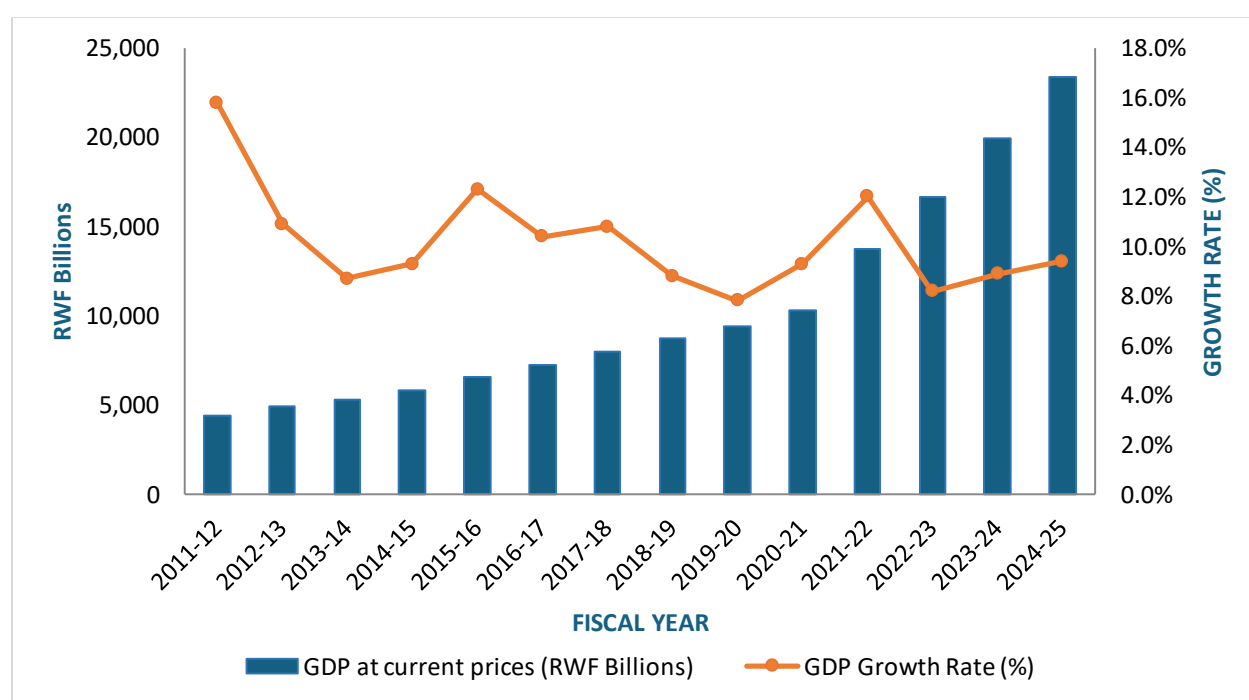


Figure 13: Gross Domestic Product: Macro-Economic Aggregates

Source: (NISR, GDP National Accounts, 2026)

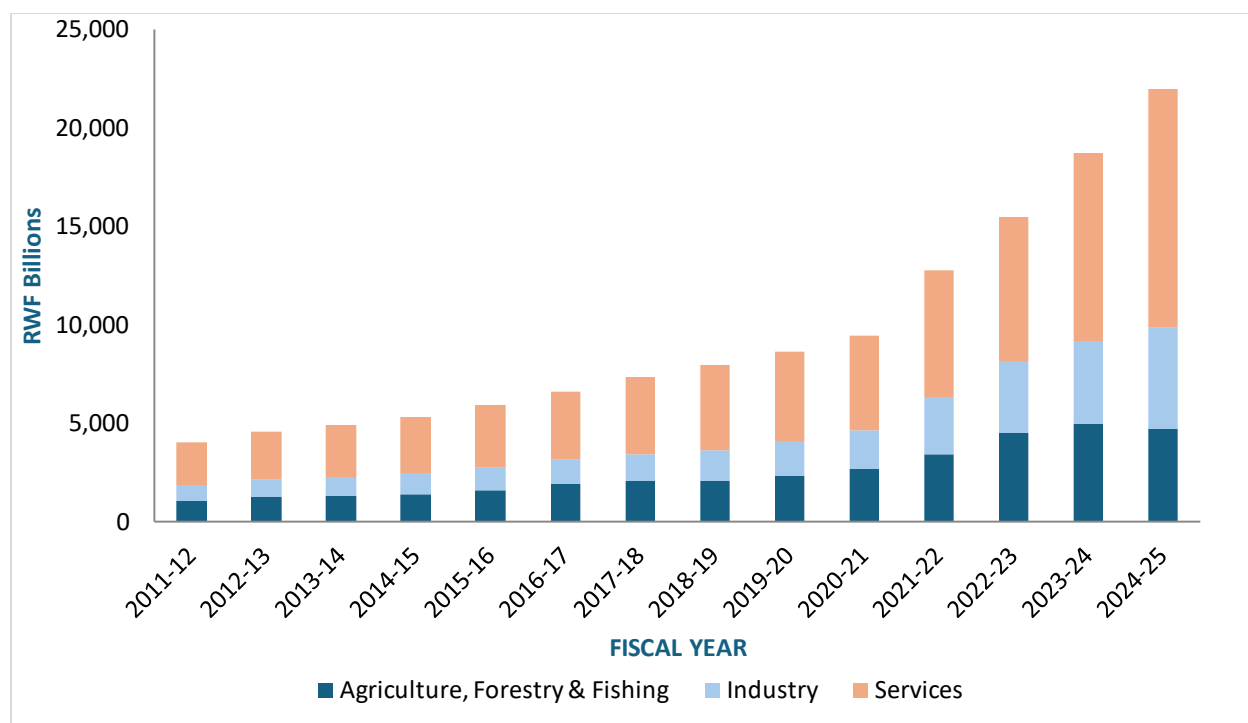


Figure 14: GDP Growth by Sector of Activity

Source: (NISR, 2026)

Rwanda experienced a 2.4% increase in foreign private investments and a 12.7% rise in capital stock from 2017–2018, led by electricity, gas & steam (35.7%), ICT (17.9%), financial sector (17.6%), and manufacturing (13.6%) (NBR, 2019). However, capital inflows dropped 23.5% in 2020 (from \$505M to \$386M) due to COVID-19, with additional pressures from the Ukraine war, inflation, and rising food insecurity (NBR, 2021).

Large investments (Airport, power plant, electricity infrastructure) and private/government spending in manufacturing, tourism, agriculture, ICT, health, and education aim to shift Rwanda to high-value activities, boosting GDP and living standards in long-term.

1.1.15. Trade and Industry

Rwanda is rapidly growing; however, the country's industrial sector has challenges mostly due to Rwanda being landlocked. More than 98% of Rwandan firms are Short and Medium Enterprises (MINICOM, 2017). To address this, the government has promoted the Made in Rwanda Policy, with the aspiration to become upper middle-income country by 2035 and higher income by 2050. The policy aims to increase economic competitiveness by increasing domestic market capacity through value chain development.

As by 2021, MINICOM administrative data indicates that in Rwanda, there are 925 industries, among them, 203 are considered large while 722 are Small and Medium Enterprises (SMEs). These industries are distributed in three main sectors of which agroprocessing takes the biggest share of 68% followed by light manufacturing with 24% and construction materials with a share of 8% of the total number of industries established in Rwanda (MINICOM 2021-2022). The country counted 9 industrial parks in order to increase the local domestic and foreign supply of manufactured goods. The industrial parks are located in Kicukiro, Bugesera, Rwamagana, Muhanga, Huye, Nyagatare, Musanze, Nyabihu and Rusizi (REMA, 2021).

The park accounts for the biggest number of firms with a share of 64% of the total firms established in special economic zones and industrial parks followed by Rwamagana and Bugesera with 16% and 9%. Rusizi and Nyagatare accounts for 5% and 2% while the remaining parks for around 1% each. In the fiscal year 2021-2022, industry sector increased 13%. Within industry, mining & quarrying increased by 17%, manufacturing activities increased by 3% while construction activities increased by 22% (NISR, 2021).

1.1.16. Employment

According to the NISR annual report, 2021 Labor Force Survey and based on labor market activities of individuals aged 16 years and older, it was determined that the working population was 7.7 million people in 2021, of whom 54% was a labor force (employed and unemployed; (NISR, 2021). For the last 5 years, employment rate has been increasing annually, except during the period of 2020-2021 where a decline in employment rate has been observed, attributable to COVID-19 pandemic. During this period, movement restrictions and the lock downs as preventive measures against the pandemic caused a significant decline in labor marked and non-labor market activities (NISR, 2022).

By 2024, recovery was firmly established: the working-age population (16+) reached 8.3 million, with 4.4 million employed and a labour force participation rate of 62.9% up from 59.3% in 2023 and 56.0% in 2022. The employment-to-population ratio rose to 53.1% in early 2024, the highest recorded since 2019 (NISR, 2025).

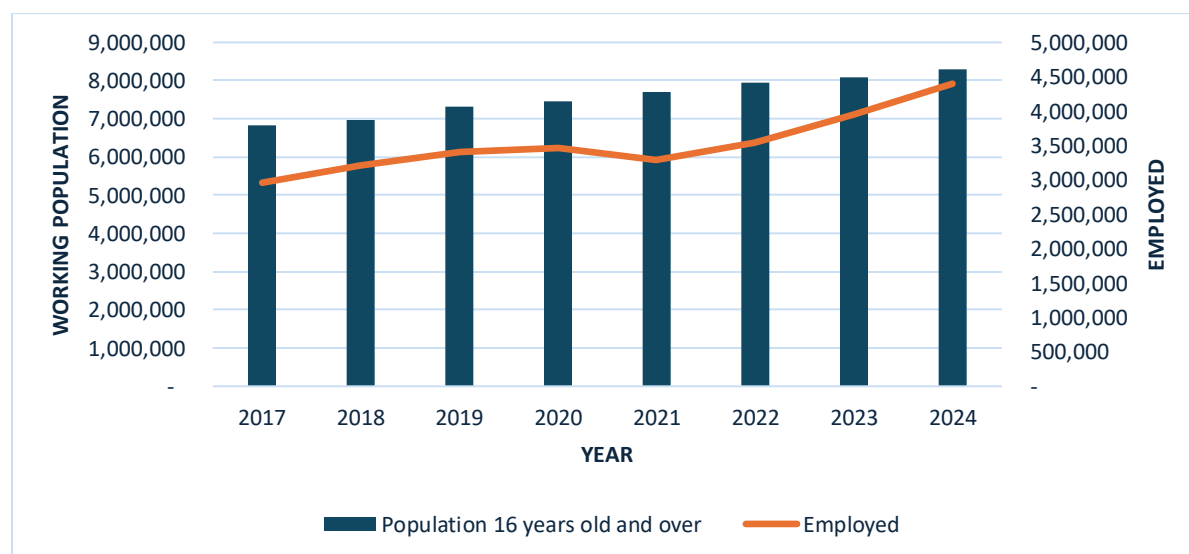


Figure 15: Rwanda's Employment Rate for Working Population

Source: (NISR, 2025)

1.1.17. Tourism

Rwanda's tourism sector sees steady growth, reaching, USD 498 million (2019), USD 131 million (2020), USD 164 million (2021), USD 455 million (2022). After the recovery from COVID-19 pandemic, tourism generated revenues rebound due to reopening of tourism services.

- In 2019, the country received 1,531,286 of international visitors and 20,158 holiday makers visitors. Most of them are from Africa and UK.
- In 2020, Rwanda welcomed 493,734 international visitors where most of them were from African countries, especially the East African Community (56%).
- In 2021, Rwanda welcomed 512,000 international visitors, more than 60% were from African countries,
- In 2022, Rwanda welcomed a total of 1,105,460 international visitors. Of these, more than 60% came from African countries, highlighting the country's growing popularity as a destination within the continent. Among these, national parks attracted over 109,800 domestic and international tourists which boosted National Parks visits. In 2022, total National Parks revenues stood at US\$ 27 million, a significant increase from US\$ 8.1 million in 2021.
- In 2023, Rwanda welcomed 1,400,000 international visitors, generating USD 620 million in tourism revenues with a 36% increase from 2022 and the first year to surpass pre-pandemic (2019) revenue levels. National parks generated USD 35.79 million. Domestic tourism reached USD 47.7 million (RDB, 2023). (NISR, 2025)
- In 2024, Rwanda welcomed 1,360,000 international visitors, generating USD 647 million in tourism revenues (+4.3%). Gorilla tourism contributed USD 200 million (+27%), national parks recorded 138,000 visits and USD 38.8 million in revenue. Travel & Tourism contributed Fr 1.9 trillion to GDP (9.8% of GDP), supporting nearly 386,000 jobs (RDB, Rwanda Development Board Annual Report 2024, 2024).
- In 2025, Rwanda welcomed 1,490,000 international visitors (+9%), generating USD 685 million in tourism revenues (+6%). Air arrivals grew by 23%. MICE revenues reached USD 94.7 million from 165 international events, with 61,888 delegates. National parks registered 155,394 visits (+3.2%) (RDB, 2025).

1.1.18. Waste Management

Waste generation in Rwanda is rising, with urban areas producing most of its municipal solid waste (MSW). Waste is categorized into four categories: solid, liquid, and hazardous waste (including medical) and electronic waste.

The main sources of solid waste are the residential, commercial, construction, and institutional sectors. Solid waste in Rwanda is largely organic representing between 64 -74% of the total waste generated, including food and yard waste; recyclable materials such as plastic, paper, metal, construction debris and glass are another key source of wastes. The amount of waste produced per capita varies considerably and is estimated between 0.56 and 0.7 kg per capita per day for urban areas. Waste is more prevalent in urban than rural areas, with daily generation rising from 180 tons in 2012 to over 600 tons in 2019, and estimated at 500–800 tons per day by 2022/23, for the city of Kigali (REMA, 2021).

Despite effort and progress in waste collection services, only 42.1% of urban wastes are collected in Rwanda (NISR, EICV5, main indicator report, 2018). Collection is mainly handled by private companies and cooperatives, which transport waste to designated dumpsites such as Nduba in Kigali, helping to reduce mismanagement at the household level. In June 2024, the Ministry of Environment and GGGI inaugurated

pilot municipal waste bio-processing facilities at Nduba landfill as part of a circular economy transition (GGGI, 2024)

Wastewater in Rwanda mainly comes from households and institutions, managed mainly through septic tanks, soak channels, direct discharges into wetlands, and about 161 semi-centralised and onsite wastewater treatment systems. Rwanda is working to establish a centralized wastewater treatment system for Kigali and faecal sludge treatment systems for secondary cities to improve liquid waste management (REMA, 2021).

Hazardous waste includes medical waste which are all waste generated during medical activities. Based on a health facilities assessment conducted across the country, 5,168 kg of medical waste is generated by in- and out-patients per day. This translates into 60,775,164 kg of medical waste per year (MoH, 2017). Medical waste is segregated, collected, and incinerated, and the incineration ashes are placed in a cement-covered septic tank and disposed at appropriate landfill or public dumpsites.

E-waste covers almost all types of electrical and electronic equipment. In Rwanda e-waste comes mainly from old household appliances and electronic devices, with about 10,000 tons generated in 2017, 82% of which was from individuals. Collection rates of e-waste improved from 15.4% in 2018 to 19.3% in 2019, reflecting progress in managing this growing waste stream (REMA, 2021). Rwanda adopted a revised Integrated Solid Waste Management Strategy in 2022 with ambitious targets including 80% of domestic waste recycled or properly disposed of in urban areas, and 50% of generated e-waste recycled by 2024 (GGGI, 2024)

Despite the current challenges in the waste sector, the country has made efforts through several well-known waste related interventions, including, but not limited to its renowned policy on the ban of plastic bags, the National E-Waste Management Policy, and other initiative such as Umuganda mostly serves for waste collection. Rwanda has also established a legal and regulatory framework for waste management and committed to several waste related multilateral environmental agreements (NISR, 2025).

1.1.19. Agriculture: Crops, Livestock and Fisheries

Crops and Agricultural Practices

Seven (7) major crops produced in Rwanda include: Maize, sweet potato, Irish potatoes, cassava, paddy rice, banana and beans. Being mostly rain-fed farming, the yield of the crops is seasonal-dependent, with mostly 2 main cropping seasons across the country (Season A: September-December and Season B: March-May; (NISR, 2021; MINAGRI, 2023). By 2025, poultry numbers surged to over 12.9 million, driven by commercial farm expansion; egg production reached 29,855 MT and chicken meat 62,233 MT in 2024/25.

In 2023, the total country land area used for agriculture for both season A and B was 1.36 million ha (MINAGRI, 2023). Regarding the practice of some of the Good Agricultural Practices (GAP), 10.3 percent of farmers practiced irrigation and 91.2 percent of farmers practiced anti-erosion activities. It has been realised that the level of adopting good agriculture practices for large scale farmers is very higher compared to the small-scale farmers which contributed to the productivity increase for major crops (MINAGRI, 2023). By Season A 2025, agricultural land expanded to 1.399 million hectares (59% of total land); total irrigated area reached 74,375 ha cumulatively; 13.4% of farmers practiced irrigation (NISR, 2025).

In 2023, 87.9% of farmers applied organic fertilizer in their farms in season A against 83.4% in season B. Inorganic fertilizers were used at the rate of 59.6% in season A and 51.6% in season B (MINAGRI, 2023). Considering the application of pesticides, 33.2 percent of small-scale farmers and 86.3 percent of large-scale farmers applied pesticides during season 2023 A, while 28.6 percent of small-scale farmers and 79.9 percent of large-scale farmers applied pesticides in season B (MINAGRI, 2023). By Season A 2025, organic fertilizer use rose to 88.0%, inorganic fertilizer to 63.2%, and pesticides to 40.6% (SSF) and 86.9% (LSF). Over 3.5 million farmers received subsidised inputs under the Smart Nkunganire System in 2024/25 (NISR, SAS 2025A; MINAGRI, 2024/25) (MINAGRI, 2023).

Livestock

The national livestock population comprises around 1.64 million cattle, 440,214 sheep, 1.99 million goats, 1.1 million pigs, and around 6.4 million laying hens, broilers, and local chickens (MINAGRI, 2023).

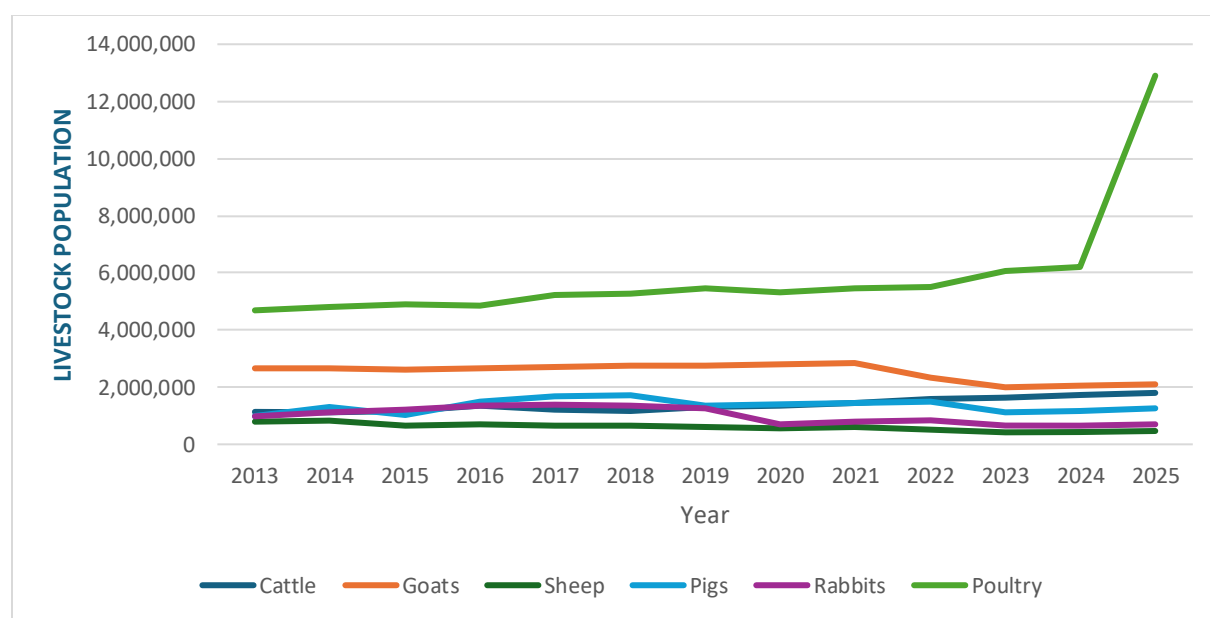


Figure 16: Increase of Livestock Over the Years

Source: (MINAGRI, 2023)

In the 2022/23 fiscal year, the national livestock population produced 197,778 MT of meat, 1,061,301 MT of milk, 17,344 MT of eggs, 46,495 MT of fish, and 7,250 MT of honey (MINAGRI, 2023). Most animal feeds are composed of plant-based, dominated by grasses such as Chloris, Brachiaria, Panicum and Pennisetum species and legumes such as Desmodium, Mucuna, Lablab, Calliandra and Leucaena species (MINAGRI, 2021).

Fishery

The fishery sector counts 3,827 members grouped into 70 cooperatives across the country. Currently, the Government of Rwanda promotes fish farming in ponds and fish farming in cages to boost fish production (MINAGRI, 2021), this saw the production of 52,6 Million (Tilapia, carpe, and catfish) fingerlings (MINAGRI, 2023). Fish production has reached 46.5 MT in 2022/2023 compared to 42 MT in 2020/2021 (MINAGRI, 2023). Fish production has grown steadily: 36,047 t (2021), 43,560 t (2022), 46,495 t (2023), 48,133 t (2024),

and 52,439 t (2025) with over 60% above 2020 levels (MINAGRI, 2023). The PSTA4 target was 112,000 t by 2024 while under PSTA5 (2024–2029), the revised target is 77,700 t by 2029.

1.2. INSTITUTIONAL AND REGULATORY FRAMEWORK

1.2.1. Institutional Arrangement

The Ministry of Environment (MoE) is the key institution in charge of developing and disseminating laws, policies, strategies, and programmes related to environment and climate change. MoE provides overall coordination as Chair of the Climate, Environment, and Natural Resources Sector Working Group (CENR SWG) which is a formal forum that facilitates dialogue, ownership, and accountability of the development agenda by all stakeholders at the sector level. The platform brings together central and local government institutions, Development Partners, Civil Society, and the Private Sector involved in or interested in the sector's development.

REMA has the legal mandate for national environmental protection, conservation, promotion, and overall management, including advisory to the government on all matters of the environment and climate change. REMA is also the national focal point institution of the UNFCCC and is, therefore, the central body responsible for the preparation of transparency reports under the Paris Agreement.

Therefore, the preparation of the Fourth National Communication was done through four Thematic Working Groups (i.e., National circumstances and Institutional Arrangements, Greenhouse gas inventory, and climate change mitigation) of technical experts supported by REMA staff and the NDC MRV Technical Working Committee.

Various institutions contribute to data gathering, measurements and reporting include public and private institutions, NGOs, CSOs and Development partners. Table 2 summarizes major key stakeholder institutions whose mandate are relevant to climate change, and relevant in the preparation of the NC4.

Table 2: Key stakeholders and their climate change-related mandates

No	Stakeholder	Main activities in their mandate relevant to climate change	Contribution in NC preparation and reporting
Government Ministries			
1	MINALOC (Ministry of Local Government)	Formulation of policies and strategies for coordination and good governance.	Data providing for NC preparation
1	MINAGRI (Ministry of Agriculture and Animal Resources)	Formulation of policies and strategies for agriculture and animal resources development	Data providing for NC preparation (e.g., agriculture-GHG related emissions)
	MINECOFIN (Ministry of Finance and Economic Planning)	Formulation of policies and strategies for raising economic opportunities and sustainable growth.	Data providing for NC preparation
2	MINEMA (Ministry in charge of Emergency Management)	Formulation of policies and strategies for disaster and refugees' management.	Data providing for NC preparation

3	MINEDUC (Ministry of Education)	Formulation of policies and strategies for education promotion in Rwanda	Data providing for NC preparation
4	MINICOM (Ministry of Trade and Industry)	Formulation of policies and strategies related to trade, investment, industry and entrepreneurship	Data providing for NC preparation
5	MININFRA (Ministry of Infrastructure)	Formulation of policies and strategies related to transport, energy, water supply and sanitation, housing and human settlement sectors	Data providing for NC preparation
6	MoE (Ministry of Environment)	Formulation of policies and strategies on the environment and climate change	Lead NC preparation and reporting
7	MoH (Ministry of Health)	Formulation of policies and strategies of the health sector	Data providing for NC preparation
Public Institutions			
1	NISR (National Institute of Statistics of Rwanda)	Production of national statistics and information for evidence-based decision-making	Data providing for NC preparation
2	RAB (Rwanda Agriculture and Animal Resources Development Board)	Implement the national policy of agriculture and animal husbandry	Data providing for NC preparation
3	RDB (Rwanda Development Board)	Accelerate Rwanda's economic development by enabling private sector growth through different services including conservation.	Data providing for NC preparation
4	REG (Rwanda Energy Group)	Provide innovative and sustainable energy solutions for national development	Data providing for NC preparation
5	REMA (Rwanda Environment Management Authority)	Implement national policies for environmental protection, conservation, promotion and overall management	Lead in NC preparation and reporting
6	RFA (Rwanda Forestry Authority)	Management and protection of national forest resources	Data providing for NC preparation
7	RHA (Rwanda Housing Authority)	improve housing and construction through planning, organizing and monitoring rural settlement, urban settlement, public building construction, affordable housing; management of public office space and public assets; and regulation of the construction industry.	Data providing for NC preparation

8	National Land Authority (NLA)	To manage and administer land in Rwanda, including developing and implementing land laws and policies, land use planning, mapping, land registration, land consolidation, and management of land conflicts.	Data providing for NC preparation
9	METEO - RWANDA (Rwanda Meteorology Agency)	Collect, gather and publish meteorological data, and advice on global climate change	Data providing for NC preparation
11	RTDA (Rwanda Transport Development Agency)	Implement policies related to transport, develop and manage public transport facilities	Data providing for NC preparation
12	RWB (Rwanda Water Resources Board)	Implement national policies related to water resources	Data providing for NC preparation
13	RMB (Rwanda Mines, Petroleum and Gas Board)	RMB mandate is to drive the economic transformation through sustainable management of mineral, oil and gas resources.	Data providing for NC preparation
14	Rwanda Green Fund (RGF)	Mobilize and manage resources (grant funding, loans, investments) from public, private, bilateral and multilateral sources for environment and climate-related projects.	Data providing for NC preparation
15	WASAC (Water and Sanitation Corporation)	Manage the water and sanitation services in Rwanda	Data providing for NC preparation
16	National Industrial Research and Development Agency (NIRDA)	NIRDA mandated with a mission to lay a solid foundation for a structural shift in industrial development by producing competitive goods and services through technology and innovation while encouraging and preserving environmental standards"	Data providing for NC preparation
17	LODA	facilitate the coordination of strategic planning and financing of districts, cities and the City of Kigali, through developing local infrastructures, creating business and job opportunities, etc.	Data providing for NC preparation
Local Government			

1	District authorities (all)	Promotion of socio-economic development in various areas including well-being of humans and environment.	Data providing for NC preparation
2	The City of Kigali (CoK)	to ensure effective urban governance and the implementation of national policies at the city level; to oversee sustainable urban development through planning, infrastructure development, and efficient resource management.	Data providing for NC preparation
Academia			
1	Higher Learning Institutions	Teaching, research, publication of extension materials relevant to climate change, and dissemination of data and knowledge/skills transfer	Data providing for NC preparation
Others			
2	NGOs (Non-Government Organizations)	Research, dissemination of data and knowledge/skills transfer	Data providing for NC preparation
3	Private Sector Federation (PSF)	Investment in climate actions business activities	Data providing for NC preparation
4	CBOs (Community-Based Organizations)	Dissemination of data and knowledge/skills transfer	Data providing for NC preparation

It has been established that there is inadequate capacity in various areas of climate change related to low involvement and participation of stakeholders, and the need for a network of experts specialized in climate change.

Although various institutions and stakeholders play an important role in climate change strategy and policy development and implementation, it has been established that there are still gaps in capacity building and incorporation of climate change aspects in the different plans (such as District Investment Plans) and Performance Contracts.

To respond to these needs, the Government of Rwanda committed to fully equip both the technical staff in sector-based institutions and related field teams across the country in various areas such as greenhouse gas (GHG) data collection and management through the ongoing CBIT (Capacity-building Initiative for Transparency) project implemented by REMA. Through this project, the government is also developing an integrated digital platform to support data sharing and decision-making processes within government and use by other stakeholders.

1.2.2. Laws, Policies and Strategies

Several laws, policies and international agreements/conventions related to climate change have been promulgated in Rwanda (Table 3).

Table 3: Rwanda's Laws Related to Climate Change Rwanda's Laws Related to Climate Change

Law/ Order/No.	Instruction	Date	Title
002/2008		01/04/2008	Ministerial Order determining modalities of land registration
006/MoE/22		12/05/2022	Ministerial Order establishing modalities of inspecting companies or activities that pollute the environment
007/2008		15/08/2018	Ministerial Order establishing the list of protected animal and plant species
004/2021		12/02/2021	Ministerial Order establishing the list of works, activities and projects that must undertake an environment impact assessment.
006/2008		15/08/2008	Ministerial Order regulating the importation and exportation of ozone layer depleting substances products and equipment containing such substances
49/2018		13/08/2018	Law putting in place the use, conservation, protection, and management of water resources regulations
26/03		23/10/2008	Prime Minister's Order determining the list of chemicals and other prohibited pollutants
007/16.01		15/07/2010	Ministerial Order determining the length of land on shores of lakes and rivers transferred to public property
006/16.01		15/07/2010	Ministerial Order establishing special regulations relating to burying toxic wastes
004/16.01		15/07/2010	Ministerial Order governing the importation and exportation of wild animals
003/16.01		15/07/2010	Ministerial Order preventing activities that pollute the atmosphere
004/ MINICOM/2010		14/09/2010	Ministerial Order determining the modalities of environment conservation in mining and quarry extraction
126/03		25/10/2010	Prime Ministerial Order determining the responsibilities, organization and functioning of committees in charge of environment conservation and protection
20/2011		21/06/2011	Law governing human habitation
10/2012		02/05/2012	Law governing urban planning and building in Rwanda
004/16.01		24/05/2013	Ministerial Order determining the list of water pollutants
006/16.01		24/05/2013	Ministerial Order determining the organization of water resources data collection, treatment, management, exploitation, and communication
002/16.01		24/05/2013	Ministerial Order Determining the Procedure for Declaration, Authorization and Concession for the Utilization of Water
46/2013		16/06/2013	Law established the Rwanda Development Board (RDB)

47/2013	28/06/2013	Law determining the Management and Utilization of Forests in Rwanda
37/ 16.09	30/07/2013	Ministerial Instructions relating to the Management and exploitation of used paper
63/2013	27/08/2013	Law determining the mission, organization and functioning of Rwanda Environment Management Authority (REMA)
005/03	27/12/2013	Prime Minister's Instructions preventing Air Pollution caused by vehicular emissions and machines using petroleum products in Rwanda
006/ MINIRENA/2015	18/06/2015	Ministerial Order determining the management of protected state forests not managed by Special laws
41/2015	29/08/2015	Law relating to disaster management
45/2015	15/10/2015	Law establishing the Gishwati -Mukura National Park
18/2016	18/05/2016	Law Governing the preservation of air quality and prevention of air pollution in Rwanda
006/03	30/01/2017	Prime Minister's Order drawing up a list of swamp lands, their characteristics and determining modalities of their use, development and management.
14/2017	14/04/2017	Law established the Rwanda Agriculture and Animal Resources Development Board (RAB)
39/2017	16/08/2017	Law establishing the National Fund for Environment and determining its mission, organization, and functioning
48/2018	13/08/2018	Law on Environment
17/2019	10/08/2019	Law relating to the prohibition of manufacturing, importation, use and sale of plastic carry bags and single-use plastic items
72/2019	29/01/2020	Law establishing Rwanda Forestry Authority (RFA)
71/2019	29/01/2020	Law establishing Rwanda Water Resources Board (RWB)
005/2021	08/04/2021	Ministerial Order relating to the national report on climate change
27/2021	10/06/2021	Law governing land
064/2021	14/10/2021	Law governing biodiversity in Rwanda
031/01	06/05/2022	Presidential Order governing Rwanda Meteorology Agency
033/01	06/05/2022	Presidential Order governing Rwanda Environment Management Authority
034/01	06/05/2022	Presidential Order governing Rwanda Forestry Authority

Table 4: Rwanda's Policies and Strategies Related to Climate Change

Policies	Year
National Cooling Strategy	2020
National Environment and Climate Change Policy	2019
National Forest Policy	2018
National Land Policy	2019
National Land Use and Development Master Plan	2020
National Policy & Strategy for Water Supply and Sanitation Services	2010
Updated Nationally Determined Contribution	2020
Rwanda Biodiversity Policy	2011
Revised Green Growth and Climate Resilience Strategy (GGCRS)	2023
Vision 2050	2015
National Climate and Nature Finance Strategy	2024

CHAPTER 2

NATIONAL GREENHOUSE GAS INVENTORY



CHAP 2. NATIONAL GREENHOUSE GAS INVENTORY

2.1. INTRODUCTION

This chapter presents Rwanda's greenhouse gas (GHG) inventory for 2006–2022. The inventory uses the 2006 IPCC Guidelines and the 2019 Refinement, recalculating 2006–2018 data and computing 2019–2022 with updated methodologies and additional information. It covers five sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use and Land-Use Change and Forestry (LULUCF), and Waste, and includes seven GHGs: CO₂, CH₄, N₂O, and HFCs (with PFCs, SF₆, and NF₃ not occurring in Rwanda). The Methodologies are based on Tier 1 and Tier 2 involving use of country specific or international activity data, applying IPCC default or country specific emission factors, and conducting QA/QC reviews. Uncertainty values were estimated from past inventories, basing on the data providers, and IPCC guidance. Data were processed in Excel, archived in National GHG Activity Data Platform, and validated by NDC MRV Technical Committee and Sectoral Working Groups, ensuring comprehensive, consistent, and cross-checked GHG reporting.

2.2. INSTITUTIONAL ARRANGEMENTS

Rwanda has (June 2021) established a greenhouse gas (GHG) inventory MRV framework which includes all sectors and key institutions involved in the collection of the activity data. The greenhouse gas (GHG) emissions inventory was prepared as part of this Fourth National Communication, it has been conducted under the leadership and coordination of the Rwanda Environment Management Authority (REMA).

REMA has the overall responsibility of developing the National greenhouse gas (GHG) Inventory with the Ministry of Environment (MoE) providing oversight. The institutional arrangements for greenhouse gas (GHG) inventory comprised of committees and working groups with REMA playing the supervisory and coordinating role. REMA updated the NIR for all the IPCC sectors.

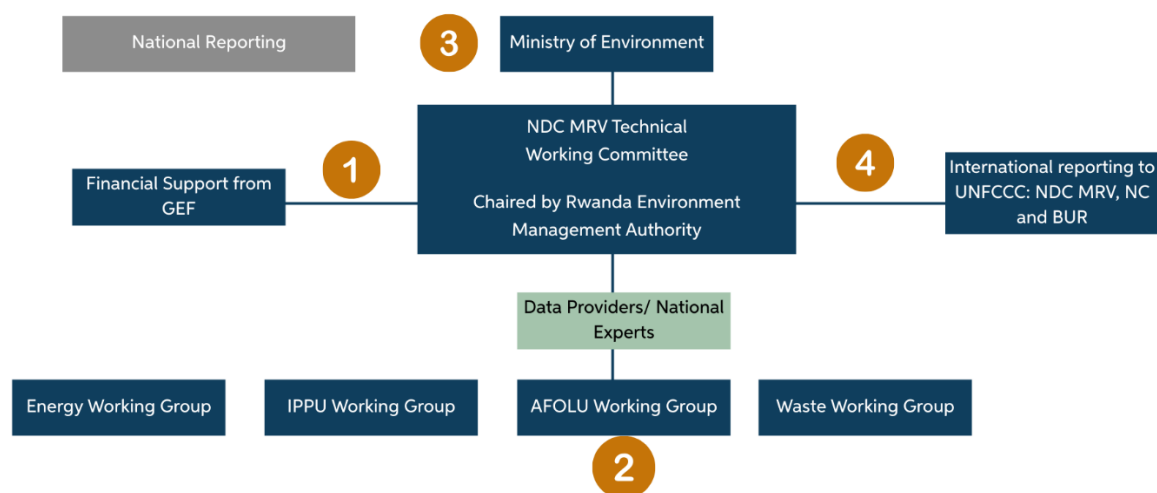


Figure 17: Rwanda National GHG Inventory Institutional Arrangements and process

The description of the institutional arrangement for the GHG inventory reporting, is arranged according to the number in the Figure 17:

1° Rwanda receive financial support from GEF, and works with other organizations to prepare the GHG inventory.

2° REMA coordinate the working groups to assess together the list all emission sources, which define needed data. The data are collected through the working groups data based on IPCC methodologies. Validation of the activity data

3° REMA lead the emissions estimation, QC/QA process and engage the NDC MRV Technical Working Committee as a sub-body of the Environment and Climate Change Thematic Working Group. This committee is responsible for the validation and quality assurance of the report before it is endorsed by the MoE or submitted to the UNFCCC.

4° The report is endorsed by the Ministry of Environment and then submitted by the national focal point based at REMA

In detail, the following table summarize the role from each institution in the process of the GHG inventory development process.

Table 5: Role of Institutions in National Inventory Preparation Process

Entity	Role
Ministry of Environment (MoE)	Provides oversight to the operations of REMA including the compilation of National Communications, Biennial Update Reports and National Greenhouse Gas Inventories.
Rwanda Environment Management Authority (REMA)	Responsible for leading the development of the National GHG Inventory Report ensuring that the requisite expertise is available for quality assurance and quality control.
Rwanda Forestry Authority (RFA)	Provides activity data on forestry
Rwanda Transport Development Agency (RTDA)	Provides activity data on road, and water transportation.
Rwanda Civil Aviation Authority (RCAA)	Provides activity data on civil aviation fuels and associated information
Ministry of Agriculture and Animal Resources (MINAGRI)	Provides activity data on crops and livestock as well as information on land use change.
National Agricultural Export Board (NAEB)	Provides data on tea, coffee areas, farming practices and fertilizers applied

Rwanda Agriculture and Animal Resources Board (RAB)	Provides data on farming systems and farming practices for all crops, livestock and fertilizers
Ministry of Trade and Industry (MINICOM)	Facilitates the provision of data on industrial processes and product use from relevant data providers in the sector.
Rwanda Revenue Authority (RRA)	Provides data on motor vehicles, and other machines imported and exported
National Institute of Statistics of Rwanda (NISR)	Provides data in relation to the household survey, agriculture survey and national census
Ministry of Infrastructure (MININFRA)	Provides activity data and information on energy, transport, housing and settlement, and waste management.
Rwanda Energy Group (REG)	Provides activity data and information on energy generation and use
Private organizations	Provision of activity data for energy use, production, and wastewater generation in industries

2.3. APPLIED METHODOLOGICAL APPROACHES

Rwanda National greenhouse gas (GHG) inventory covers a total of seven greenhouse gases: Carbon dioxide (carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O) and Hydrofluorocarbons (HFCs) which are emitted or removed from the atmosphere. Perfluorocarbons (PFCs), Sulphur hexafluoride (SF₆) and Nitrogen fluoride (NF₃) were not estimated as they are not occurring in the country. A total of five sectors were covered including Energy; Industrial Processes and Product Use (IPPU); Agriculture; Land Use and Land Use Change and Forestry (LULUCF); and Waste. Each sector includes categories (indicated by capital letters), and sub-categories (identified by numbers), and emissions sources (denoted by small letters).

- **Energy:** Emissions were estimated using IPCC methodologies (Tiers 1 and 2), with cross-checking via the reference approach.
- **Industrial Processes and Product Use (IPPU):** Emissions from chemical/mechanical processes and F-gases were mainly calculated with Tier 1 methods; country-specific factors were used for cement production.
- **Agriculture:** Covered livestock, managed soils, rice cultivation, biomass burning, and aquaculture. Emissions (CO₂, CH₄, N₂O) were estimated using IPCC factors, national data, and EFDB references.
- **Land Use, Land-Use Change and Forestry (LULUCF):** Assessed forest land, cropland, grassland, wetlands, settlements, and other lands using Tier 1 methods. Weighted averages were applied for emission/removal factors across agro-ecological zones. Dead organic matter pools were estimated using IPCC equations and national studies.

- **Waste:** Included solid waste disposal, wastewater treatment, incineration, and open burning. Due to limited country-specific data, Tier 1 methods were used with surrogate data (population, GDP) for missing years. Interpolation/extrapolation techniques addressed data gaps.

Uncertainty values were derived from data providers, past inventories, and IPCC guidelines. Emissions were computed with IPCC software and Excel as a cross-check. Entered data was checked by the Nationally Determined Contribution (NDC) MRV Technical Committee and members of the Sectoral Working Groups to correct any omissions and errors during data entry. Uncertainty values were entered for both activity data and emission factors and the sectoral inventories were combined in one database file.

Table 6: Methodological Approaches for Activity Data and Emission Factors

Categories	AD							
		CO2	CH4	N2O	HFC	PFC	SF6	NF3
1.A - Fuel Combustion Activities	PS, CS	T1, T2	T1	T1				
1.A.1 - Energy Industries	PS	T1	T1	T1				
1.A.1.a - Main Activity Electricity and Heat Production	PS	T1	T1	T1				
1.A.1.a.i - Electricity Generation	PS	T2	T1	T1				
1.A.1.a.ii - Combined Heat and Power Generation (CHP)	NO	NO	NO	NO				
1.A.1.a.iii - Heat Plants	NO	NO	NO	NO				
1.A.1.b - Petroleum Refining	NO	NO	NO	NO				
1.A.1.c - Manufacture of Solid Fuels & Other Energy Industries	NO	NO	NO	NO				
1.A.1.c.i - Manufacture of Solid Fuels	NO	NO	NO	NO				
1.A.1.c.ii - Other Energy Industries	NO	NO	NO	NO				
1.A.2 - Manufacturing Industries and Construction	PS	T1	T1	T1				
1.A.2.a - Iron and Steel	PS	T1	T1	T1				
1.A.2.b - Non-Ferrous Metals	NO	NO	NO	NO				
1.A.2.c - Chemicals	NE	NE1	NE	NE				
1.A.2.d - Pulp, Paper and Print	NA	NE1	NE	NE				
1.A.2.e - Food Processing, Beverages and Tobacco	CS	T1	T1	T1				
1.A.2.f - Non-Metallic Minerals	PS	T1	T1	T1				
1.A.2.g - Transport Equipment	NO	NO	NO	NO				
1.A.2.h - Machinery	NO	NE	NE	NE				
1.A.2.i - Mining (excluding fuels) and Quarrying	CS	T1	T1	T1				
1.A.2.j - Wood and wood products	CS	NE	NE	NE				
1.A.2.k - Construction	CS	T1	T1	T1				

1.A.2.l - Textile and Leather	NE	NE1	NE	NE				
1.A.2.m - Non-specified Industry	NE	NE1	NE	NE				
1.A.3 – Transport	T1	T1, T2	T1	T1				
1.A.3.a - Civil Aviation	CS	T1	T1	T1				
1.A.3.a.i -International Aviation (International Bunkers) (1)								
1.A.3.a.ii - Domestic Aviation	CS	T1	T1	T1				
1.A.3.b - Road Transportation	CS	T2	T1	T1				
1.A.3.b.i – Cars	CS	T2	T1	T1				
2.A Mineral industry	CS	T1	NA	NA				
2.A.1 - Cement production	CS	T1	NA	NA				
2.A.2 - Lime production	CS	T1	NA	NA				
2.A.3 - Glass Production	NO	NE						
2.A.4 - Other Process Uses of Carbonates	NO	NE	NA	NA				
2.B Chemical industry	NO	NE	NA	NA				
2.B.1 - Ammonia Production	NO	NE						
2.B.2 - Nitric Acid Production	NO	NE		NE				
2.B.3 - Adipic Acid Production	NO	NE		NE				
2.B.4 - Caprolactam, Glyoxal & Glyoxylic Acid Production	NO			NE				
2.B.5 - Carbide Production	NO	NE	NE					
2.B.6 - Titanium Dioxide Production	NO	NE						
2.B.7 - Soda Ash Production	NO	NE						
2.B.8 - Petrochemical and Carbon Black Production	NO	NE	NE					
2.B.9 - Fluorochemical Production	NO	NE			NE	NE	NE	NE
2.B.10 - Hydrogen Production	NO	NE	NE	NE				
2.B.11 - Other (Please specify)	NO	NE	NE	NE	NE	NE	NE	NE
2.C Metal industry	PS, CS	T1	T1	NE		NE	NE	NE
2.C.1 - Iron and Steel Production	PS, CS	T1	T1					
2.C.2 - Ferroalloys Production	PS, CS	T1	T1					
2.C.3 - Aluminium production	NO					NE		
2.C.4 - Magnesium production	NO						NE	
2.C.5 - Lead Production	NO							
2.C.6 - Zinc Production	NO							
2.C.7 - Rare Earths Production	NO	NE	NE	NE		NE		
2.C.8 - Other (please specify)	NO	NE	NE	NE		NE	NE	NE
2.D Non-energy products from fuel and solvent use	CS	T1	NE	NE				
2.D.1 - Lubricant Use	CS	T1						

2.D.2 - Paraffin Wax Use	CS	T1						
2.D.3 - Solvent Use	CS							
2.D.4 - Other (please specify)	NO	NE	NE	NE				
2.E - Electronics Industry				NE	NE	NE	NE	NE
2.E.1 - Integrated Circuit or Semiconductor				NE	NE	NE	NE	NE
2.E.2 - TFT Flat Panel Display				NE	NE	NE	NE	NE
2.E.3 - Photovoltaics					NE	NE	NE	NE
2.E.4 - Heat Transfer Fluid						NE		
2.E.5 - Other (please specify)	NO	NE	NE	NE	NE	NE	NE	NE
2.F - Product Uses as Substitutes for O3 Depleting Substances	CS				T1	T1	NE	NE
2.F.1 - Refrigeration and Air Conditioning	PS, CS				T1	T1		
2.F.2 - Foam Blowing Agents	NO				NE	NE		
2.F.3 - Fire Protection	NO				NE	NE		
2.F.4 - Aerosols	NO				NE	NE		
2.F.5 - Solvents	NO				NE	NE		
2.F.6 - Other Applications (please specify)	NO				NE	NE	NE	NE
2.G - Other Product Manufacture and Use	NO	NE	NE	NE	NE	NE	NE	NE
2.G.1 - Electrical Equipment	NO					NE	NE	
2.G.2 - SF6 and PFCs from Other Product Uses	NO				NE	NE	NE	
2.G.3 - N2O from Product Uses	NO			NE				
2.G.4 - Other (Please specify)	NE	NE	NE	NE	NE	NE	NE	NE
2.H - Other	NE	NE	NE	NE	NE	NE	NE	NE
2.H.1 - Pulp and Paper Industry	NE	NE	NE	NE				
2.H.2 - Food and Beverages Industry	NE	NE	NE	NE				
2.H.3 - Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE
3.A.1 Enteric Fermentation	CS		T1, T2					
3.A.2 Manure Management	CS		T2	T2				
3.C.1 Burning	CS		T1	T1				
3.C.2 Liming	CS	T1						
3.C.3 Urea application	CS	T1						
3.C.4 Direct N2O Emissions from managed soils	CS			T1				
3.C.5 Indirect N2O Emissions from managed soils	CS			T1				
3.C.6 Indirect N2O Emissions from manure management	CS			T1				
3.C.7 Rice cultivation	CS		T1					
3.C.8 CH4 from Drained Organic Soils	CS		T1					

3.C.9 CH ₄ from Drainage Ditches on Organic Soils	CS		T1*					
3.C.10 CH ₄ from Rewetting of Organic Soils	CS		T1*					
3.C.11 CH ₄ Emissions from Rewetting of Mangroves and Tidal Marshes	NO		NO					
3.C.12 N ₂ O Emissions from Aquaculture	CS			T1*				
3.C.13 CH ₄ Emissions from Rewetted and Created Wetlands on Inland Wetland Mineral Soils	NO		NE					
3.C.14 Other (please specify)								
3.B.1 Forest land	CS	T1						
3.B.2 Cropland	CS	T1						
3.B.3 Grassland	CS	T1						
3.B.4 Wetlands	CS	T1						
3.B.5 Settlements	CS	T1						
3.B.6 Other Land	CS	T1						
3.D.1 Harvested Wood Products	CS	T1						
3.D.2 Other (please specify)	NE							
4.A.1 - Managed Waste Disposal Sites	NO		NO					
4.A.2 - Unmanaged Waste Disposal Sites – Municipal	CS		T1					
4.A.2 - Unmanaged Waste Disposal Sites – Industrial	CS		T1					
4.A.3 - Uncategorised Waste Disposal Sites	NO		NO					
4.B - Biological Treatment of Solid Waste	CS		T1	T1				
4.C.1 - Waste Incineration	CS	T1	T1	T1				
4.C.2 - Open Burning	CS	T1	T1	T1				
4.D.1 - Domestic WW Treatment and Discharge	CS		T1	T1				
4.D.2 - Industrial Wastewater Treatment and Discharge –coffee processing	CS		T1	T1				

T1 – Tier 1 (IPCC, 2006); T1 – (IPCC, 2019); T2 – Tier 2 (IPCC, 2006); CS – Country specific, PS – Plant specific, NE – Not Estimated, NO – Not occurring; Grey colored cell – Not Applicable; Dark blue colored cells are for international bunkers and not part of the national emissions.*

Sources of Activity data

Principal sources of activity data used for each sector are shown in Table 7. 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 7: Activity data sources for the National Inventory

Category	Type of data	Data source and treatment method
1. Energy sector		
1.A.1 Energy industries	Quantities of diesel, peat and methane combusted in power plants	Energy Utility Corporation Limited (EUCL); Power plants
1.A.2 Manufacturing industries and construction	Biomass, RFO, diesel and peat combusted in industry and construction	RRA, NISR, Private enterprises
1.A.2a Iron and Steel industries	HFO fuel use	Iron and steel industries
1.A.2e Food, beverage and tobacco production	Biomass, RFO and peat consumption	Enterprises
1.A.2f Non-metal minerals	Quantities and types of fuel combusted	Cement industries
1.A.2i Mining and quarrying	Liquid fuel use	NISR
1.A.2k Construction	Diesel quantity	Rwanda Third National Communication
1.A.3a Aviation	Fuel used in aviation	RRA
1.A.3b Road transportation	Number of vehicles registered for each type of vehicle/ truck/ motorcycle	NISR
1.A.3d Waterborne navigation	Fuel consumption per boat, number of boats	REMA Survey
1.A.4a Residential and Commercial	Fuel consumed in commercial establishments, wood waste, fuelwood, charcoal and LPG use in households	Survey report; NISR
1.B Fugitive emissions from fuels	Quantity of primary and secondary fuels imported, and charcoal production quantity	RRA, Surveys of REMA and NISR
1.B.2b Natural gas	Quantity of natural gas used	REMA surveys

2. IPPU sector		
2.A Mineral Industry	Quantity of cement and lime produced	Cement industry, national statistics, REMA surveys
2.C Metal Industry	Iron and steel production; ferrochromium and ferromanganese production	Iron and Steel industries; ferroalloy industries
2.D Non-energy products from fuels and solvent use	Lubricant imports; paraffin wax imports	RRA
2.F Consumption of HFC/PFC and SF6	Quantity of refrigeration equipment and mobile air conditioning	ODA survey of REMA
3. A, C Agriculture sector		
3.A Livestock	Livestock species numbers and composition by age and breed, types and proportions of manure management systems, diet composition	NISR, MINAGRI, RAB, REMA, survey on livestock emission factors (2022), FAOSTAT
3.C Aggregate and non-CO2 emissions from managed land	The area burnt per land category, live and dead biomass, carbon stock in soil, lime and fertilizer quantity applied per each type, cropping system types and area and agricultural practices, including manure applied, biomass use, rice area and practices, area of drained organic soil and drainage ditches; fish production data, area of fish farming	MINAGRI, MINECOFIN, RAB, REMA, MINEMA, FAO online database on area burnt, NAEB, NISR, RWB
3. B, D LULUCF sector		
3.B Land	Area of each land class and changes since past 20-30 years; biomass and soil C stocks	Land cover maps 2000, 2019, data on land use from Master plans, NISR, MINAGRI, REMA, RWB, MINECOFIN, NISR, NLA, FAOSTAT, published papers; World Soil database (FAO/IIASA/ISRIC/ ISSCAS/JRC, 2012); Global Land Cover dataset, GLC2000 (EU-JRC, 2003); Gishoma and Hakan peat power plants, MININFRA

3.D Harvested Wood Products	Volume of harvested wood and wood products, wood characteristics	MINICOM, MoE, RFA, FAOSTAT
4. Waste sector		
4.A Solid Waste Disposal	Annual amount of solid waste deposited in dump sites waste generation per capita and served population; GDP to evaluate industrial waste.	MININFRA, NISR, MINECOFIN
4.B Biological Treatment of Solid Waste	National population, urban population, households using composting, quantity of municipal waste and its types, proportion of decomposable waste	MININFRA, NISR surveys, WASAC
4.C Incineration and Open Burning of Waste	Quantity of waste incinerated, and burnt openly, national population, per capita waste generation	NISR, REMA, MININFRA
4.D Wastewater Treatment and Discharge	National population, proportion of households under specific wastewater discharge system, national average protein supply per capita, industrial wastewater treatment data	MINALOC, MININFRA, NISR, REMA surveys on emission factors (2022)

Description of Metrics

In Rwanda National Inventory, the GWP values used were from the IPCC Fifth Assessment Report (IPCC, 2014) . The reference gas for GWP is carbon dioxide (CO₂) with GWP value equal to one. Thus, GWPs are expressed in carbon dioxide (CO₂) equivalents.

Table 8: GWP Values for GHGs used in Rwanda National Inventory 2006 - 2022

Gas	GWP (CO ₂ -eq.)
CO ₂	1
CH ₄	28
N ₂ O	265
HFC 134a	1,300

Quality Control and Quality Assurance

The general greenhouse gas (GHG) inventory QC was conducted in accordance with the 2006 IPCC Guidelines Volume 1, Chapter 6 using a QA/QC and verification template covering the procedures (REMA, 2023). The QC covered issues on: (1) data gathering, (2) data input, (3) data documentation, and (4) calculations. It involved checking the activity data, emission factors, analysis of emission trends, and achieving reference materials. The following specific procedures were followed to improve the Transparency, Accuracy, Consistency, Completeness and Comparability (TACCC) principles:

- A review of the Rwanda Greenhouse Gas (GHG) inventories and summary sections for the National Communications (NC1, NC2 and NC3), BUR1 and BTR1 was done in between to identify gaps and QA/QC issues. A review report was compiled, presented and validated with action points for the current inventory cycle.
- Trainings need assessment was conducted for the inventory compilers, and key stakeholders were trained on the compilation process and use of the IPCC software through an initiative from REMA.
- To ensure that all required datasets were covered, sector-specific data collection templates were developed, presented, and approved in review meetings. The templates covered required data, data providers and their contact details.
- All procedures on the selection of activity data, emission factors, conversion factors and their uncertainty values were peer reviewed in weekly progress meetings and documented.
- Before entering the data into the IPCC software, the data and their sources for each year were entered into MS Excel worksheets and checked for data gaps to allow a peer reviewed selection of splicing techniques to be applied for each data set.

A verification process involving comparison of national data with international sources, including the International Energy Agency (IEA), the Food and Agriculture Organisation of the United Nations (FAO), and the World Bank data on the four sectors. Besides, the validation workshop was organized by REMA for data providers, key stakeholders and National Nationally Determined Contribution (NDC) MRV Technical Committee to check the national inventory report.

Uncertainty Assessment

The uncertainty analysis by sub-categories has shown that the overall uncertainty for the inventory was 28.43%. The previous NIR for the BUR1 estimated the uncertainty to be 9.97%. These changes were attributed to the use of default emission factors and activity data with high uncertainty levels especially for the early inventory years (2006-2010). The next inventory cycle would therefore prioritize reducing the levels of uncertainty through establishment of country specific values. The trend uncertainty was high (417.18), and it should be priority and be addressed in the next national inventory.

Key Category Analysis

A total of 26 IPCC categories were identified as key categories by level assessment against the 21 identified in the previous NIR (Republic of Rwanda, 2021). The key categories by level are shown in (Table 9). Forestland remaining forestland and land converted to forestland, enteric fermentation,

road transportation and manure management were the most important taking 69% of greenhouse gas (GHG) emissions/removals.

For trend assessment, 19 categories were identified as key categories (Table 9). The biggest contributors to trend (78%) are the categories from Agriculture and LULUCF.

Table 9: Key Category

IPCC Category code	IPCC Category	Greenhouse gas
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO ₂)
3.B.1.b	Land Converted to Forest land	CARBON DIOXIDE (CO ₂)
3.A.1	Enteric Fermentation	METHANE (CH ₄)
1.A.3.b	Road Transportation - Liquid Fuels	CARBON DIOXIDE (CO ₂)
3.A.2	Manure Management	METHANE (CH ₄)
3.B.2.b	Land Converted to Cropland	CARBON DIOXIDE (CO ₂)
4.D	Wastewater Treatment and Discharge	METHANE (CH ₄)
4.A	Solid Waste Disposal	METHANE (CH ₄)
3.C.4	Direct N ₂ O Emissions from managed soils	NITROUS OXIDE (N ₂ O)
3.B.2.a	Cropland Remaining Cropland	CARBON DIOXIDE (CO ₂)
1.A.4	Other Sectors - Biomass - solid	METHANE (CH ₄)
3.A.2	Manure Management	NITROUS OXIDE (N ₂ O)
3.C.7	Rice cultivation	METHANE (CH ₄)
3.B.5.b	Land Converted to Settlements	CARBON DIOXIDE (CO ₂)
2.A.1	Cement production	CARBON DIOXIDE (CO ₂)
3.B.3.b	Land Converted to Grassland	CARBON DIOXIDE (CO ₂)
3.C.5	Indirect N ₂ O Emissions from managed soils	NITROUS OXIDE (N ₂ O)
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N ₂ O)
1.A.1	Energy Industries - Peat	CARBON DIOXIDE (CO ₂)
3.B.3.a	Grassland Remaining Grassland	CARBON DIOXIDE (CO ₂)
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CARBON DIOXIDE (CO ₂)
3.D.1	Harvested Wood Products	CARBON DIOXIDE (CO ₂)
4.B	Biological Treatment of Solid Waste	METHANE (CH ₄)
1.A.1	Energy Industries - Liquid Fuels	CARBON DIOXIDE (CO ₂)

3.C.6	Indirect N ₂ O Emissions from manure management	NITROUS OXIDE (N ₂ O)
4.B	Biological Treatment of Solid Waste	NITROUS OXIDE (N ₂ O)

2.4. OVERVIEW OF NATIONAL GHG EMISSIONS AND REMOVALS

Agriculture is the main emitting sector, accounting for 58% of total emissions. The energy sector contributes 22%, while the waste sector accounts for 18%, and the Industrial Processes and Product Use (IPPU) sector comprises 2%. These figures do not include Land Use, Land Use Change, and Forestry (LULUCF). Emissions by gas type indicate that methane remains the dominant greenhouse gas in Rwanda, constituting 53% of emissions in 2006 and 67% in 2022, primarily from enteric fermentation. Nitrous oxide (N₂O) emissions increased from 10% to 11% over the same period, while hydrofluorocarbons (HFCs) rose from 0% close to 1%.

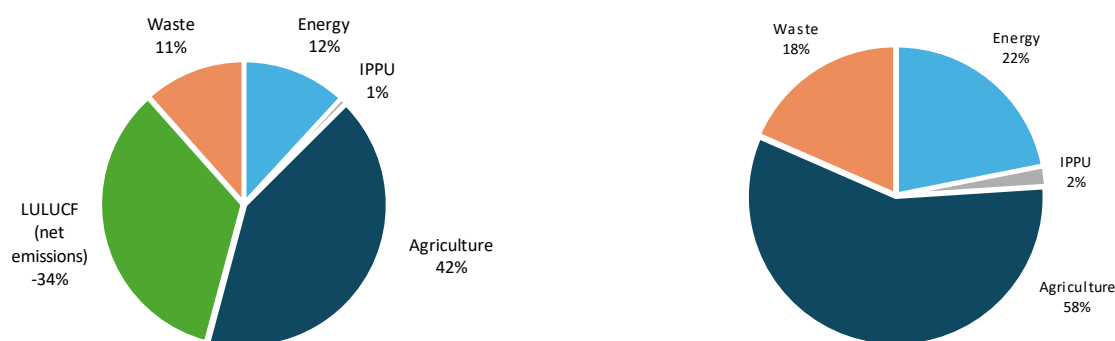


Figure 18: Share of Sector specific GHG inventories (**Left:** Including LULUCF and **Right:** Excluding LULUCF) in 2022

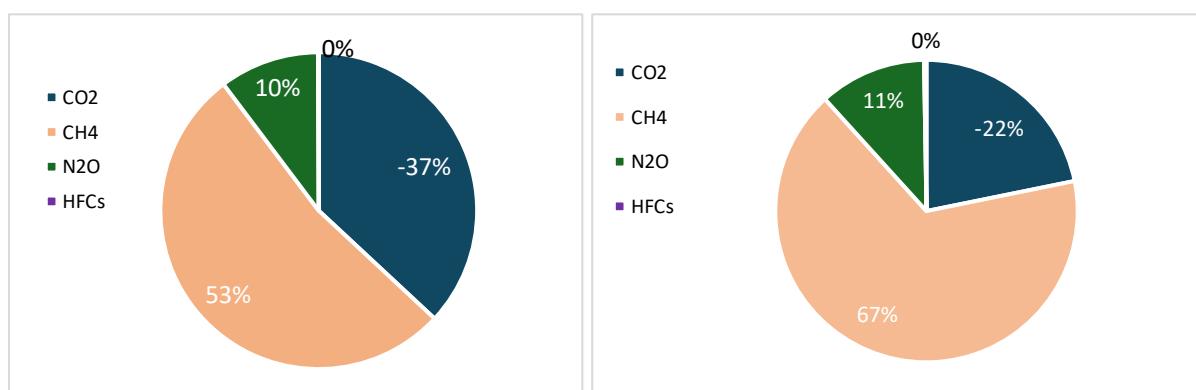


Figure 19: Share of Emissions Per Gas (**Left:** Year 2006 and **Right:** Year 2022)

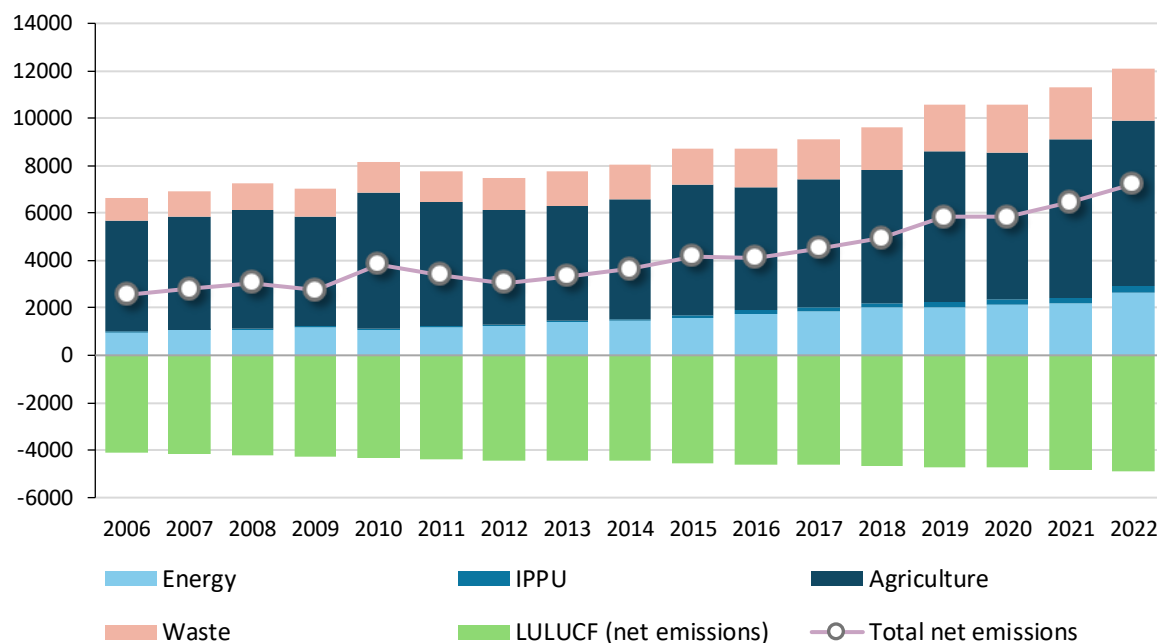


Figure 20: GHG Emissions Trend from 2006 – 2022 in Gg CO₂e

The total emissions rose from 6,657 Gg (2006) to 12,108 Gg (2022). This is an 82% increase over the time series. Despite year-to-year fluctuations, emissions rise steadily, the main growth was strongest after 2014. The agriculture sector is the largest source of emissions throughout the period, reflecting its central role in Rwanda's economy as it shares 21% in the national GDP, and employ around 65% people. The main emissions are sourced from livestock (enteric fermentation, and manure management).

As energy demand and consumption grow, they are linked to a consistent increase in emissions from the energy sector, particularly since 2015. This rise is driven by increased electricity generation, which has now reached 406.4 MW by early 2025, primarily from hydro, methane, solar, and peat sources. Hydro (renewable energy) and thermal (fuel oil/diesel, methane) account for the largest shares. Additionally, the demand for transportation and the prevalence of old cars contribute to rising emissions from mobile combustion. Furthermore, urbanization and economic growth lead to increased energy consumption mainly at the household and institutional level, further exacerbating emissions.

IPPU emissions remain relatively small but show a gradual increase, linked to industrial development (cement, manufacturing). While, Waste sector emissions grow steadily, reflecting population growth, urban expansion, and increased solid waste and wastewater generation. Table 10 summarize the GHG emissions per sector from 2006-2022 indicating yearly values.

Table 10: Summary of GHG Emissions Per Sector from 2006 - 2022

Gg CO ₂ e	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Energy	965.8	1040.9	1094.2	1190.9	1091.0	1178.0	1258.5	1384.8	1487.1	1567.5	1768.9	1874.4	2019.6	2032.1	2151.5	2220.6	2649.2
IPPU	46.4	45.3	45.7	40.7	42.9	44.6	45.8	50.4	57.4	91.8	138.3	161.7	167.3	197.8	217.3	215.0	253.3
Agriculture	4648.4	4749.8	5013.9	4617.2	5746.6	5227.3	4823.2	4879.1	5033.8	5514.4	5189.7	5398.9	5629.9	6399.0	6174.4	6700.4	6971.3
LULUCF (net emissions)	-4107.5	-4133.3	-4192.0	-4260.1	-4316.6	-4376.7	-4416.4	-4464.2	-4426.0	-4539.2	-4588.6	-4627.9	-4659.3	-4703.9	-4746.9	-4820.9	-4884.2
Waste	996.9	1101.2	1101.2	1157.6	1269.6	1328.4	1328.4	1473.1	1477.0	1532.1	1616.1	1699.0	1787.7	1921.7	2029.2	2141.4	2234.1
Total emissions (excl LULUCF)	6657.5	6937.2	7255.1	7006.3	8150.1	7778.2	7455.9	7787.4	8055.3	8705.8	8713.0	9134.0	9604.5	10550.6	10572.4	11277.4	12107.9
Total emissions (incl LULUCF)	2550.0	2803.9	3063.1	2746.2	3833.5	3401.6	3039.5	3323.2	3629.4	4166.7	4124.4	4506.1	4945.2	5846.7	5825.5	6456.5	7223.7

2.5. SUMMARY OF SECTOR SPECIFIC GHG INVENTORIES

2.5.1. Energy Sector

In 2022, total greenhouse gas (GHG) emissions from the Energy sector reached 2,649.24 Gg CO₂eq, comprising 1,819.4 Gg of carbon dioxide (CO₂), 680.3 Gg of methane (CH₄), and 149.3 Gg of nitrous oxide (N₂O). The largest share of emissions came from the Transport sector, accounting for 47%, followed by Other Sectors at 30%. Energy Industries contributed 14%, while Manufacturing Industries made up the remaining 9%.

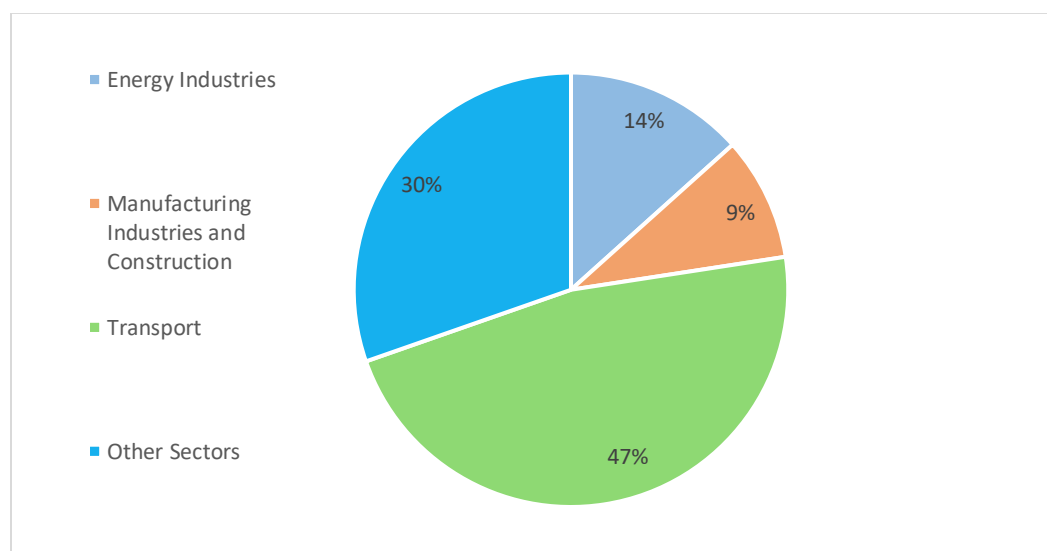


Figure 21: Energy sector greenhouse gas (GHG) emissions share by category in 2022, Gg CO₂ eq.

Trends in energy emissions by category

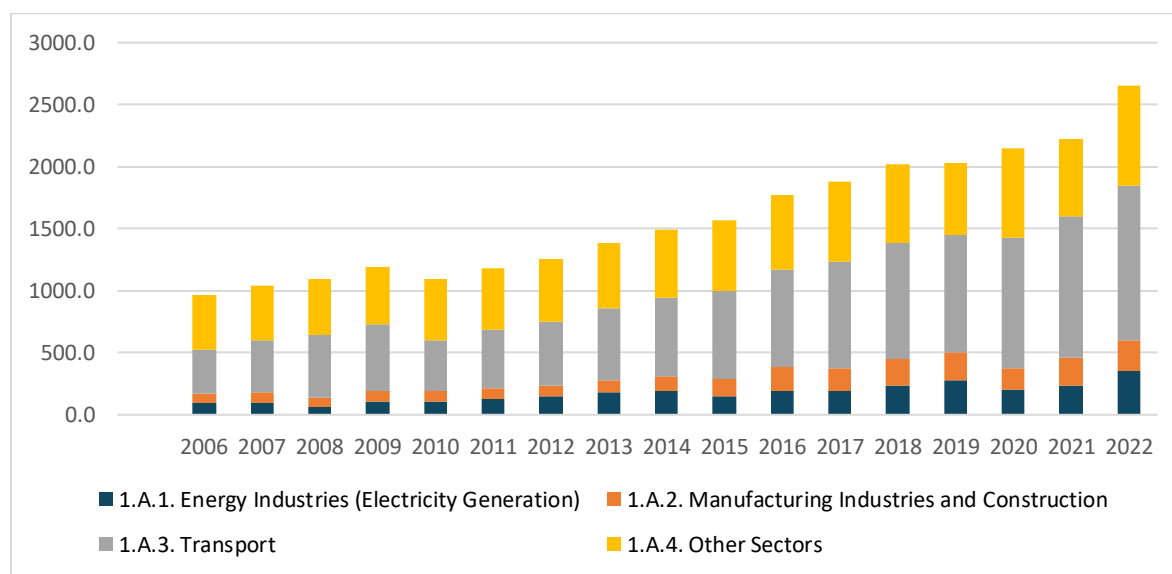


Figure 22: Trends in energy emissions by category and by gas from 2006 to 2022, Gg CO₂ e

From 2006 to 2022, greenhouse gas emissions from Rwanda's energy sector show a clear upward trend across all fuel combustion subcategories, although the pace of growth differs among them. The transport sector exhibits the most rapid and consistent increase, rising from 359.8 GgCO₂e in 2006 to 1247.3 GgCO₂e in 2022, reflecting expanding vehicle numbers, increased fuel consumption, and growing mobility demand. Other sectors, including residential, commercial, and agriculture, also display a steady increase over time, growing from 438.7 GgCO₂e to 804.0 GgCO₂e, with minor fluctuations but an overall upward movement driven by rising energy use in households and services.

Emissions from electricity generation grow significantly as well as starting at 91.7 GgCO₂e in 2006 and reaching 354.0 GgCO₂e in 2022 showing increased electricity demand due to the increase of populations. Meanwhile, manufacturing industries and construction experience moderate but continuous growth, moving from 75.6 GgCO₂e to 244.0 GgCO₂e, with stability in the early years and stronger growth after 2013 due to expanding industrial activities. Generally, the energy sector's emissions have risen substantially over the last 17-year period, with the transport sector emerging as the dominant and fastest growing source.

Memo Items in 2022

In 2022, the memo items under category, greenhouse gas emissions are dominated by CO₂, with a total of 14,853.67 Gg CO₂e, compared to very small amounts of 0.04648 Gg CO₂e of CH₄ and 1.752816 Gg CO₂e of Nitrous oxide. The largest contributor within this category is CO₂ emissions from biomass combustion, which account for 14,617.19 Gg CO₂, reflecting Rwanda's high dependence on biomass fuels such as firewood and charcoal in cooking. International bunkers, specifically aviation, constitute the second major component, contributing a total of 119.1397 Gg CO₂e, representing emissions from international flights departing Rwanda. In general, the memo items illustrate that biomass use, and international aviation are the only significant sources in this category, with biomass CO₂ making up nearly the entire total.

2.5.2. IPPU Sector

The Industrial Processes and Product Use (IPPU) sector covers emissions from the mineral industry (cement and lime), metal industry (iron, steel, and ferroalloy), fuel and solvent use (lubricants and paraffin wax), and product uses substituting ozone-depleting substances (refrigeration and air conditioning). From 2006 to 2022, emissions from Rwanda's IPPU sector show a steady and significant overall increase, driven mainly by growth in cement production and refrigeration as well as air conditioning use.

Trends in IPPU Emissions by Category

Cement production remains the dominant source of IPPU emissions throughout the period, rising from 38.9 GgCO₂e in 2006 to 208.3 GgCO₂e in 2022. The most notable surge occurs after 2014, reflecting expansion in Rwanda's construction industry and increased cement demand. Emissions from lime production remain low and relatively stable, fluctuating slightly between 0.6 and 3.7 GgCO₂e. In the metal industry, emissions from iron and steel production begin at zero and increase gradually from 2011 onward, reaching 7.1 GgCO₂e in 2021 before slightly decreasing to 5.9 GgCO₂e in 2022, showing moderate growth linked to industrial development.

Lubricant as non-energy products emissions rose around 1 to 4.5 GgCO₂e, in 2006 and 2022 respectively. In contrast, emissions from product uses as substitutes for ozone-depleting substances show a clear and

continuous increase. Refrigeration and air-conditioning use rise significantly from 5.1 GgCO₂e in 2006 to 32.6 GgCO₂e in 2022, reflecting economic growth, increased urbanization, and rising demand for cooling systems. The IPPU sector shows strong upward growth, driven primarily by cement manufacturing and refrigerant use, while other subcategories contribute only marginal emissions with minimal variation over time.

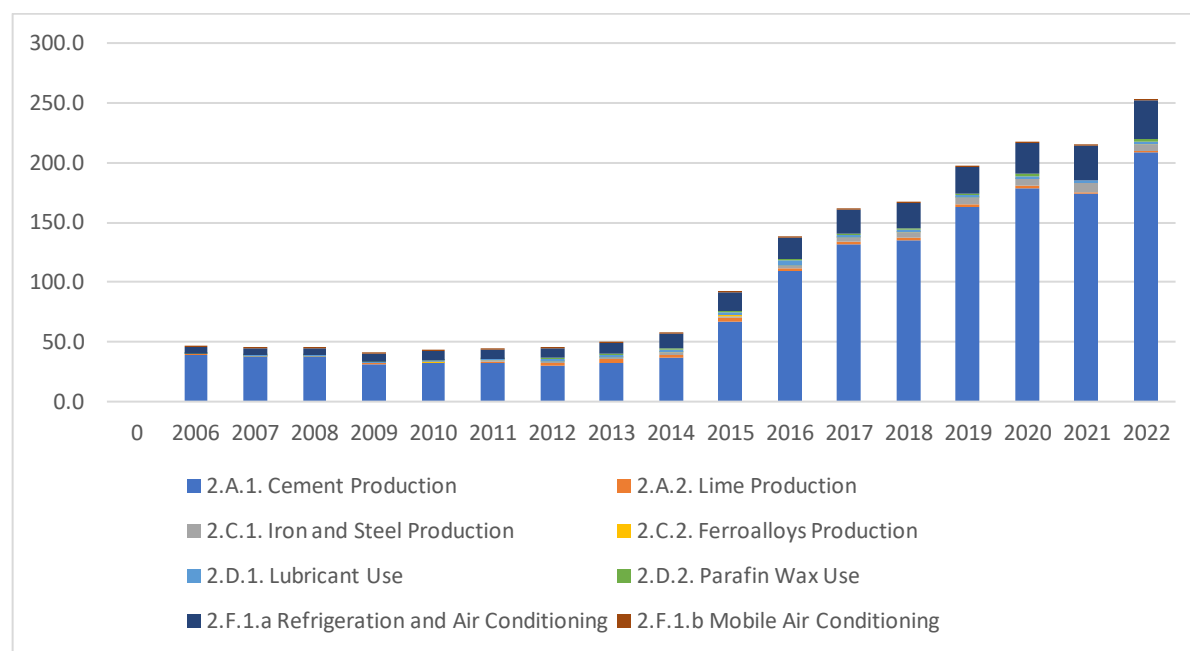


Figure 23: IPPU sector greenhouse gas (GHG) emissions trend, 2006–2022

The main gases emitted by the IPPU sector were carbon dioxide (CO₂), methane (CH₄), and hydrofluorocarbons (HFCs). From 2006 to around 2007, CO₂ accounted for more than 98% of total IPPU emissions. However, its share gradually declined to below 80% by 2012 due to increasing contributions from HFCs and emissions from iron and steel production. The availability of more detailed activity data after 2012 further revealed the growing significance of HFC emissions. Despite this shift, CO₂ remained the dominant gas throughout the period 2006–2022, reaching 219.6 Gg CO₂eq in 2022, followed by HFCs at 32.6 Gg CO₂eq.

In 2022, the major emission sources within the IPPU sector were cement production (82%), refrigeration and air conditioning (13%), iron and steel production (2%), lubricants (1%), and lime production (1.5%). The steady increase in cement production driven by Rwanda's expanding construction and infrastructure development has been the largest contributor to the rise in IPPU emissions.

2.5.3. Agriculture Sector

The agriculture sector is the largest contributor to greenhouse gas emissions in the country, mainly emitting methane (CH₄) from livestock and nitrous oxide (N₂O) from managed land. In 2022, agricultural emissions were 6971.3 Gg CO₂eq split between Livestock production (81%) and aggregate sources of non-

CO₂ emissions from land (19%). Methane and nitrous oxide were the dominant gases, accounting for about 84% and 16% of emissions, respectively, while carbon dioxide (CO₂) contributed less than 1%.

Trends of agriculture emissions by category

The agriculture sector remains the key sector contributing to greenhouse gas emissions in the country with 58% in 2022. The agricultural sector is the main source of CH₄ emissions (mostly from livestock enteric fermentation and manure management) and N₂O emissions from managed land and manure management. The key categories contributing to agriculture emissions were and remain enteric fermentation from ruminant animals, mainly dairy cows, and manure management, followed by Direct N₂O emissions from managed soil.

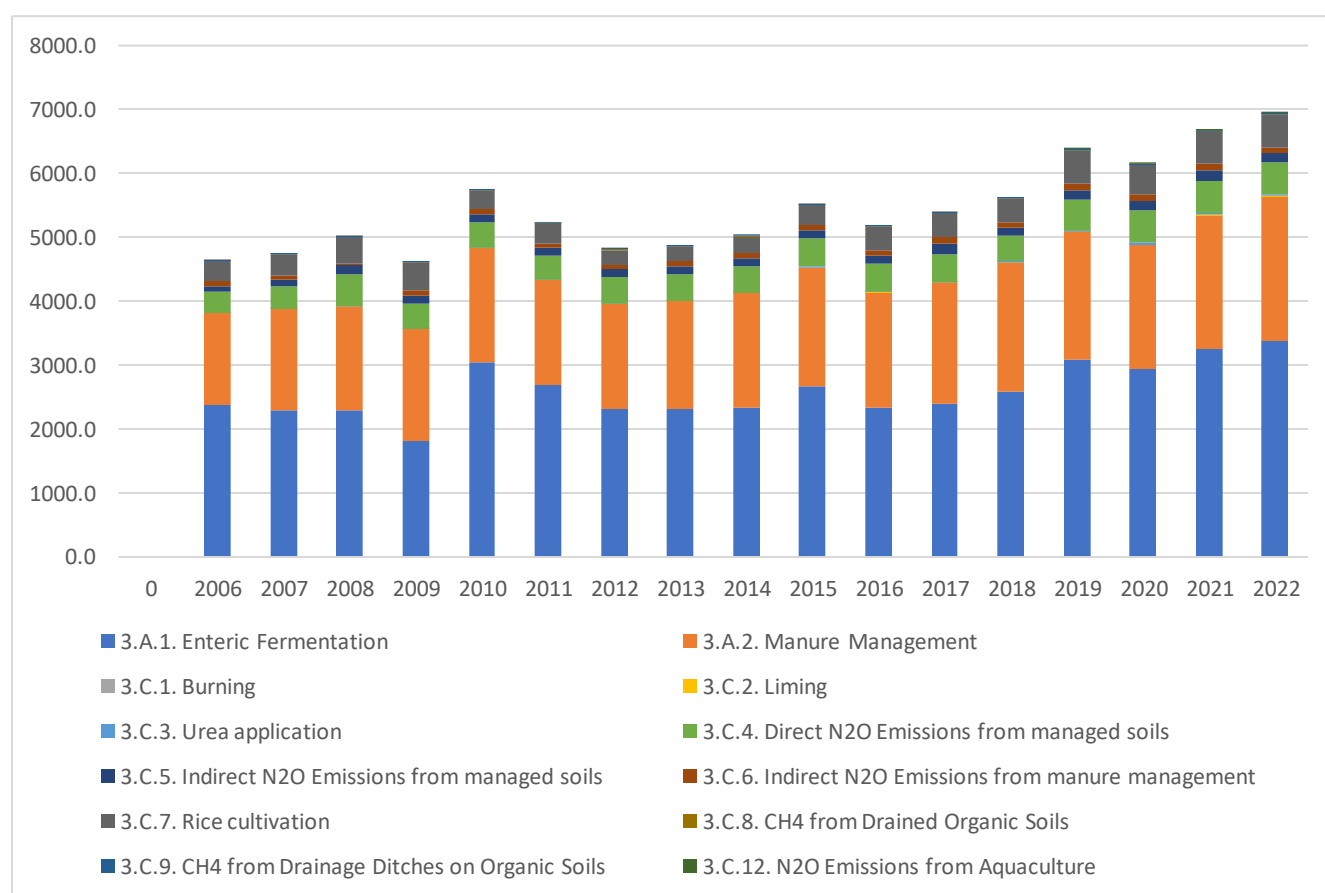


Figure 24: Agriculture greenhouse gas (GHG) emission trend by category, 2006-2022

2.5.4. Land Use, Land Use Change and Forestry

Forestry is an important economic activity in Rwanda where its contribution was about 618 million USD contributing 5.9% in national GDP. Forests of Rwanda occupy now about 724,695 ha of the total country land (30.4%) of which 387,425 ha (53.5%) are plantations and 130,850 ha (18.1%) are natural mountain rainforests, 161,843 ha are wooded savannah (22.3%) and 43,963 ha are shrubs (6.1%) (MoE, 2019), while

bamboo stands occupy only 613 ha. In terms of the density, about 318,434 ha are very dense forests (44%), 234,004 are moderately dense (32%), 146,222 ha are sparse (20%), and only 26,035 ha are much degraded (4%). In terms of regional leverage, South and Western Province have a big share (50% of total forests) with 174,199 hectares in West and 177,537 hectares in South. Eastern provinces take up to 38% of the total forestland (274,630 ha). Northern Province contains only 85,688 ha, and Kigali city remains with 12,641 ha.

Other land use classes include Cropland extending to about 1,343,933 ha; Grassland defined by national statistics as rangeland (used as pasture for dairy cows) and occupying 144,490 ha, Settlements (rural on 78,928 ha and urban 31,612 ha; bare land or land covered with rocks on 15,404 ha. Besides, Rwanda has different categories of wetlands: cultivated wetlands (except rice) 55,807 ha; rice cultivation 21,848 ha; non-cropped wetlands: protected – 12,201 ha and unprotected - 37,743 ha; and National parks of 241,455 has considered as savanna or shrub area under Forestland in this report.

Trends of LULUCF Emissions by Category

LULUCF is the only sector contributing to removals due to sink from Forestland and from harvested wood, this reduced -5011.3 Gg CO₂e. Rwanda's land use is made up of a diversity of protected natural ecosystems and managed ecosystems in which agriculture and forestry are the main land uses taking up more than 70% of the country's total land area.

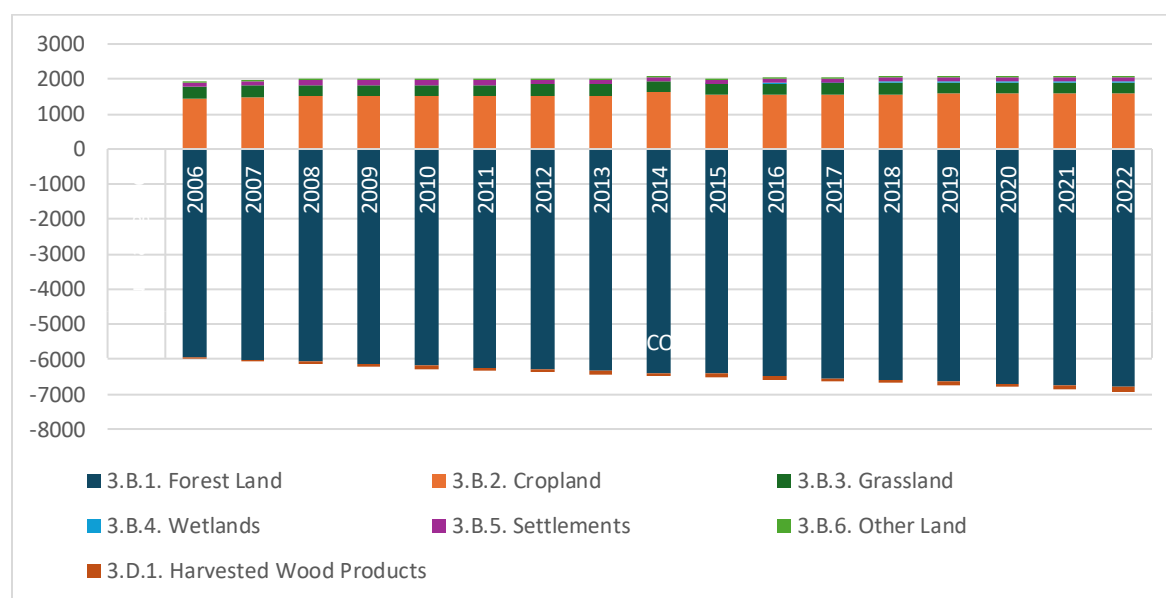


Figure 25: LULUCF greenhouse gas (GHG) emission trend by category, 2006-2022

The observed light rises in emissions between 2014 and 2015 was largely a result of changes in the Cropland subcategory. Up to 2014, the CO₂ removal capacity of perennial crops (coffee and tea plantations) was increasing and offsetting some emissions from cropland because of conversion of forest land to cropland. However, in 2015 there was a record decline in areas under coffee from about 55,000 ha to about 36,000 ha, and since then the area has never fully recovered.

2.5.5. Waste

Overview

Figure 26 summaries the GHG inventory trend of Waste sector at the national level from 2006 up to the reporting year 2022. The total net emissions were 2234.1 Gg CO₂ eq. for the sector in 2022. Domestic Wastewater Treatment and Discharge (4.D.1) dominated the emissions from the Waste sector which was associated mainly with the increase in urban population and to a lesser extent increase in industries. Rwanda's manufacturing industry is relatively growing and dominated by food processing, beverages, and tobacco with a collective GDP contribution below 4% in 2006 and 6% in 2022 (NISR, 2023). This could explain the relatively low discharge volumes and subsequently low GHG emissions from industrial wastewater discharge in comparison with the same from domestic wastewater discharge.

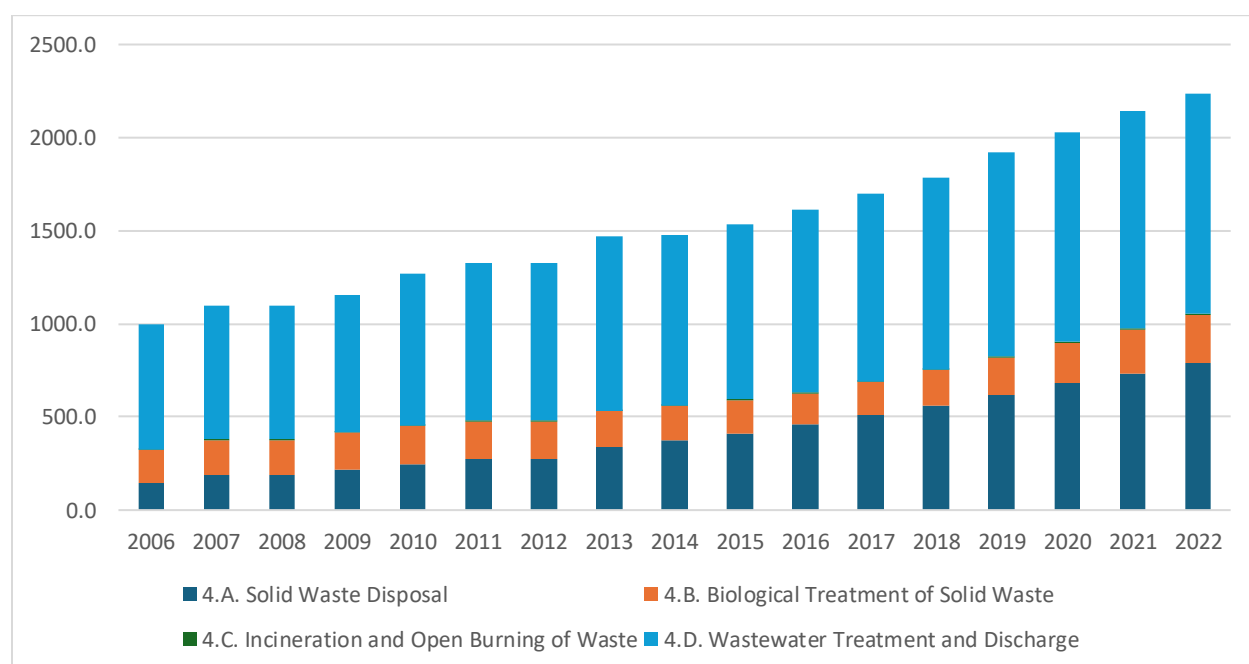


Figure 26: Waste sector greenhouse gas (GHG) emissions trend by category, 2006-2022

Trends of waste sector emissions by category

Total emissions of greenhouse gas (GHG)s from the Waste sector have doubled and reached 2,234.1Gg carbon dioxide (CO₂) eq. Methane emissions had the highest contribution to the levels of greenhouse gas (GHG) emissions in the waste sector, followed by N₂O and lastly carbon dioxide (CO₂). Most of the CH₄ emissions in 2022 emanated from wastewater treatment and discharge (53%), followed by solid waste disposal sites (35%), composting of solid waste (12%), and Incineration with almost insignificant % of the sector emissions. In all these source activities there is currently no CH₄ recovery or flaring activities in Rwanda.

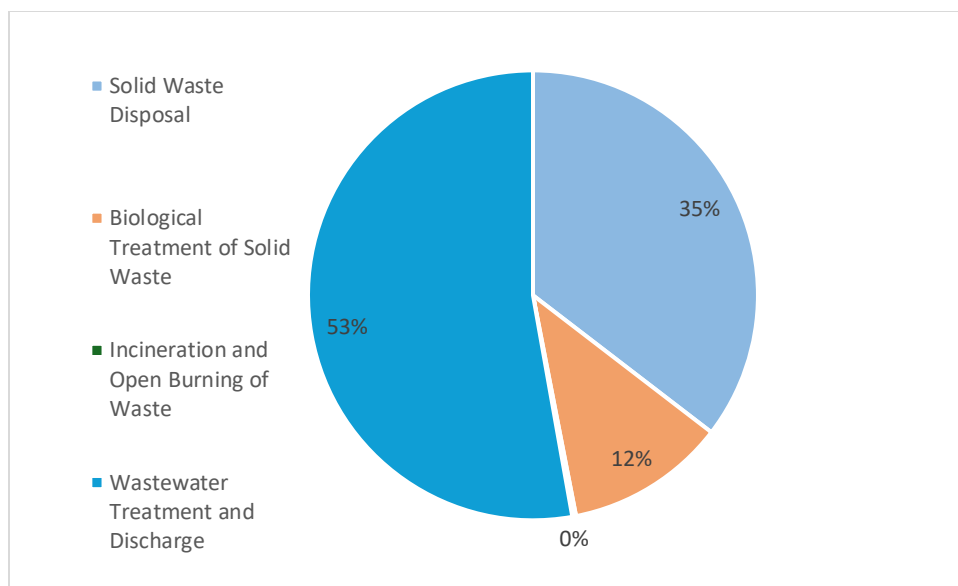
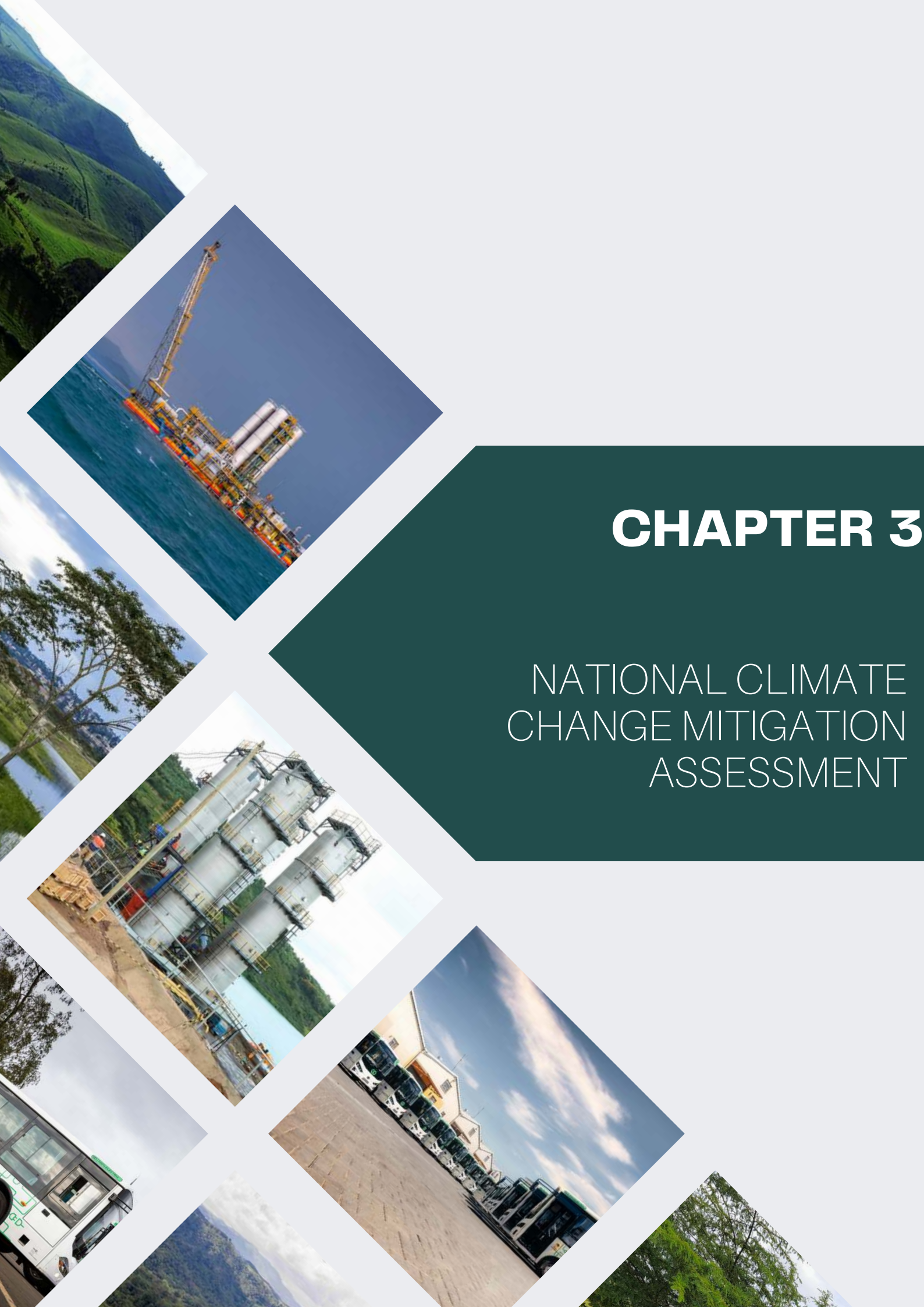


Figure 27: Waste Sector Greenhouse gas (GHG) Emission trend by Category for 2022



CHAPTER 3

NATIONAL CLIMATE CHANGE MITIGATION ASSESSMENT

Chap 3: NATIONAL CLIMATE CHANGE MITIGATION ASSESSMENT

3.1. INTRODUCTION

Climate change presents major challenges for Rwanda, which, despite its minimal contribution to global emissions, is highly vulnerable due to its reliance on climate-sensitive sectors. Through its Fourth National Communication (NC4) to the UNFCCC, Rwanda assessed mitigation options across Energy, IPPU, Agriculture, LULUCF, and Waste, aligning with national strategies like Vision 2050, NST2, the GGCRS, and updated NDCs. Using tools such as LEAP and IPCC guidelines with stakeholder input, the assessment prioritized practical, cost-effective measures that support both climate goals and development. Projections show emissions could triple by 2035 under business-as-usual, but interventions such as expanding hydropower, promoting electric mobility, reducing industrial fluorinated gases, adopting sustainable farming practices, and capturing landfill methane could curb emissions significantly, some at net economic savings. This approach highlights Rwanda's proactive integration of climate action with economic growth, social equity, and resilience.

3.2. METHODOLOGICAL APPROACH

The mitigation assessment for Rwanda's sectors (Energy, IPPU, agriculture, LULUCF, and Waste) used a standardized methodology aligned with GHG inventory parameters (IPCC, 2006; IPCC, 2019) and Stockholm Environment Institute guidelines (UNFCCC, 2022). Key steps included:

- **Emissions Review:** Analysing current GHG inventories to determine emission intensities.
- **Baseline Scenario:** Projecting future emissions (2022–2035) under a Business-as-Usual (BAU) path without additional mitigation policies, factoring in population growth, urbanization, GDP, and sector-specific trends.
- **Mitigation Options:** Identifying, screening, and prioritizing actions based on cost, emission reduction potential, alignment with development goals, technology availability, and co-benefits.
- **Mitigation Scenario:** Estimating GHG reductions achievable through selected interventions compared to BAU.

Emission reductions are calculated as:

$$ER = \text{Baseline Emissions (BE)} - \text{Project Emissions (PE)}$$

Baseline represents emissions without mitigation, while project emissions reflect emissions after applying mitigation measures.

The assessment uses models (e.g., LEAP) and methodologies similar to the Clean Development Mechanism (CDM). Energy sector projections consider electricity demand growth (~12% annually). Industrial emissions were forecasted using GDP- and population-linked regressions, while cement production assumes a 10% growth rate. Transportation emissions were modelled from vehicle fleet growth (linked to GDP/population), fuel use, and IPCC factors. Building emissions scale with GDP and population trends.

Population is projected to grow from 13.2 million in 2022 to 17.5 million by 2035 (1.9% annual growth, (NISR, 2023)), while GDP shows historical volatility but is expected to recover and expand long-term.

For IPPU and Waste sectors, projections extend baseline emissions to 2035 based on updated national indicators, GDP, population, and urbanization-driven waste generation. Waste sector modelling accounts for disposal and treatment trends but assumes no major technology changes. Cumulative GHG emissions are reported in CO₂ equivalents and adjusted for demographic and economic growth. Overall, this analysis establishes Rwanda's BAU emissions trajectory and identifies practical, cost-effective mitigation pathways for reducing emissions across all major sectors.

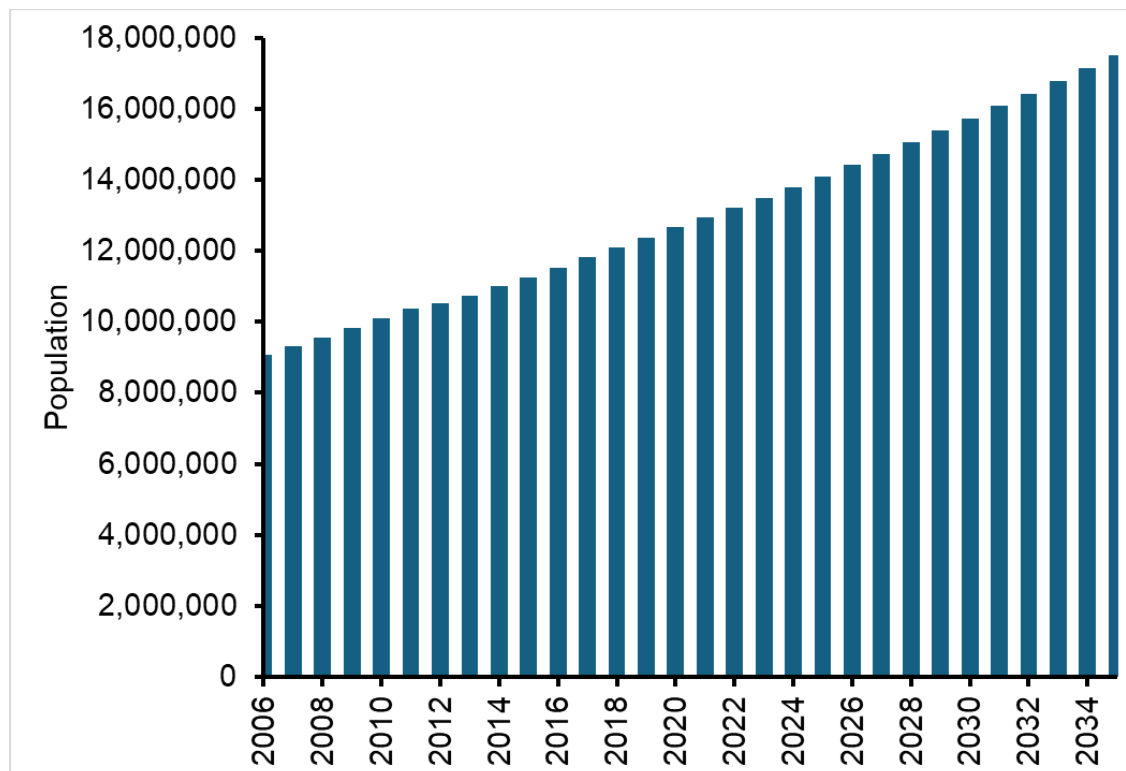


Figure 28: National Population and its Projection

Source: NISR

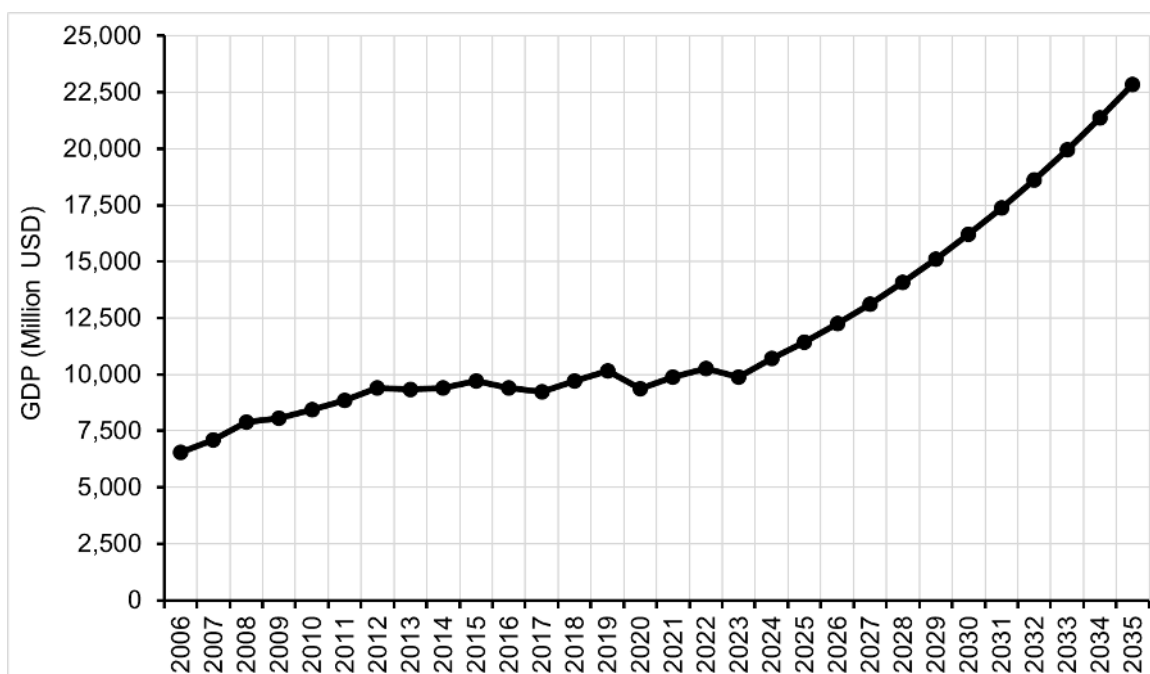


Figure 29: Projected GDP for Rwanda of 2006-2035

Source: NISR, 2015-2024. National Accounts 2015-2024

3.3. RWANDA BAU EMISSION PROJECTIONS

Under the Business as Usual (BAU) scenario, Rwanda's projected greenhouse gas emissions reveal a nation on a steep upward trajectory for the period 2022-2035. Figure 30 shows Rwanda's BAU emissions projections trends for all the sectors. Over this period, total emissions excluding land-use changes are forecasted to more than double from 12,107.9 GgCO₂eq in 2022 to 31,712 GgCO₂eq by 2035. This acceleration is primarily fuelled by explosive growth in transportation emissions, which will surge nearly fivefold from 1,274 to 6,002 GgCO₂eq as urbanisation intensifies. Meanwhile, agricultural activities, especially enteric fermentation from livestock and manure management, will maintain their dominance, rising from 3,381.6 to 7,450 GgCO₂eq and 2,255.2 to 5,418 GgCO₂eq, respectively. The waste sector also emerges as a critical pressure point, with both solid waste and wastewater emissions doubling to exceed 2,800 GgCO₂eq each by 2035, reflecting rapid urban expansion.

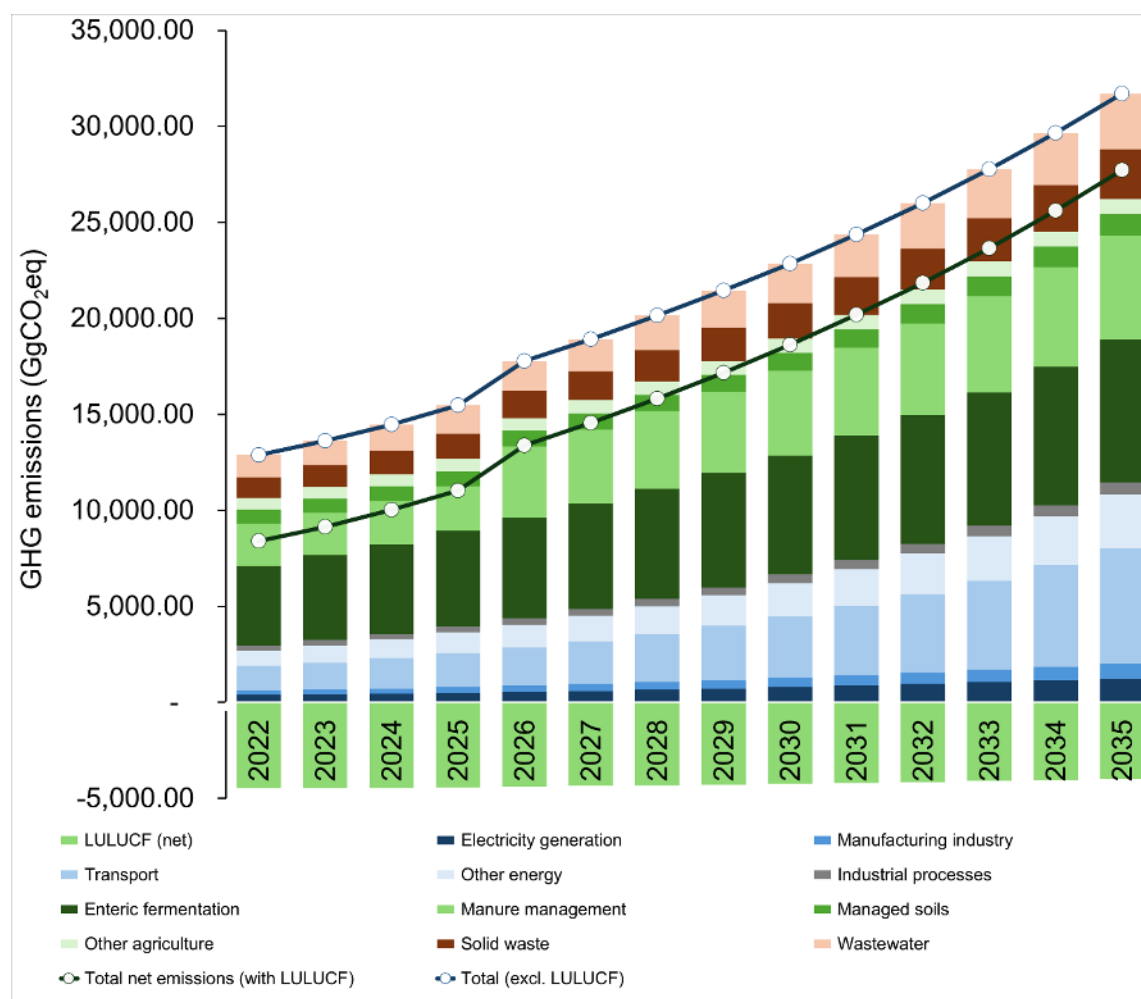


Figure 30: Rwanda's BAU Emissions Projection (2022-2035)

The land-use sector (LULUCF), which offset 35% of emissions in 2022, will see its sequestration capacity decline by 11% to just -3,983 GgCO₂eq by 2035, reducing its offset contribution to 14% of gross emissions. Consequently, net emissions including LULUCF will increase from 7,224 to 27,729 GgCO₂eq over the period. This trajectory highlights a pivotal challenge: sustaining development while containing emissions that threaten to outpace natural mitigation within a single decade.

3.4. MITIGATION ACTIONS AND THEIR EFFECTS

Under the Business-As-Usual (BAU) scenario, emissions surge dramatically over this period, starting at 7,224 GgCO₂eq in 2022 and climbing to 27,729 GgCO₂eq by 2035. By contrast, the Mitigation Scenario achieves significant reductions, holding 2035 emissions to 14,265 GgCO₂eq. Though still higher than 2022 levels, this represents a cumulative avoidance of 134,635 GgCO₂eq compared to BAU, equivalent to removing three years of current global emissions.

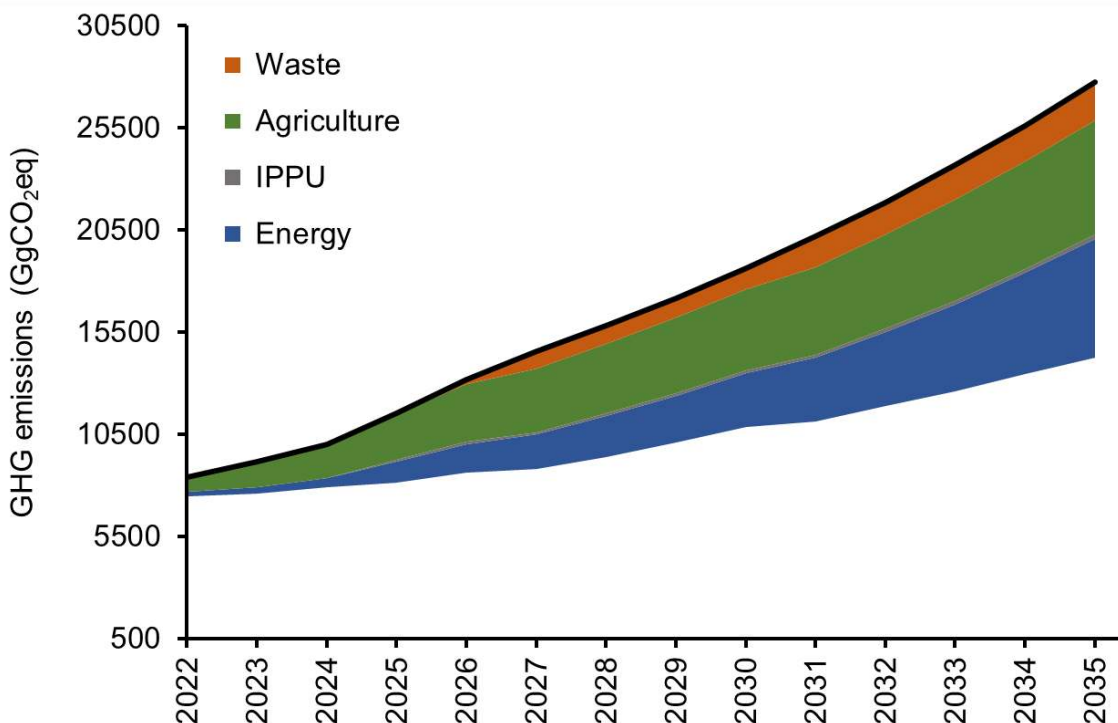


Figure 31: Rwanda's Mitigation Scenarios (2022-2035)

Sectoral dynamics reveal where mitigation succeeds and falls short. Agriculture emerges as an early leader, slashing 3,612 GgCO₂eq between 2022–2024 through sustainable farming practices. Energy follows a transformative path, starting modestly but accelerating to deliver 5,822 GgCO₂eq reductions by 2035, the largest single-sector contribution. Its progress accelerates after 2025 when policy shifts trigger renewable energy adoption. The Waste sector stages a remarkable turnaround after 2026, jumping from negligible impact to 1,863 GgCO₂eq reductions by 2035, suggesting breakthroughs in landfill methane capture or circular economy models. Industrial processes (IPPU), however, lag persistently, contributing under 200 GgCO₂eq annually.

The year 2025 marks a pivotal shift when all sectors actively contribute, driving mitigation to 3,398 GgCO₂eq, more than double the previous year. By 2027, Waste sector innovations will trigger the steepest annual drop. Agriculture's momentum plateaus after 2030, while IPPU's minimal impact exposes gaps in decarbonising heavy industry.

Figure 32 shows the sectoral contribution to total emissions reduction in 2035. 13,463.56 gigagrams of CO₂ equivalent (GgCO₂eq). As evidenced from the figure, energy sector is the main contributor, accounting for 43% of the total emissions reduction, followed by the agriculture sector at 42%, nearly matching energy's dominant share. Together, these two sectors represented 85% of the total emission reduction.

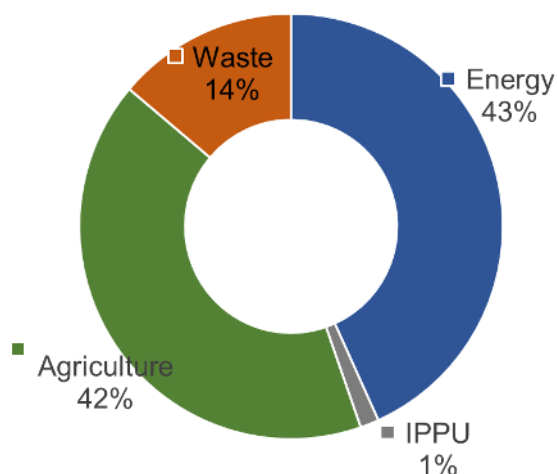


Figure 32: Sectoral Contributions to Greenhouse Gas Emissions Reduction in 2035

Beyond these major contributors, waste sector represented a significant third source at 14% of total emission reduction. Meanwhile, industrial processes and product use (IPPU) will play a minimal role, contributing just 1% to the overall emission reduction profile. This distribution highlights where mitigation efforts would yield the greatest results: any substantial reduction strategy must prioritize transforming energy systems and agricultural practices, while also addressing waste management's notable emissions. The negligible contribution from industrial processes suggests this sector requires less immediate intervention compared to the others.

3.5. SECTORAL MITIGATION ASSESSMENT

3.5.1. Energy Sector

Rwanda's energy sector is a key contributor to greenhouse gas emissions, balancing economic growth with climate challenges. Most energy consumption comes from renewable biomass (fuelwood, charcoal, biogas), but wood fuel use (76% of households) drives deforestation and reduces carbon sequestration. Industries and transport still rely heavily on fossil fuels (diesel, gasoline), while peat remains vital for manufacturing and power generation.

Business-as-usual (BAU) projections from Rwanda's NDC 2.0 estimate energy-related emissions will rise from 31% to 40% of national emissions by 2030, driven by urbanisation and industrial growth. To counter this, the Energy Sector Strategic Plan (ESSP) aims to expand renewable energy infrastructure and cut high-emission practices. Measures include promoting efficient cookstoves, biogas, LPG, and electric cooking systems; modernising the grid to cut transmission losses; deploying LED streetlights; and enforcing solar water heating in new urban buildings.

Despite these strategies, fossil fuel use in transport and industry and reliance on biomass in households and commercial sectors continue to make energy a major source of Rwanda's GHG emissions.

Energy Sector Policies

The existing Energy Sector Strategic Plan (ESSP) has significantly advanced Rwanda's energy sector towards sustainability and resilience. It has achieved substantial improvements in electricity access, reliability of

energy supply, and promotion of renewable energy sources. As of June 2024, electricity installed capacity was about 406.4 MW. The increasing use of renewable energy for power generation has played a pivotal role in maintaining low energy emissions per capita over the years.

The Energy Sector Strategic Plan (ESSP) 2024/25–2028/29, aligned with Rwanda's commitments to the NDC, the Green Growth and Climate Resilient Strategy (GGCRS), prioritises the integration of climate change adaptation and mitigation measures. The Rwanda ESSP sets forth the following objectives:

- I. Ensure universal energy access for households and industries, with a focus on underserved communities and marginalised populations.
- II. Enhance the reliability, affordability, and sustainability of energy services to promote economic growth and improve living standards.
- III. Integrate climate change adaptation and mitigation measures across all facets of the energy sector to build resilience and reduce greenhouse gas emissions.
- IV. Foster innovation and investment in renewable energy sources and energy efficiency technologies to diversify the energy mix and mitigate environmental impacts.
- V. Strengthen institutional capacity and governance frameworks to facilitate effective implementation, monitoring, and evaluation of sectoral policies and programs.
- VI. Foster partnerships and collaboration with stakeholders, including government agencies, private sector entities, civil society organisations, and development partners, to mobilise resources and drive collective action towards achieving sectoral goals.

These objectives and the policies outlined in the updated ESSP were the central reference to policy actions and measures (PAMs) evaluated in this chapter.

Energy Sector BAU Scenario

The energy sector's GHG emissions BAU scenario was modelled using Rwanda's updated GHG inventory data spanning the 2006–2022 period. These projections establish a reference baseline for evaluating potential emissions reductions under alternative mitigation pathways. The energy sector BAU modelling approach is based on detailed bottom-up activity and GHG projections developed for the considered subsector through 2035. These reflect some assumptions that determine changes, i.e., energy supply and demand, sector output, technology uptake, and policy choices. The modelling heavily draws upon and updates the emissions projections work undertaken as part of the updated NDC. These provide emissions projections for Rwanda through 2035 using the Low Emissions Analysis Platform (LEAP) software system developed by the Stockholm Environment Institute and supplemented by various Excel-based calculations (Heaps, 2022).

Figure 33 shows the trajectory of the energy sector's BAU emissions from 2022 to 2035. Under the BAU scenario, GHG emissions are expected to grow from a baseline of 2,649.2 GgCO₂eq to 10,822 GgCO₂eq. This relentless increase, averaging 15% annual growth, reflects a business-as-usual path where fossil fuel dependency deepens alongside economic modernisation efforts.

Electricity generation emerges as the dominant driver throughout the timeline, its emissions increasing from 354 GgCO₂eq to 1231 GgCO₂eq. By 2035, this single sector will account for over half of Rwanda's total

energy emissions. Transport follows as the secondary contributor, accelerating sharply after 2028 as vehicle ownership likely surpasses infrastructure modernisation efforts.

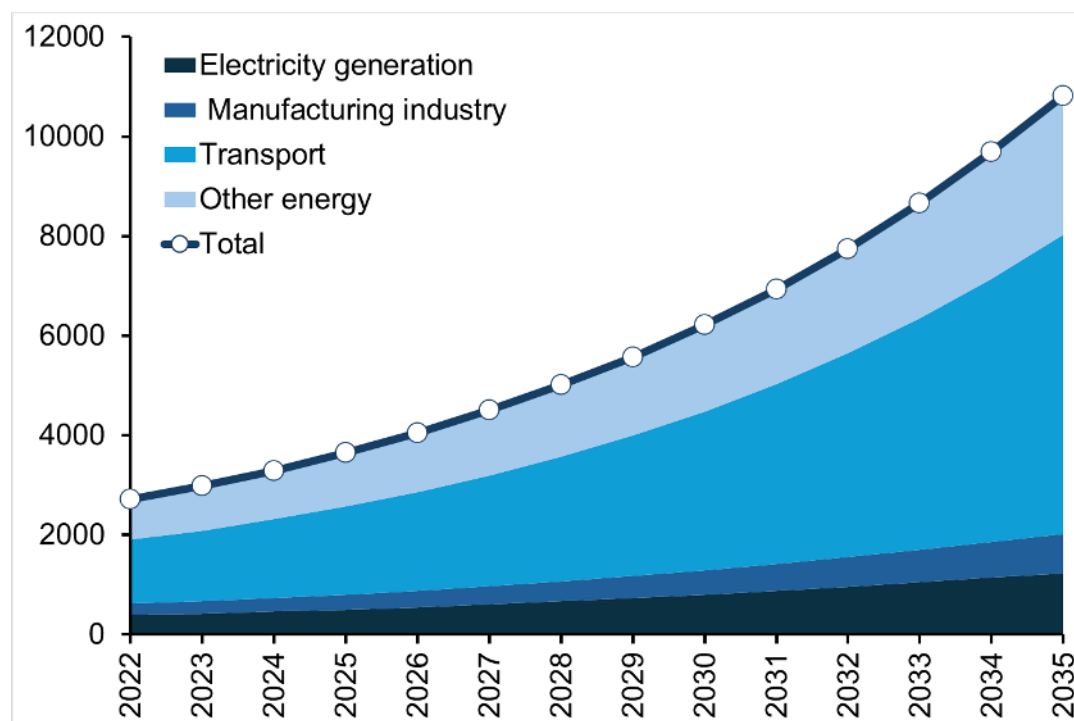


Figure 33: Energy Sector BAU Emissions Projection (2022-2035)

Two pivotal inflexion points reshape the emissions landscape. In 2028, transport emissions overtake manufacturing, highlighting how motorisation trends could undermine industrial decarbonisation gains. By 2032, electricity generation's footprint will exceed the combined output of all other sectors, a troubling milestone suggesting grid expansion priorities outweigh renewable integration. The persistent "Other energy" category, while smallest in scale, doubles its emissions through 2035, revealing systemic challenges in residential/commercial fuel transitions.

Energy Mitigation Actions and their Effects

The mitigation policies and measures in the energy sector, as reported in the published updated NDC 2.0 were taken as the basis of the analysis as detailed project provided in the subsequent sections. An extensive range of project data and assumptions was used in undertaking the mitigation analysis. Information on costs and benefits, and supporting project details and technical information, was requested from the relevant government department and stakeholders. Wherever possible, this was used in the analysis, although significant information gaps and the need to ensure consistent values for common assumptions meant that in-country data was complemented by a range of assumptions and inputs drawn from the international literature and analogous/regional project case studies and schemes.

Mitigation Scenarios in the Energy Sector

Figure 34 illustrates Rwanda's projected greenhouse gas (GHG) emissions in the energy sector under BAU and mitigation scenarios for the period 2022-2035.

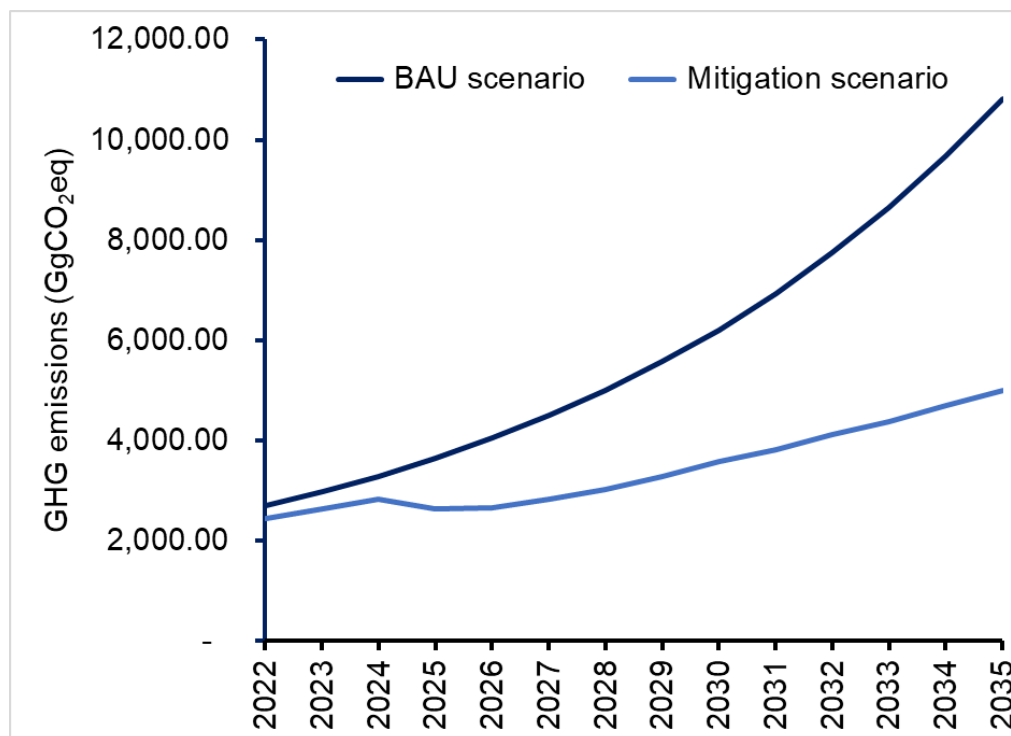


Figure 34: Mitigated vs BAU GHG emissions for the Energy Sector

As aforementioned, under the business-as-usual (BAU) scenario, emissions show a concerning trajectory. In contrast, the mitigation scenario begins at the same baseline but demonstrates the transformative potential of climate-conscious policies. While emissions initially follow a similar upward pattern, a decisive divergence occurs around 2028. At this critical juncture, when BAU emissions hit 4,500 GgCO₂eq compared to 3,200 GgCO₂eq under the mitigation scenario, the implementation of renewable energy systems and efficiency measures begins yielding substantial returns. Post-2028, the mitigation curve flattens markedly, ultimately halving projected emissions by 2035 compared to BAU levels.

Energy Sector Policies Implementation Plan

The energy sector policies implementation plan is presented in Table 11 which summarises the policies, needed actions, implementation timeline and institutions responsible for implementation. Considering the nature of the energy projects, the existing plans as published in the ESSP, most of the measures will be implemented in the long run.

Table 11: Energy Sector Policies Implementation Plan

Mitigation measure	Action	Timeline	Responsible
Grid-connected hydropower generation	Development of large hydro capacity (capacity > 5 MW), small and mini hydro projects (capacity <5 MW) and regional projects	Long term	REG, MININFRA
Solar minigrids	Solar mini-grids to be installed in off-grid rural areas by 2030, as reflected in the Rural Electrification Strategy.	Long term	REG, MININFRA
Energy-efficient brick kilns	Phasing out the use of clamp kilns and applying energy efficiency measures in the brick manufacturing industry.	Long term	RHA, NIRDA
Energy efficiency in agro-processing industries	Apply a range of energy efficiency measures focused on reducing firewood in the tea factories	Long term	MINAGRI, RAB
Energy-efficient cement industry	Use of waste heat recovery (WHR) and increased use of rice husks as fuel within clinker production	Long-term	CIMERWA, NIRDA
Electric motor replacement in mining	Phasing out of diesel gensets for on-site electricity consumption, to be replaced with grid and/or on-site renewable power production	Medium term	RMB
Vehicle fuel economy standards	Implementation of measures introduced to increase the vehicle emissions performance of the national vehicle fleet, including tax incentives and scrappage of older vehicles, and inspection.	Medium term	MININFRA, CoK, RURA, RTDA
Electric vehicles (EVs)	The e-mobility programme plans for the phased adoption of electric buses, passenger vehicles (cars) and motorcycles from 2020 onwards	Medium term	MININFRA, CoK, RURA, RTDA
Public transportation measures	Implementation of a wide range of measures, including bus rapid transport (BRT) projects, bus lanes, non-	Medium term	MININFRA, CoK, RURA, RTDA

Mitigation measure	Action	Timeline	Responsible
	motorised transport lanes, and other modal shift projects		
Rooftop solar in commercial buildings (grid back-up)	Adoption of rooftop solar PV panels in commercial buildings	Long term	REG, MININFRA
Efficient cookstoves	Dissemination of modern, efficient cook stoves to 80% of the rural population and 50% of the urban population by 2030, achieving a more sustainable balance between supply and demand of biomass, and reducing firewood and fossil energy consumption for cooking.	Medium term	REG, MININFRA
Solar water heaters in the residential sector	Installation of solar thermal water heaters within urban residential buildings	Long term	REG, MININFRA
Off-grid solar electrification (SHS and mini-grids)	Adoption of SHS and mini-grids	Medium term	REG, MININFRA
Domestic on-farm biogas	Increase the use of on-farm anaerobic digestion of manure for bioenergy (bio-digestors).	Medium term	REG, MININFRA
Solar pumping for irrigation	Use of solar water pumping systems for irrigation within agricultural production to replace diesel pumps, displacing fossil fuel use and associated GHG emissions.	Medium term	MINAGRI, RAB

Conclusion and Recommendation

Rwanda's energy sector is undergoing a major transition to balance economic growth with climate goals, aiming to cut emissions by 38% below business-as-usual levels by 2035. Renewable energy is central to this shift, with hydropower and solar expected to boost renewable grid share from 53% to 60%, while mini-grids and solar home systems expand rural electrification and replace diesel power.

Transport reforms target high emissions from motorcycles by introducing electric alternatives and charging networks, potentially avoiding 1,500 GgCO₂eq annually. Household energy use is also transforming, with 1.5 million improved cookstoves distributed and LPG adoption reaching 50% of urban homes, reducing 1.2 million tonnes of CO₂eq yearly.

Key challenges include grid reliability, dependence on fossil fuel imports, and rising urban energy demand, requiring behavioral changes and stronger data systems for tracking emissions. Rwanda's approach demonstrates how low-income countries can pursue sustainable development through renewable energy, electrified transport, and climate-smart urban planning, paving a path toward upper-middle-income status.

3.5.2. IPPU Sector

The Industrial Processes and Product Use (IPPU) sector comprises GHG emissions generated directly from non-energy-related industrial activities as the GHG emissions from fuel combustion are considered in the energy sector. In Rwanda, the GHG emissions from the IPPU sector represent the emissions generated from the following categories: (i) 2A mineral industry, (ii) 2.C metal industry, (iii) 2D Non-Energy Products from Fuels and Solvent Use and, (iv) 2F product use as substitutes for ozone-depleting substances (Republic of Rwanda, 2018).

Among the above categories, the applicable sub-categories considering Rwanda circumstances are: (i) 2A mineral industry: 2A1: cement production and 2A2: lime production; (ii) 2.C metal industry: 2C.1 iron and steel and 2C.2 ferroalloys production; (iii) 2D Non-Energy Products from Fuels and Solvent Use: 2.D.1 Lubricant use and 2.D.2 Paraffin Wax use; and (iv) 2F product use as substitutes of ozone depleting substances: refrigeration and air conditioning.

IPPU BAU Scenario

Under the BAU scenario, GHG emissions from the IPPU sector are projected to increase from 253.3 Gg CO₂eq. in 2022 to 621.59 Gg CO₂eq. by 2035, representing an overall increase of nearly 145% over the 13 years. This growth reflects Rwanda's rapid industrialisation trajectory, which is aligned with Vision 2050 and NST2 targets.

The mineral industry (primarily cement production) remains the dominant source of emissions, rising from 209.84 Gg CO₂eq. in 2022 to 514.93 Gg CO₂eq. by 2035, accounting for over 82% of total IPPU emissions by the end of the period. This trend is driven by increased demand for infrastructure, urban housing, and construction materials.

Emissions from product use as substitutes for ozone-depleting substances (2F) also increase sharply, from 33.7 Gg CO₂eq. in 2022 to 82.75 Gg CO₂eq. by 2035, reflecting the rapid adoption of HFC-containing equipment in refrigeration and air conditioning. This sub-category becomes the second-largest IPPU emissions contributor, underscoring the importance of enforcing Kigali Amendment targets and national HFC phase-down regulations.

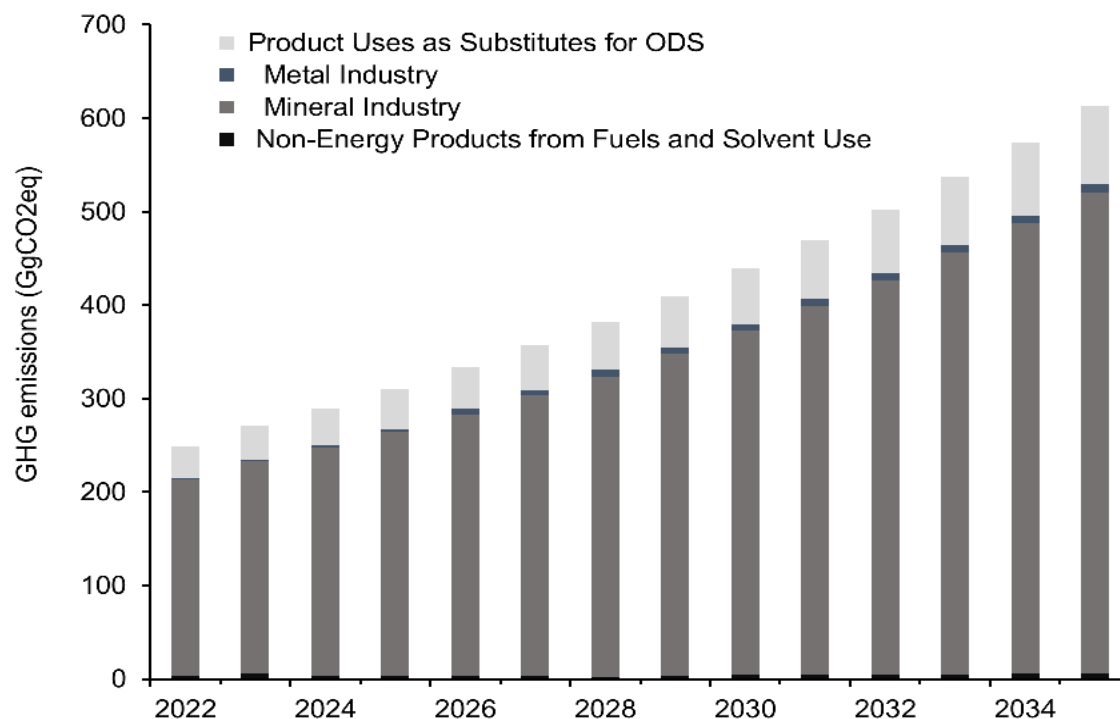


Figure 35: BAU emissions scenario for the IPPU sector

Overall, the BAU trajectory confirms the critical need for targeted mitigation actions in cement decarbonisation, F-gas management, and cleaner production technologies to avoid uncontrolled GHG growth in Rwanda's emerging industrial economy.

Mitigation Actions in the IPPU Sector

The GHG mitigation analysis for the IPPU sector was based on the two projects: (i) Clinker Substitution-Increased proportions of Pozzolana in cement and (ii) Gradual substitution of F-gases by less polluting substitutes. These are also two prioritised projects in Rwanda TNC (2018) and NDC (2020). Under the Business-as-Usual (BAU) scenario, GHG emissions from the IPPU sector are projected to increase from 253.31 GgCO₂eq in 2022 to 621.59 GgCO₂eq in 2035, mainly driven by cement production and F-gas usage in refrigeration and air conditioning.

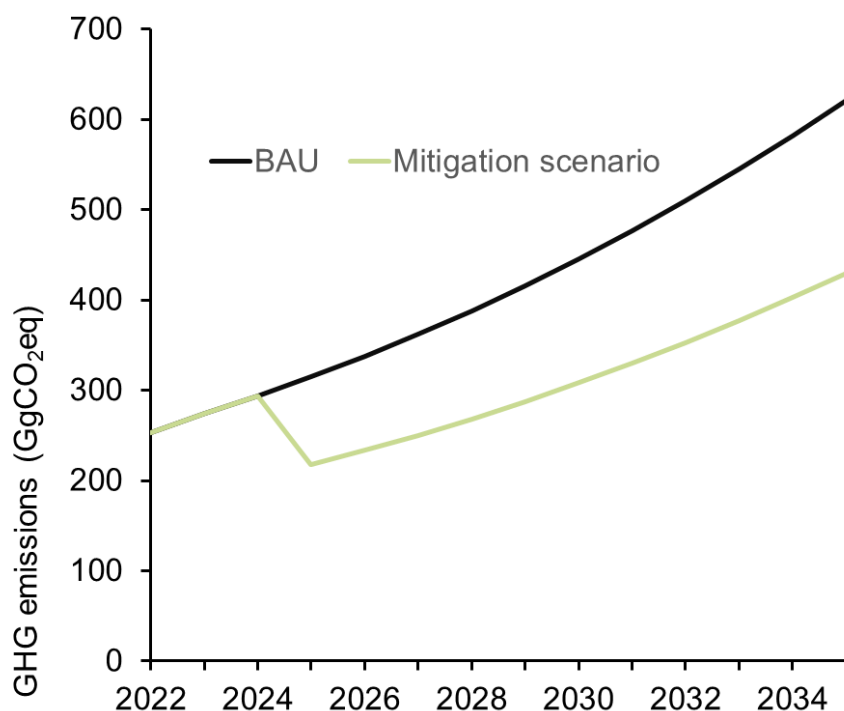


Figure 36: Mitigated vs BAU GHG Emissions for the IPPU sector

However, when two mitigation measures are implemented: (i) increased use of pozzolanas in cement and (ii) the gradual substitution of F-gases with low-GWP alternatives, the emissions pathway significantly deviates from BAU. As shown in Figure 36, the mitigation scenario projects a total of 429.80 Gg CO₂eq in 2035, representing a 31% reduction compared to the BAU projections.

The total GHG emissions reduction potential from the IPPU sector in 2035 is 191.8 Gg CO₂eq achieved through:

- (i) Increased use of pozzolanas in cement production
 - **Contribution:** 138.0 Gg CO₂eq (≈72% of total reduction)
 - **Rationale:** Reduces the clinker factor, which is the main source of process CO₂ emissions in cement.
 - **Economic Impact:** Cost-effective, with a negative abatement cost of -38.37 USD/tCO₂eq, indicating cost savings.
- (ii) Gradual substitution of F-gases with less polluting alternatives
 - **Contribution:** 53.79 Gg CO₂eq (≈28% of total reduction)
 - **Rationale:** Aligns with Kigali Amendment implementation to reduce high-GWP HFCs.
 - **Economic Impact:** Moderate cost of mitigation, at 16.09 USD/tCO₂eq.

These reductions are cumulative and start having visible impacts by 2025, where emissions fall below BAU levels by over 97 Gg CO₂eq. The difference continues to grow steadily through 2035, supported by technological shifts and policy enforcement.

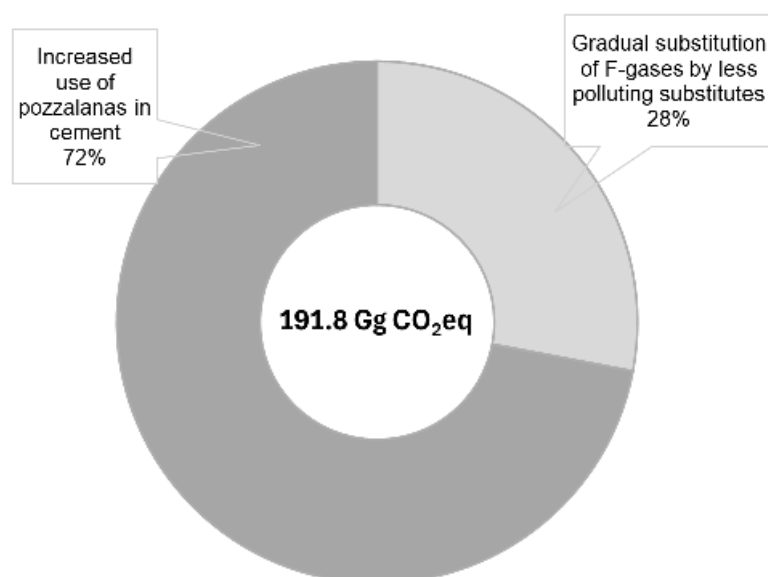


Figure 37: Reduction potential from the IPPU sector in 2035

Implementation Plan of Mitigation Measures in the IPPU sector

The implementation plan of mitigation measures in the IPPU sector is summarised in 2 and categorised in their implementation timeline. Considering the nature of the proposed measures, they will all be implemented in the medium term. In addition, the table 12 highlights the needed actions and the responsible institution for implementation.

Table 12: Implementation plan of mitigation measures in the IPPU sector

Mitigation option	Action	Timeline	Responsibility
Increased use of pozzolanas in cement production	Applying lower clinker/cement ratio (increasing the ratio of additives/cement): blended cements, Research, development, and commercial demonstration of new technologies and processes	Medium term	CIMERWA MINICOM REMA RDB
Gradual substitution of F-gases by less polluting substitutes	Find alternative technology solutions to shift to low-GWP substitutes.	Medium term	MINICOM REMA RDB

3.5.3. AFOLU sector

Rwandan agriculture sector is based on small-scale farming with 1.3 million hectares of cultivated lands (NISR, 2023). Agriculture is one of the most important sectors for the national economy, and it contributes 25% to the national GDP (NISR, 2023), however, it was responsible for 58% of GHG emissions (without FOLU) in 2022. FOLU subsector was the only source of sink, and it removed 28% of the total GHG emissions in 2022 (Republic of Rwanda, 2024). Forests are represented by natural highland montane forests as well as forest plantations, serving as the source of biomass energy, conservation of wildlife and tourism and extending on 724,695 ha (Republic of Rwanda, 2024).

AFOLU BAU Emissions Scenario

The Business-as-Usual scenario was developed (Figure 38), and it shows an increase of GHG emissions for AFOLU from 6,971.3 to 14,786.89 Gg CO₂eq. in 2035 without FOLU, and from 2,087.1 to 10,803.71 Gg CO₂eq. with FOLU for 2022 and 2035, respectively.

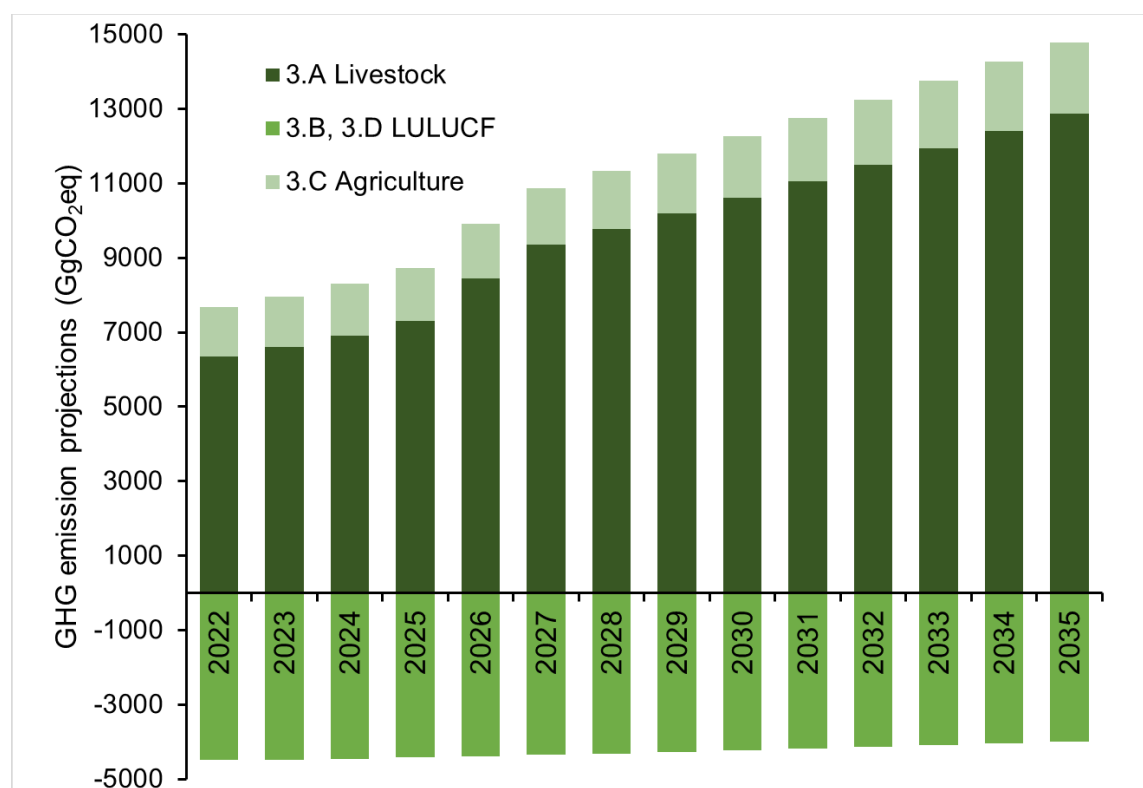


Figure 38: BAU emission projection per category (2006-2035)

In the baseline year (2022), methane emissions from livestock (3.A) and nitrous oxide from croplands (3.C) are partially offset by forests and land-use practices (3.B & 3.D) that act as carbon sinks. Net emissions hover near neutrality, but this balance is short-lived, and by 2025, the scales tip decisively. Agriculture intensifies to meet food demands for a growing population, unleashing a surge in emissions from fertiliser use and soil management. Simultaneously, livestock herds expand, Rwanda's cattle population alone grew by 24% in the five years preceding 2022, leading to more methane emissions.

Forests, once robust carbon sinks, shrink under pressure from farmland conversion and fuelwood extraction. By 2030, the LULUCF sector (Land Use, Land-Use Change, and Forestry) transitions from a mitigator to a marginal contributor, its carbon removals dwindling as emissions from degraded peatlands and deforested zones creep upward. The year 2030 marks a point of no return: net emissions double, fuelled by Rwanda's push to modernise agriculture, a sector employing 65% of its population. Diesel-powered irrigation systems, synthetic fertilisers, and mechanised tillage lock in high-emission practices, while agroforestry initiatives struggle to scale.

By 2035, the trajectory crescendos at 15,000 GgCO₂eq 15,000 GgCO₂eq, a fivefold increase from 2022 (Figure 40). This peak reflects not just agricultural growth but systemic trade-offs. Policies prioritising food security, such as converting wetlands to rice paddies or savannas to grazing land, exact a heavy carbon toll. Even reforestation efforts, though expanding, cannot counterbalance the methane emissions.

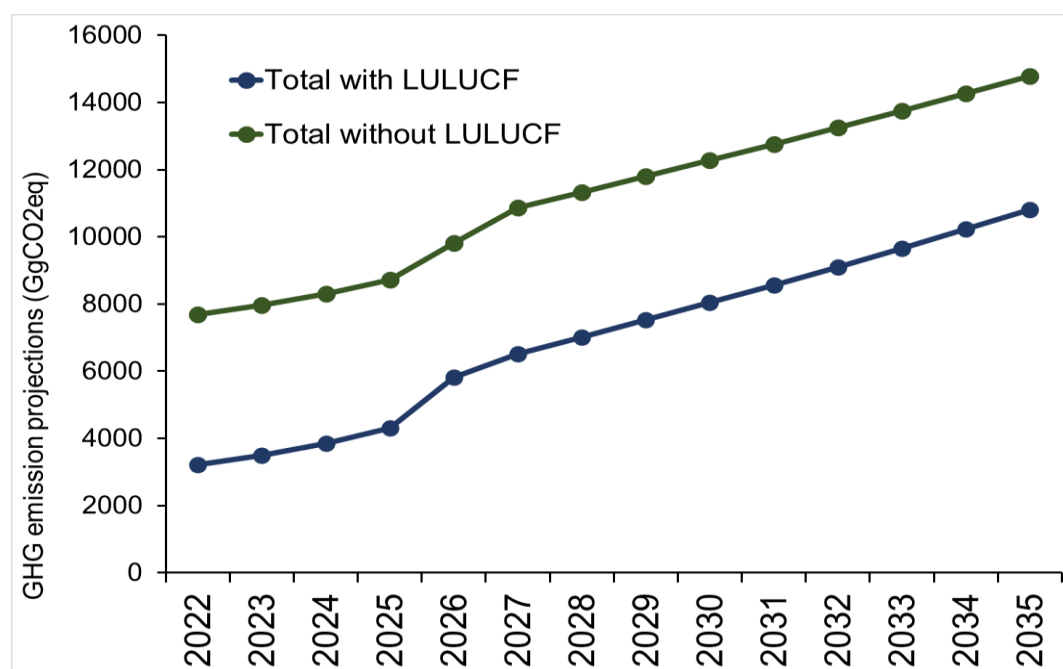


Figure 39: Total BAU scenario with and without LULUCF

The subtext of this graph is a race against time. Rwanda's Nationally Determined Contribution (NDC) pledges 53% emissions cut by 2035, but the AFOLU pathway is in the opposite direction. Without rapid adoption of climate-smart agriculture through reduced tillage, biogas digesters for manure, nitrogen-efficient fertilisers, the sector risks consuming 60% of Rwanda's carbon budget by 2035.

Mitigation Actions in AFOLU

Mitigation potentials were summed and subtracted from the BAU baseline emissions in order to derive the potential reduction of emissions. The mitigation trend is shown in Figure 40.

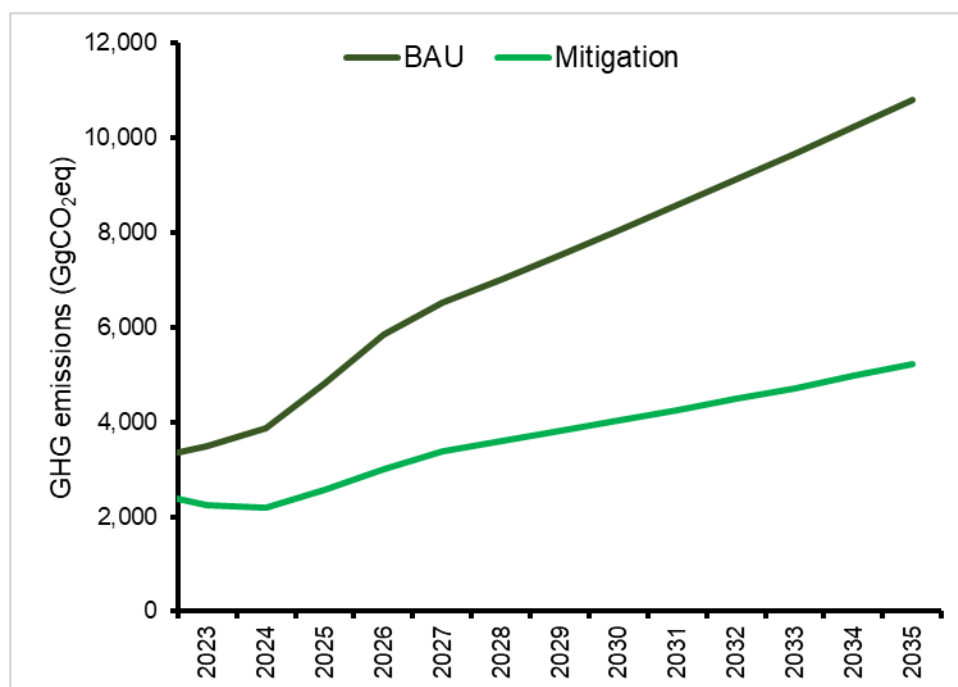


Figure 40: Reduced emission trend and BAU scenarios, 2022-2035

The overall emission reduction for all selected projects for 2022 – 2035 is estimated to reach a maximum of 51.54% with all proposed mitigation actions, and 44.81% with the four most significant mitigation projects: mulching, composting, terracing and crop rotation.

Mitigation Implementation Plans for the AFOLU Sector

Table 13 proposes implementation indicators and targets for each mitigation option. Potential implementing institutions for each indicator and target are also proposed. The implementing institutions would develop yearly targets along with a reporting framework and assign the staff responsible for reporting. Arrangements will be made to add all NDC targets to the MIS system at MINAGRI.

Table 13: Proposed targets, indicators and reporting institutions for NDC mitigation projects

Mitigation option	Target indicator For 2022-2029	Target for 2029-2035	Implementing institutions
Composting	100,000 tonnes/year of compost produced; it is used on 100,000 ha	100,000 tonnes/year compost produced; it is used on 1,000,000 ha	RAB and Districts
Terracing	5000 ha radical terraces/year; 10000 ha progressive terraces per year	5000 ha radical terraces/year; 10000 ha progressive terraces per year	NGO and MINAGRI

Mitigation option	Target indicator For 2022-2029	Target for 2029-2035	Implementing institutions
Crop rotation	60,000 ha under rotation in 2020; increase early by 20,000 ha	600,000 ha under rotation in 2020; increased early by 20,000 ha	RAB and Districts
Banana-coffee	14,000 ha of coffee and 75,000 ha of banana mulched area by 2030	28,000 ha of coffee and 137,800 ha of banana area mulched by 2035	NAEB and Districts
Conservation tillage	275,000 ha under conservation tillage by 2030	425,000 ha under conservation tillage by 2040	RAB and Districts
Fodder	5,000ha under Medicago; 23,500 ha under Leycaena; 23,500ha under Calliandra; 23,500ha under Brachiaria by 2030	6,000 ha under Medicago; 25,500 ha under each Leycaena and Calliandra; 24,500 ha under Brachiaria by 2035	RAB and Districts
Improved manure	550,000 cows and 550,000 goats in better MMS	1.4 million cows and 1.4 million goats in better MMS by 2035	RAB and Districts
Improved livestock	130,000 improved cows replaced 260,000 local cows	230,000 improved cows replaced 460,000 local cows	RAB and Districts

Alignment to the Existing Government Policies and Plans

The proposed mitigation projects were prepared in accordance with the existing policy documents. These are PSTA-5 for Agriculture and NST-2. The size of the mitigation was discussed with partners and the targets for 2025-2030 were set. The PSTA 5 targets were used for the period 2025-2030 (e.g., expansion on fertiliser use, mulching practices, projected production of different crops, planned area under land protection practices, etc). The primary focus was to propose mitigation options that match and contribute to the achievement of the already planned activities and targets.

The proposed mitigation projects were aligned with the ongoing programs and plans within the agriculture, forestry, and land use subsectors. Table 14 shows the proposed indicators, targets, and relative policies for each project.

Table 14: Mitigation actions, indicators, mitigation effects and relative policies

Mitigation action	Indicators	Mitigation effect	Policy or programme
Composting	Quantity of compost produced and applied; Area of land under compost application	Increased use of crop biomass for compost production will reduce storage period for manure and emissions from manure management; while increased quantities of compost applied will increase C-stock in soil, especially in soils that have been cultivated without fallow and rotation	Green Growth Strategy (2011); AgriTAF, 2016
Terracing	Area under radical terraces (ha); Area under progressive terraces (ha)	Increased soil C due to soil stabilisation and reduced soil loss from erosion	PSTA-4
Crop rotation	Rotation scheme applied (crop sequence and actual crop, seasonally); Area under crop rotation (ha)	Reduction of N ₂ O emissions from reduced mineral N-fertilizer use per unit area with increased rotation with leguminous N-fixing crops	AgriTAF, 2016
Mulching of banana and coffee	Area under mulched coffee and banana planted/maintained (ha)	Increased C-fixation in biomass in coffee-banana systems	No policy support, option from research
Conservation tillage	Area under conservation tillage (ha)	Reduction of N ₂ O emissions from soil with reduced CO ₂ emissions from bare soil.	AgriTAF, 2016
Fodder	Area under Medicago (ha), Brachiaria (ha), Leycaena spp (ha) and Calliandra spp. (ha)	Increase of soil carbon through supply of organic matter through root underground biomass, increased aboveground biomass produced per unit area, and reduced soil losses with erosion.	National Livestock Development Master plan (2017)

Mitigation action	Indicators	Mitigation effect	Policy or programme
Improved manure	Number of farms with slurry systems; Number of cows under slurry systems; Number of farms using manure covering with plastic	Reduction of CH ₄ emissions will be done with establishing new biogas digesters. N ₂ O emissions will be reduced with promotion and expansion of covering of manure, using higher straw quantity in stored manure and by covering manure during storage.	National Livestock Development Master plan (2017)
Improved livestock	Number of local cows removed; number of improved cows replaced the local cows (inventory reports)	Main mitigation effect will be through reduction of emissions from enteric fermentation from reduced number of cows while maintaining and improving the production of milk	National Livestock Development Master plan (2017)

Beyond the NST2 period, there would be a wider choice of maintaining similar targets or proposing higher mitigation targets, as well as new, potentially promising mitigation options beyond the existing plans and programs. The last would serve as awareness for the new mitigation options that would help in future settings, setting the targets beyond 2029, the final year approved by the government NST-2.

Conclusion and Recommendations for the AFOLU Sector

Mitigation potentials were summed and subtracted from the BAU baseline emissions in order to derive the potential reduction of emissions. The overall emission reduction for all selected AFOLU projects for 2022 – 2035 is estimated to reach a maximum of 51.54% with all proposed mitigation actions, and 44.81% with the four most significant mitigation projects: mulching, composting, terracing and crop rotation. The implementation of the proposed mitigation projects will contribute to successfully achieve the targets of the Updated NDC by 2035.

3.5.4. Waste Sector

The inventory was performed at the IPCC categories and subcategories, from which the IPCC methods and decision trees are generally provided in the sectoral volumes. For that purpose, we adapted the recommended categories to the national circumstances. In particular, the following clauses show subcategories of concern in the waste sector:

- Solid Waste Disposal
- Biological Treatment of Solid Waste
- Incineration and Open Burning of Waste
- Wastewater Treatment and Discharge

Waste BAU Scenario

As shown in Figure 41: BAU emissions projection from the waste sector up (2006- 2035) , under the BAU scenario, total GHG emissions from the waste sector are projected to rise sharply from 2,234.1 GgCO₂eq in 2022 to 5,482.12 Gg CO₂eq in 2035, a 145% increase over the past 13 years. This rapid growth is driven by population increase, urbanisation, and limited deployment of low-emission technologies in waste and wastewater management.

The wastewater treatment and discharge category remain the dominant source of emissions, contributing 1,179.5 GgCO₂eq in 2022 and more than doubling to 2,894.40 GgCO₂eq by 2035. This trend reflects the rising volumes of domestic and industrial wastewater, combined with the widespread use of pit latrines and septic tanks, which have high methane emissions.

Emissions from solid waste disposal are also significant, rising from 791.32 GgCO₂eq in 2022 to 1,941.78 GgCO₂eq by 2035. The increase is primarily due to the continued reliance on unmanaged or semi-managed landfills, as well as the absence of methane recovery or flaring systems. Urban waste generation is expected to rise alongside GDP and consumption patterns, further intensifying emissions.

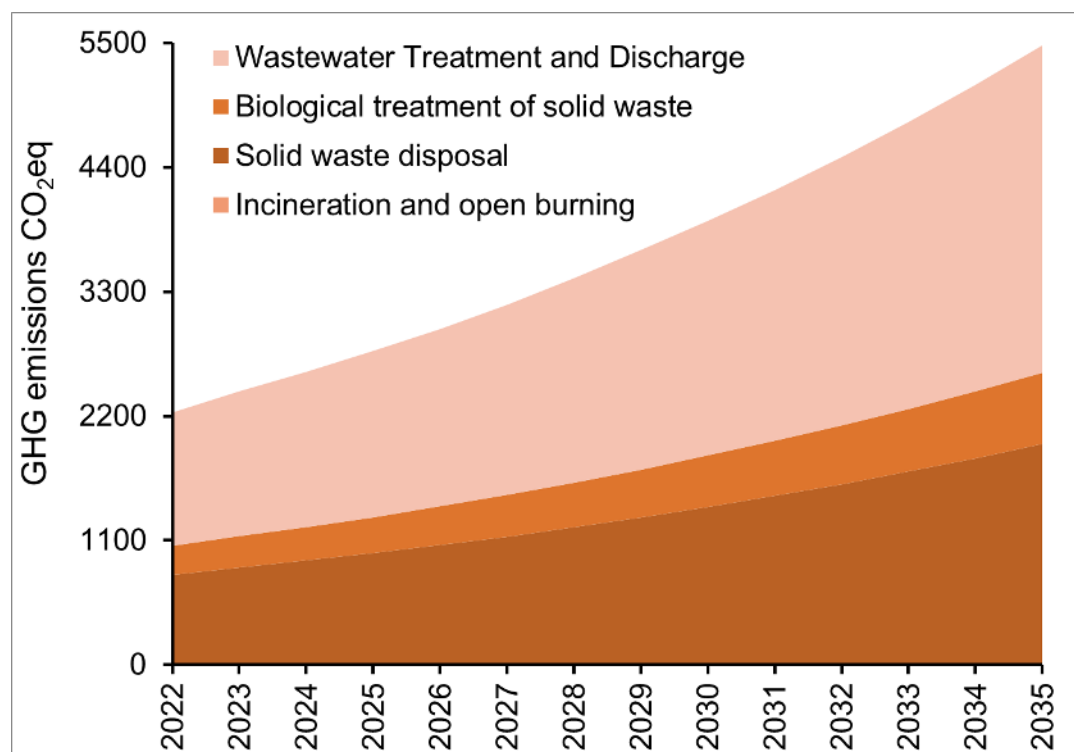


Figure 41: BAU emissions projection from the waste sector up (2006- 2035)

The biological treatment of solid waste, which includes composting and anaerobic digestion, shows a more modest but steady increase from 257.17 Gg CO₂eq to 631.06 Gg CO₂eq over the same period. This category reflects the partial treatment of biodegradable waste, often under sub-optimal conditions that result in methane leaks rather than complete stabilisation.

Although incineration and open burning remain the smallest source of emissions in absolute terms, emissions nearly triple from 6.07 Gg CO₂eq in 2022 to 14.88 Gg CO₂eq by 2035, reflecting informal practices and increased thermal treatment of waste without adequate pollution controls.

This BAU pathway underscores Rwanda's urgent need to implement mitigation measures in both the solid waste and wastewater sectors, including sanitary landfills with methane capture, centralised and decentralised wastewater treatment upgrades, and enhanced composting under aerobic conditions. Without intervention, the waste sector is poised to become one of Rwanda's most rapidly growing sources of GHG emissions.

Mitigation Actions in the Waste Sector

Under the Business-as-Usual (BAU) scenario, GHG emissions from the waste sector are projected to increase significantly from 2,234.07 Gg CO₂eq in 2022 to 5,482.12 Gg CO₂eq by 2035. This rapid growth is driven by increased solid waste generation, unmanaged landfilling, and rising domestic and industrial wastewater discharges.

In contrast, as shown in Figure 42: Mitigation scenario Vs BAU GHG emissions for the waste sector the mitigation scenario projects emissions of 3,619.58 Gg CO₂eq by 2035, reflecting the effect of implementing six prioritised mitigation interventions. This results in an absolute reduction of 1,862.55 Gg CO₂eq, corresponding to a 34% emissions reduction compared to the BAU projection for 2035.

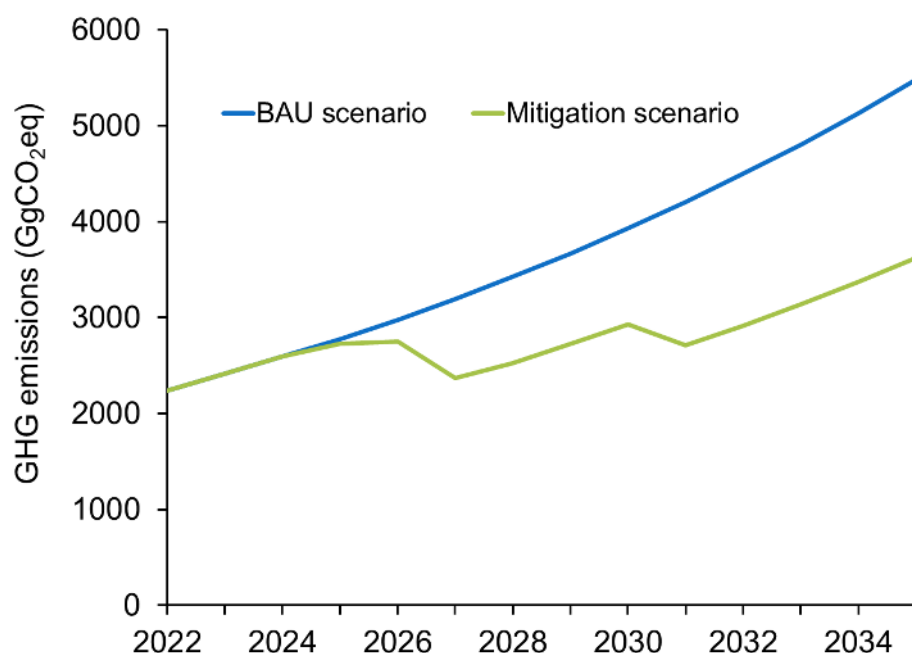


Figure 42: Mitigation scenario Vs BAU GHG emissions for the waste sector

As shown in Figure 42: Mitigation scenario Vs BAU GHG emissions for the waste sector 9, the largest portion of mitigation in 2035, with 63% (1,165.07 Gg CO₂eq,) is attributed to the landfill gas extraction program, which captures methane from solid waste disposal sites and converts it to energy. Not only is this

intervention technically mature, but it also exhibits a negative abatement cost of -8.35 USD/tCO₂eq, making it highly cost-effective. Other major contributors include:

Mechanical-Biological Treatment (MBT) & Extended Producer Responsibility (EPR):

- **Contribution:** 285.57 Gg CO₂eq
- **Abatement cost:** 1.19 USD/tCO₂eq

Reduces organic fractions entering landfills and strengthens circular economy practices.

Waste-to-Energy (WtE) Plants:

- **Contribution:** 230.15 Gg CO₂eq
- **Abatement cost:** 0.11 USD/tCO₂eq

Converts residual waste into electricity while minimizing landfill use.

Aerobic Composting:

- **Contribution:** 128.42 Gg CO₂eq
- **Abatement cost:** 1.53 USD/tCO₂eq

Targets the biodegradable organic waste fraction.

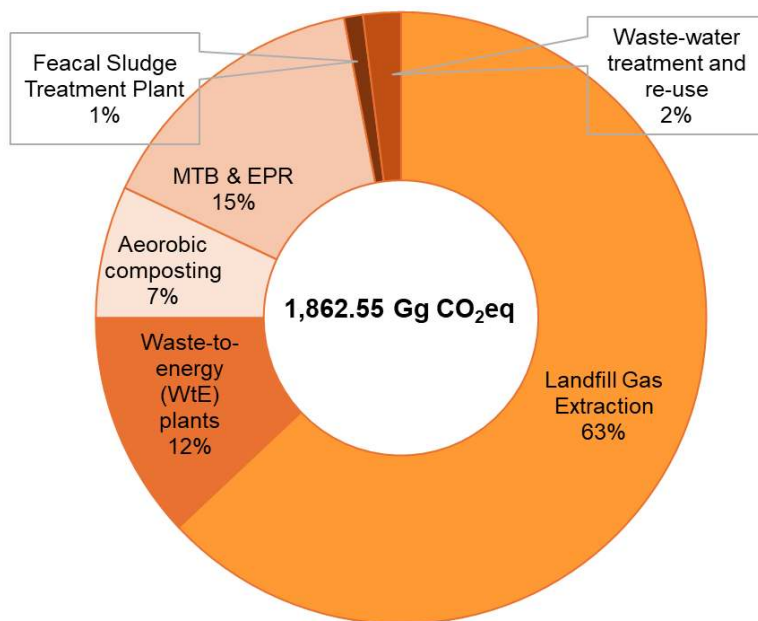


Figure 43: Reduction potential from the Waste sector in 2035

The wastewater sub-sector contributes modestly but importantly through:

- Wastewater treatment and reuse (42.58 Gg CO₂eq)
- Faecal sludge treatment plants (10.76 Gg CO₂eq)

While their mitigation share is small, they are critical for health and environmental co-benefits. Notably, faecal sludge treatment has a negative cost (-33.32 USD/tCO₂eq), indicating savings through avoided pollution and households' payments for downstream treatment.

Waste Sector Mitigation Actions Implementation Plan

The waste sector mitigation policies implementation plan is summarised in Table 15. The timeline for the mitigation implementation plan is categorised into short, medium and long-term. In terms of years, short, medium and long term can correspond to 2-3, 4-6, and 7-10 years, respectively. The categories are identified: long-term projects for the most demanding projects, medium-term for those projects in the pipeline and short-term for those projects already in the implementation phase and less demanding in terms of finance and time.

Table 15: Waste section mitigation policies implementation plan

Mitigation option	Action	Timeline	Responsible entity	lead
Landfill gas utilisation	Shifting from conventional to engineered landfill gas recovery systems (Controlled landfill bioreactor, permeable layers to improve LFG recovery, use of subsurface gas probes, methods to overcome water-logging that can impede gas extraction); Engineered landfill gas recovery systems are recommended technologies	Long term	Utility MINALOC MININFRA RURA REMA	
Waste-to-energy (w2t) plant	Waste to energy technologies, including plasma arc technology, refuse-derived fuels (RDF) and solid refuse fuel SRF) and finally incinerators	Long term	Utility Districts CoK MININFRA MINALOC RURA REMA	
Integrated Solid Waste Management (ISWM)	Expansion of recycling infrastructures and facilities; Single and dual-stream recycling plants are recommended technologies. Composting of degradable waste that is wasted (burned or left off)	Medium term	Districts CoK MININFRA MINALOC REMA RURA	
Aerobic composting	Implement windrow composting at household and community levels by placing organic waste into long rows of piles (windrows) that are aerated through regular turning, either manually or mechanically. This method ensures	Short to Medium term	Districts CoK MINALOC MINAGRI MININFRA REMA	

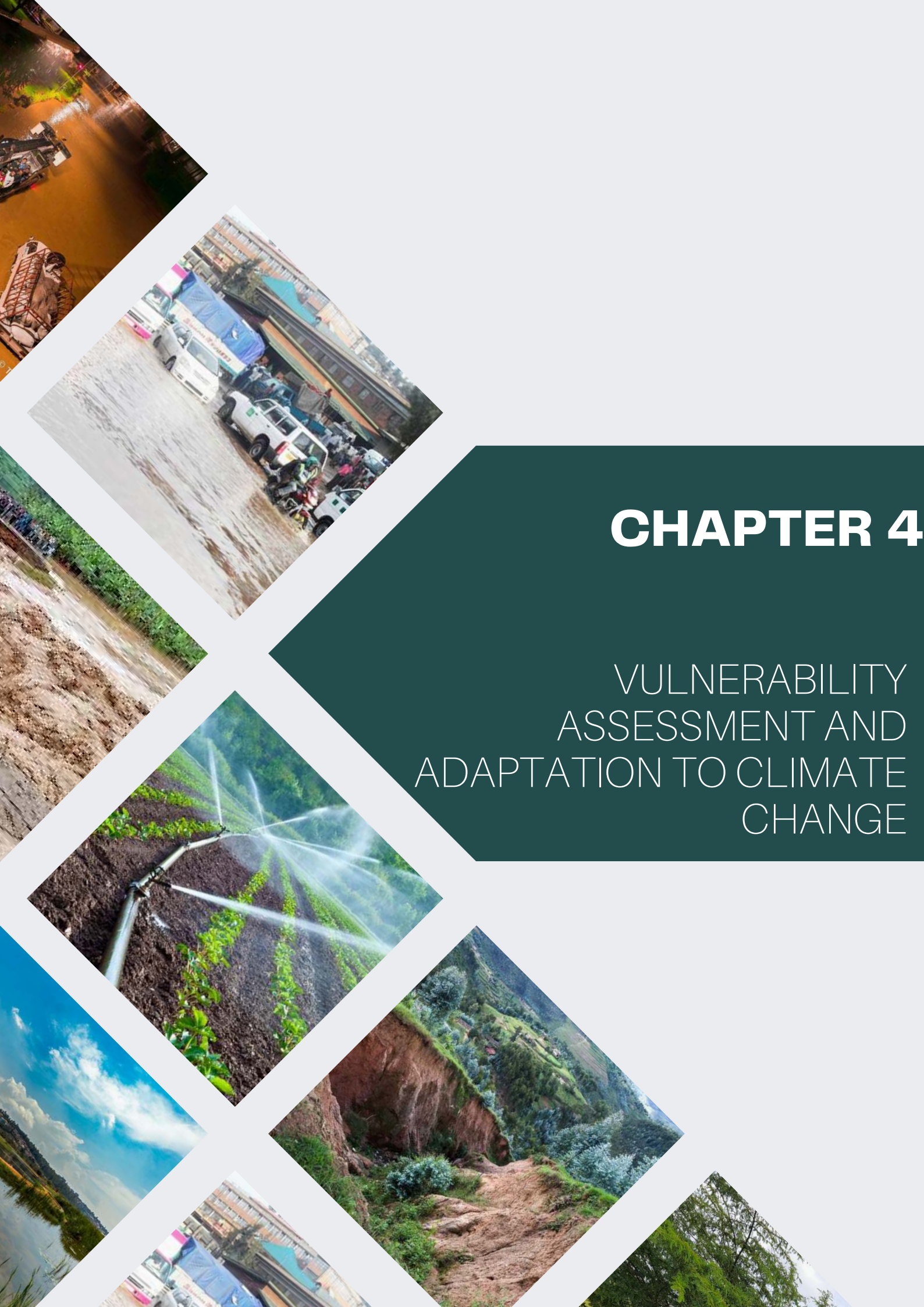
Mitigation option	Action	Timeline	Responsible entity	lead
	sufficient oxygenation to prevent methane formation and promotes the breakdown of organic waste into compost.		RURA RAB	
MBT & EPR	Establish MBT facilities to process mixed municipal waste, enabling recovery of recyclables, compostable fractions, and reducing landfill volumes. Integrate EPR schemes by mandating producers to take responsibility for post-consumer waste, especially plastics and packaging, through structured collection, sorting, and recycling programs. This dual approach will minimize methane emissions from landfills and promote circular economy practices.	Medium term	REMA, WASAC, MINICOM, Districts, Private Sector Federation (PSF)	
FSTP	Construct and operationalize decentralized faecal sludge treatment plants to manage sludge collected from pit latrines and septic tanks, especially in urban and peri-urban areas. The treatment process will include thickening, drying, and safe disposal or reuse of sludge, thereby reducing methane emissions from unmanaged anaerobic decomposition.	Short to Medium term	WASAC, MININFRA RURA REMA Districts	
Wastewater treatment and reuse	Providing opportunities to reuse highly-Long term Local Government treated water from the plants; Engineered wastewater treatment plants are recommended technologies	Medium to long term	WASAC, MININFRA Districts CoK MINALOC MINAGRI REMA RURA RAB	

Conclusion and Recommendation

Rwanda stands at a pivotal juncture in its climate-resilient development journey, where the interplay of profound challenges and transformative opportunities demands decisive action. Without intervention, business-as-usual trends would triple greenhouse gas emissions by 2035, primarily driven by surging transportation demands, industrial expansion, and rapid urbanisation. Yet this assessment reveals a

compelling alternative: strategic mitigation measures could slash 2035 emissions by around 45% below projected levels while simultaneously advancing economic competitiveness, forest conservation, and public health. The energy sector emerges as the key of this transformation, where renewable electrification, biomass modernisation, and industrial efficiency upgrades could halve emissions intensity. Meanwhile, waste-to-energy innovations offer the rare advantage of negative-cost abatement, turning landfill liabilities into power generation assets. In agriculture, responsible for over half of Rwanda's emissions, scaled-up soil conservation and agroforestry promise dual victories in carbon sequestration and farm resilience. Crucially, every sector demonstrates how emission reductions align with core national priorities: lowering industrial energy costs, purifying urban air, and securing sustainable rural livelihoods.

Underpinning these actions, robust enabling frameworks will institutionalise progress: integrating mitigation targets into National Strategy for Transformation performance contracts, deploying a real-time emissions tracking platform by 2026, and embedding "Climate Prosperity" metrics that formally link emission reductions to GDP growth in national accounts. By embracing this integrated blueprint, Rwanda can transcend its climate-vulnerable status to become an architect of climate solutions, transforming mitigation imperatives into engines of job creation, energy sovereignty, and ecosystem regeneration. This path not only exceeds Rwanda's current climate commitments but also pioneers a development model where economic advancement actively replenishes the environmental foundations it depends upon.



CHAPTER 4

VULNERABILITY ASSESSMENT AND ADAPTATION TO CLIMATE CHANGE

Chap 4: VULNERABILITY ASSESSMENT AND ADAPTATION TO CLIMATE CHANGE

4.1. CLIMATE CHANGE TRENDS AND PROJECTIONS

4.1.1. Introduction

This section provides detailed insights into Rwanda's climate, covering seasonal rainfall and temperature distribution, long-term trends, and future climate projections. It highlights how Rwanda's diverse topography from high mountains and steep hills to eastern savannas and wetlands creates varied microclimates and influences rainfall patterns.

Historical data show notable changes in rainfall and temperature over recent decades, with projections indicating significant future warming and shifting rainfall patterns. These changes pose risks to agriculture, water resources, and socio-economic development, requiring proactive adaptation measures to enhance resilience.

4.1.2. Methodology

This report analyzes Rwanda's climate using rainfall and temperature data from 236 meteorological stations, merged with satellite and reanalysis datasets. To enhance spatial coverage, observational data were reconstructed by combining ground observations with TAMSAT rainfall resulting in gridded rainfall with a spatial resolution of (4 km) and JRA55 reanalysis with observed temperatures resulting in gridded temperature data (at a spatial resolution of 5 km resolution), enhancing spatial coverage. Seasonal averages were computed for Rwanda's four main seasons, and climate extremes were assessed using 18 ETCCDI indices (e.g., heavy rainfall days, warm/cold nights and days,). Variability was quantified using the coefficient of variation (CV), while long-term trends were identified using the Mann-Kendall test and Theil-Sen slope estimator.

Future climate projections were derived from CMIP5 global climate models and dynamically downscaled through the CORDEX initiative. The analysis focused on two Representative Concentration Pathways (RCPs): RCP4.5, representing a moderate mitigation scenario, and RCP8.5, reflecting a high-emission, business-as-usual trajectory. For projection purposes, the best-performing regional climate models were selected based on their simulation skill: MPI (REMO2009) for rainfall, MOHC (CCLM) for maximum temperature, and ICHEC (CCLM) for minimum temperature. Projected changes for the period 2024–2053 were evaluated relative to the historical baseline of 1991–2020.

Table 16: Definition of Indices used in this Report

Code	Name	Definition	Unit
Temperature indices			
TXx	Annual maximum of daily maximum temperature	Annual maximum value of daily maximum temperature	°C
TNx	Annual maxima of daily minimum temperature	Annual maximum value of daily minimum temperature	°C
TXn	Annual minima of daily maximum temperature	Annual minimum value of daily maximum temperature	°C
TNn	Annual minima of daily minimum	Annual minima value of daily minimum temperature	°C
TN10p	Cold nights	Percentage of days when daily minimum temperature < 10th percentile	%Days
TX10p	Cold days	Percentage of days when daily maximum temperature < 10th percentile	%Days
TN90p	Warm nights	Percentage of days when daily minimum temperature > 90th percentile	%Days
TX90p	Warm days	Percentage of days when daily maximum temperature > 90th percentile	%days
DTR	Diurnal temperature range	Annual mean difference between daily max and min temperature	°C
Rainfall indices			
Rx1day	Max 1-day precipitation amount	Annual maximum 1-day precipitation	mm
CDD	Consecutive dry days	Number of maximum consecutive days with RR < 1 mm	Days
Rx5day	Max 5-day precipitation amount	Annual maximum consecutive 5-day precipitation	mm
R95p	Very wet days	Annual total precipitation from days > 95th percentile	mm
R99p	Extremely wet days	Annual total precipitation from days > 99th percentile	mm
R10 mm	Heavy precipitation days	Annual count when precipitation ≥ 10 mm	days
R20 mm	Very heavy precipitation days	Annual count when precipitation ≥ 20 mm	days
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (RR > = 1mm)	mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP > = 1.0mm) in the year	mm/day

4.1.3. Results

Distribution of Seasonal Rainfall and Temperature

From 1983 to 2021, Rwanda's rainfall and temperature patterns were strongly shaped by its diverse topography. The western and northern highlands consistently received the highest rainfall and experienced cooler temperatures, while the eastern and central lowlands were drier and warmer. Mountain forest and highland zones such as the southern, south-western, Congo-Nile divide, northern volcanic highlands, and Lake Kivu region recorded the greatest rainfall amounts, ranging from 300-400 mm in January-February, 500-700 mm in March-May, 100-200 mm in June-August, and 700-800 mm in September-December. In contrast, the central highlands, central plateau, and eastern lowlands received comparatively less rainfall, with values below 200 mm in January-February, 300-500 mm in March-May, 0-100 mm in June-August, and 300-500 mm in September-December. Temperature patterns followed a similar topographical influence: mountainous regions had average temperatures of 12-16°C with minimums below 11°C and maximums under 20°C, while central highlands exhibited averages of 20-24°C, maximums of 26-28°C, and minimums of 15-19°C. The lowlands and Lake Kivu region showed similar averages of 20-24°C but higher maximums of 28-32°C.

These findings confirm a west-to-east rainfall gradient and cooler temperatures in high-altitude areas compared to Rwanda's lower elevations.

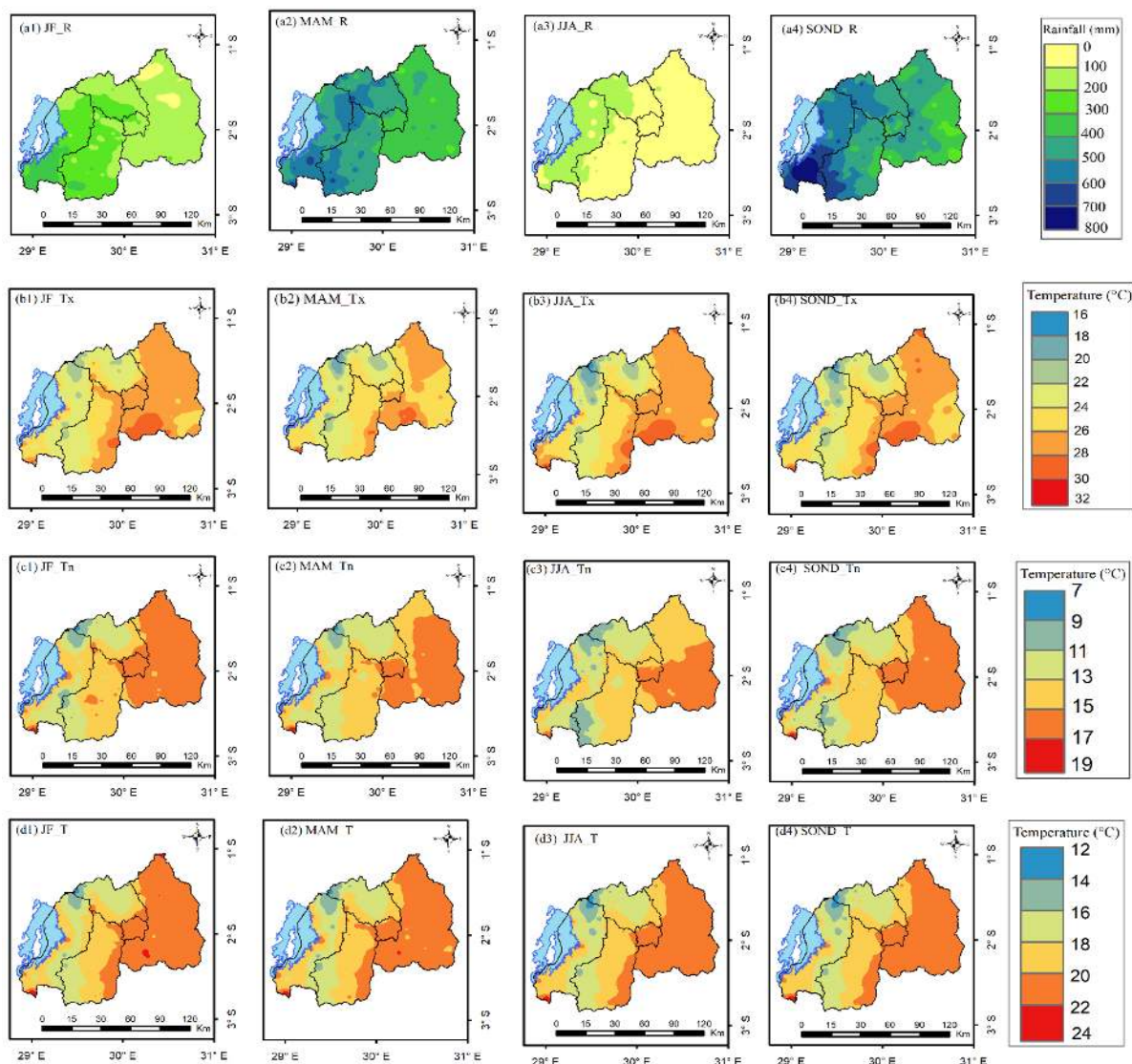


Figure 44: Spatial distribution of seasonal mean rainfall and temperatures, over Rwanda for the period 1983-2021

Distribution of Rainfall Extreme Indices

Between 1983 and 2021, Rwanda experienced distinct regional rainfall extremes shaped by its climate zones. The eastern lowlands were characterized by more consecutive dry days (CDD), fewer consecutive wet days (CWD), and a lower frequency of heavy and very heavy precipitation days (R10mm, R20mm) and extreme rainfall events (R95pTOT, R99pTOT), resulting in overall rainfall deficits despite high rainfall intensity when it occurred, as indicated by high SDII values. These conditions led to challenges such as droughts, reduced crop yields, and water scarcity. In contrast, the mountain highland and Lake Kivu region recorded more wet days and a higher frequency of heavy and extreme rainfall events (Rx1day, Rx5day, R95pTOT, R99pTOT, RPCPTOT), with fewer CDD, making these regions more susceptible to flooding, soil erosion, and landslides. The temperate zone of the central highlands and central plateau showed moderate levels of extreme rainfall, higher than the eastern lowlands but lower than the high-altitude western zones. Overall, these patterns reveal a clear climatic divide: low-lying eastern regions are drought-prone, while elevated western areas face increased flood risks, underscoring the need for region-specific adaptation strategies.

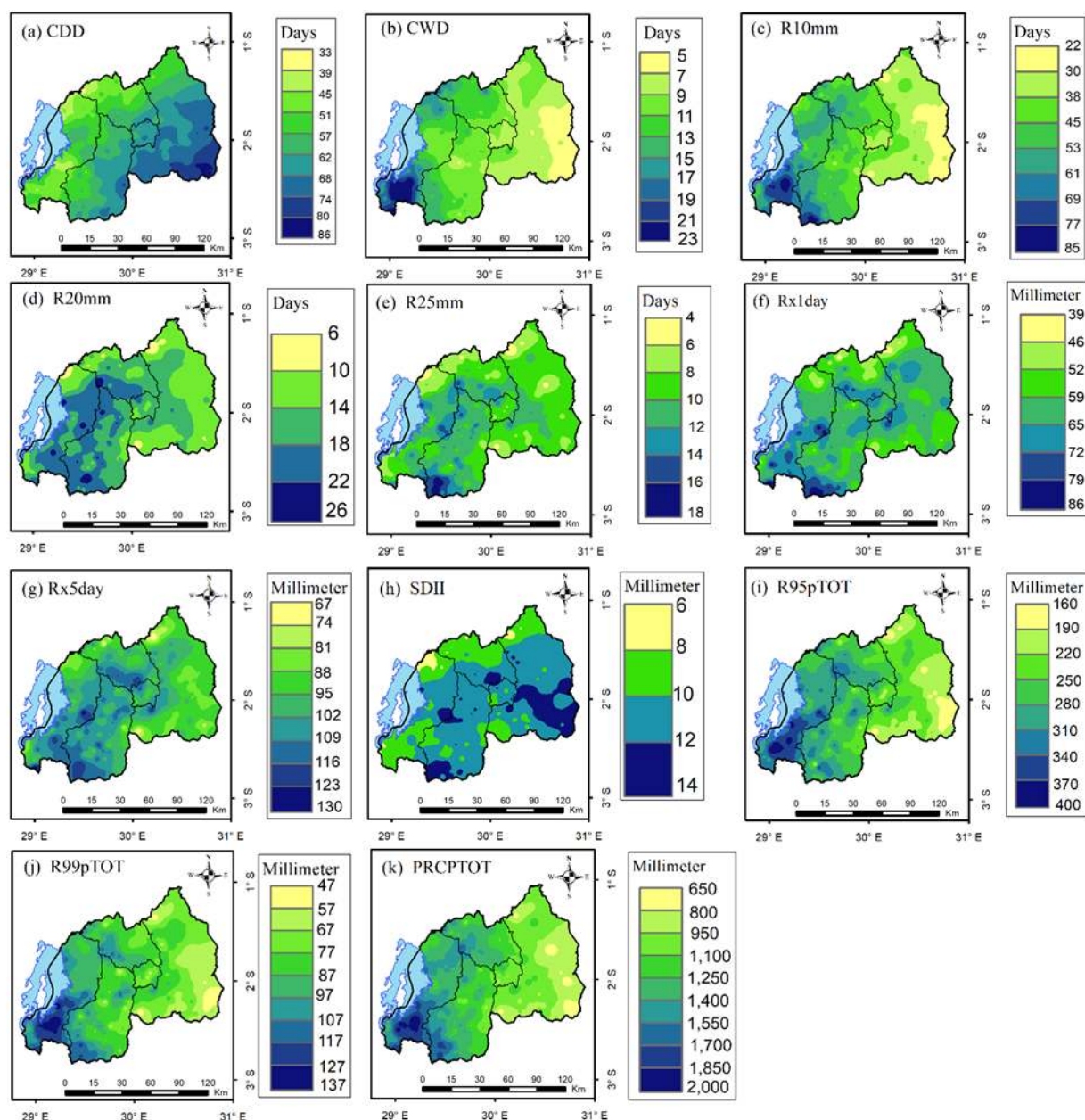


Figure 45: Spatial distribution in mean annual rainfall extreme indices for the period of 1983-2021

Distribution of Mean Annual Temperature Extreme Indices

Between 1983 and 2021, Rwanda experienced significant regional variations in temperature extremes influenced by elevation and geographic location. The Diurnal Temperature Range (DTR) was highest, averaging 12–14°C, in the northern and south-eastern areas of the eastern lowlands and south-eastern parts of the Lake Kivu, while it was lowest, at 8–10°C, in the mountain highland. The central highlands and central plateau recorded moderate DTR values of 10–12°C. Minimum temperature extremes revealed that cold nights (TN10p) were more frequent in the central highlands' and, mountain areas, exceeding 9.6 days annually, whereas fewer cold nights were recorded

in the eastern lowlands and Lake Kivu region. Warm nights (TN90p) occurred more often in the western highland Lake Kivu and central plateau regions with over 9.7 warm nights per year, while the eastern lowlands, central highlands and north-western mountain had fewer warm nights.

Patterns for maximum temperature extremes were similar, with more cold days (TX10p) observed in the western-highland, while fewer cold days occurred in the central plateau, northern eastern lowlands, and Lake Kivu region. Warm days (TX90p) were more frequent in the mountain highland and central plateau areas, whereas the eastern lowlands, parts of the central highlands, and north-western Lake Kivu recorded fewer warm days. Absolute temperature extremes further highlighted regional contrasts: the lowest minimum temperatures (TNn 6-8°C and TNx 12-14°C) occurred in the central highlands and mountain climate areas, while the highest minimums (TNn 11-13°C and TNx 18-20°C) were found in the eastern lowlands. Similarly, the lowest daily maximum temperatures (TXn 10-14°C and TXx 23-27°C) were recorded in the mountain highland, while the highest (TXn 18-22°C and TXx 31-37°C) occurred in the eastern lowlands, central plateau, and southern Lake Kivu areas.

Overall, these findings underscore distinct climatic differences across Rwanda, with low-lying eastern regions experiencing more extreme heat, while elevated central and western areas remain significantly cooler. This variability highlights the importance of developing region-specific climate adaptation strategies to address the diverse temperature challenges across the country.

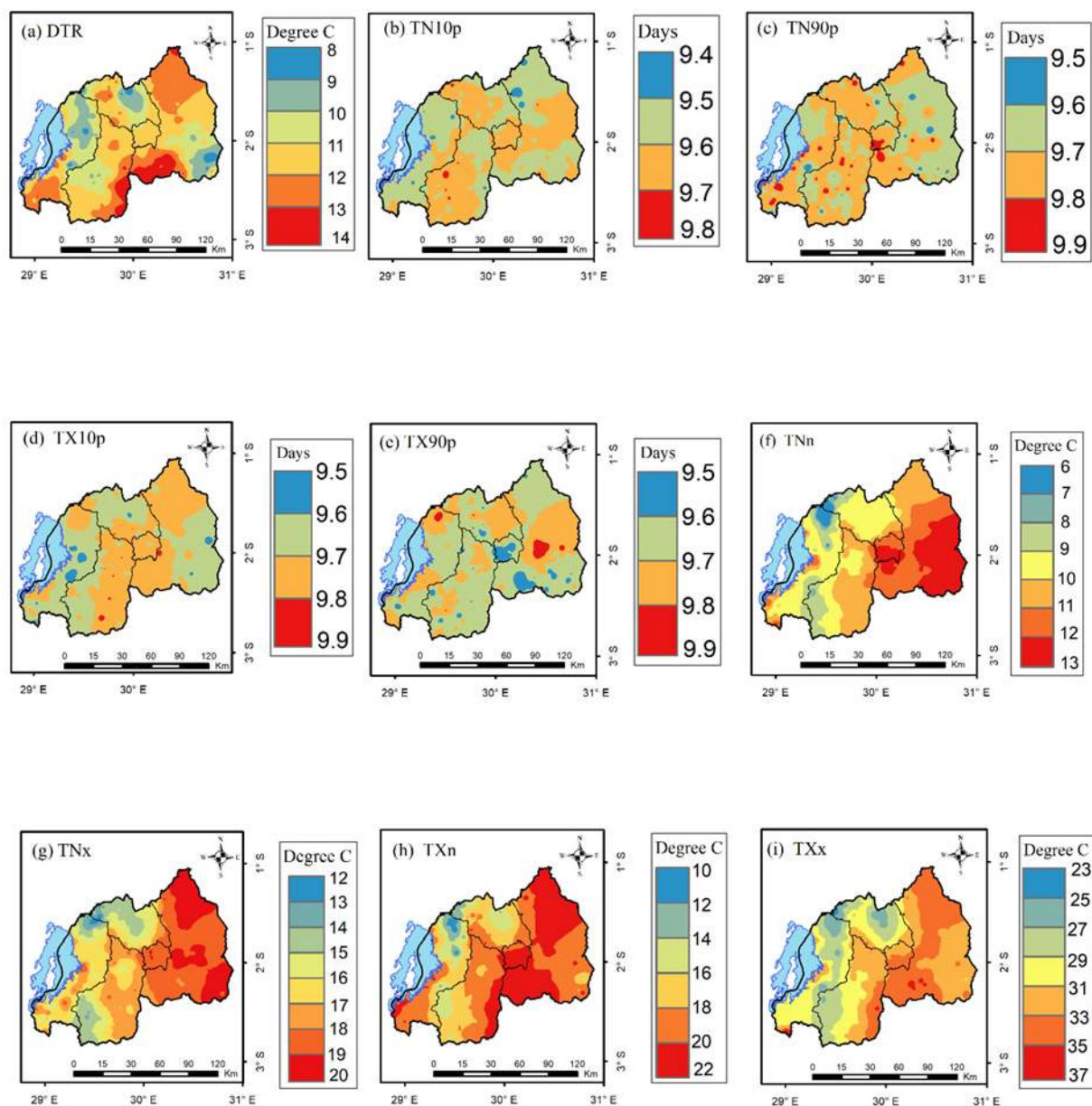


Figure 46: Spatial distribution in mean annual temperature extreme indices for the period of 1983-2021

Trends in Annual Rainfall and Temperature

From 1983 to 2021, annual rainfall shows a slight, non-significant decline with notable fluctuations, peaking around 1998 and 2002 and dropping sharply in 2016 and 2021, likely linked to El Niño and La Niña events. In contrast, temperatures display a clear upward trend, with minimum temperatures rising the most. The mean annual temperature peaks in 2021, aligning with global warming patterns. These changes suggest reduced frost, longer growing seasons, biodiversity shifts, increased heat stress, ecosystem alterations, and

higher energy demands for cooling, emphasizing the need for urgent climate action.

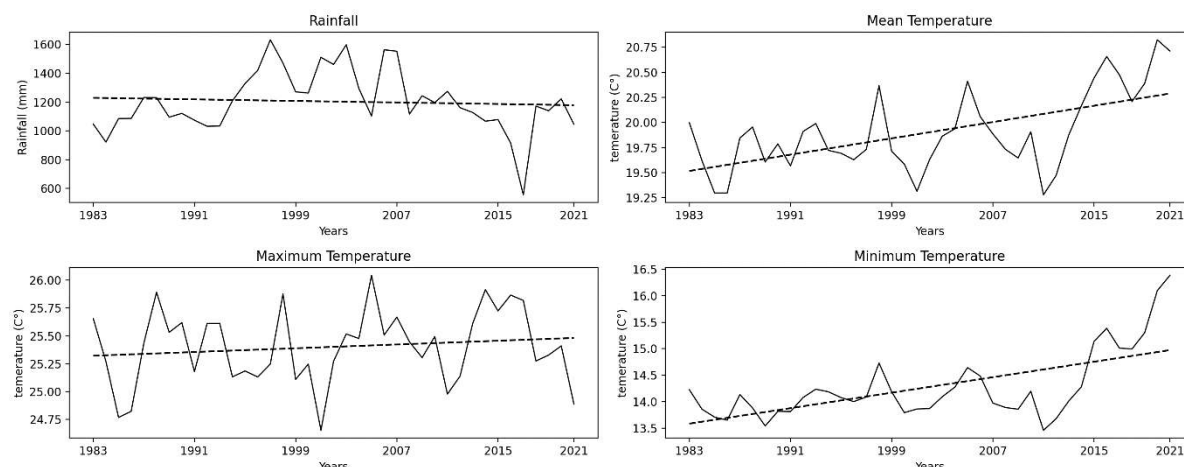


Figure 47: Country averaged trends in annual rainfall, mean temperature, maximum temperature, and minimum temperature for the period of 1983-2021

Trends in Temperature Extreme Indices

Between 1983 and 2021, Rwanda experienced a warming trend marked by a decreasing diurnal temperature range (DTR), fewer cold nights (Tn10p) and cold days (Tx10p), and a decline in extreme high daily maximum temperatures (TXx). At the same time, warm nights (Tn90p) and warm days (Tx90p) became more frequent, and both daily minimum and maximum monthly minimum temperatures (TNn and TNx) increased. This shift toward consistently warmer conditions and fewer cool periods has implications for agriculture (altered crop cycles, lower yields), higher water and energy demands, increased heat-related health risks, and disruptions to ecosystems and species distributions.

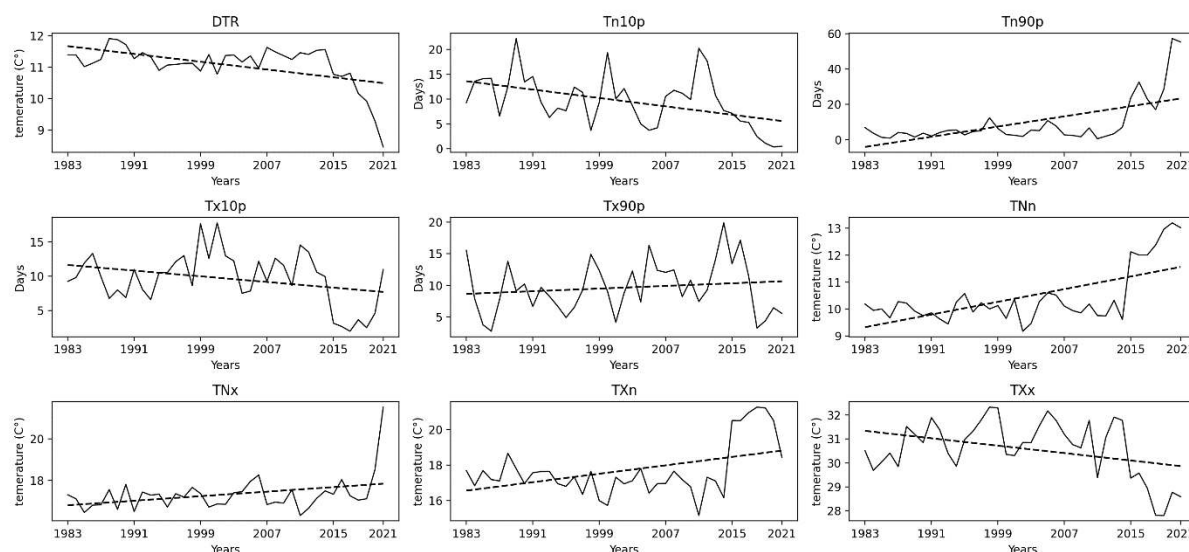


Figure 48: Country averaged extreme temperature indices from 1983 to 2021

Trends in Rainfall Extreme Indices

In the last decades, Rwanda experienced a significant decline in all rainfall extreme indices, including consecutive dry (CDD) and consecutive wet days (CWD), heavy precipitation days (R10mm) and very heavy precipitation days (R20mm), maximum one-day rainfall (Rx1day) and five-day rainfall (Rx5day), Daily simple intensity index (SDII), and precipitation from very wet days (R95pTOT) and precipitation from extremely wet days (R99pTOT). This indicates a marked decrease in both the frequency and intensity of extreme rainfall events, which may impact water resources, agricultural productivity, and disaster preparedness in the region.

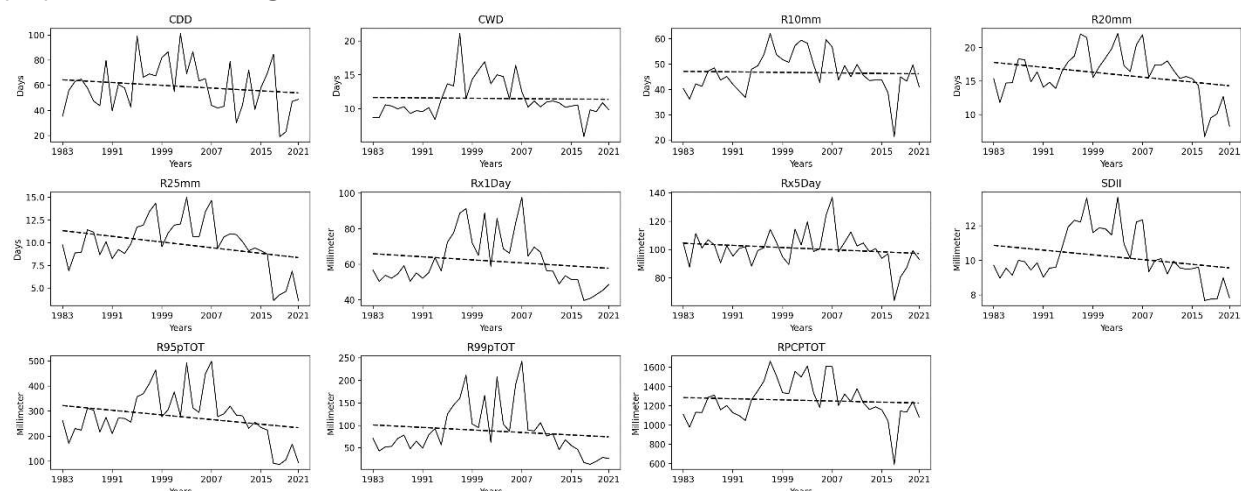


Figure 49: Country averaged extreme rainfall indices from 1983 to 2021

Climate Change Projections

Between 2024 and 2053, Rwanda is projected to face increased temperature extremes under both RCP4.5 and RCP8.5 scenarios. Minimum and maximum temperatures will rise, leading to more warm nights, more hot days, fewer cool periods, and greater frequency and intensity of extreme heat events. These changes are expected to increase water and energy demands, worsen heat-related health risks, and disrupt ecosystems, potentially shifting species distributions. Historical data already shows a warming trend, highlighting the urgent need for Rwanda to prepare and adapt to these climate impacts.

Between 2024 and 2053, Rwanda is projected to experience notable regional shifts in temperature extremes under both RCP4.5 and RCP8.5 scenarios. The Diurnal Temperature Range (DTR) is expected to increase by 2 to 4°C in the eastern and northern regions, whereas Bugesera may experience a decrease of 4 to 6°C, a pattern that remains consistent under RCP8.5. Cold nights (TN10p) are projected to increase in the country, with the most pronounced rise in the northeast under RCP8.5, reaching an additional 13.5 to 15 days. In contrast, warm nights (TN90p) are expected to decline nationwide, with reductions of 9 to 10 days under the same scenario. Cold days (TX10p) show slight low increase (3 to 8 days) under RCP4.5 than under RCP8.5 (8 to 14 days), with Bugesera expected to receive more cold days under both emission scenarios. Warm days (TX90p), however, are anticipated to decrease throughout Rwanda, with the largest reductions (-8 to -9 days) projected under RCP8.5.

Changes in daily temperature extremes further highlight regional contrasts: monthly minimum values of the minimum temperatures (TNn) are likely to cool by 1 to 4°C in central and western regions and warm by 2 to 4°C in Bugesera and the north. The monthly maximum values of the minimum temperatures (TNx) are expected to increase by up to 5°C in Bugesera, the southwest, and the northern highlands and slight reduction of 1 day in the north-eastern and western highland under both emission scenarios. The monthly minimum values of the maximum temperatures (TXn) may rise by 3 to 7°C in northern and southeastern regions while slightly cooling of up to -2°C in Kigali, southern western areas surrounding Lake Kivu region. The monthly maximum values of the maximum temperatures (TXx) may warm by 2.5-5°C across the north, southeast, and Congo Nile Ridge, with slight cooling of 2.5 to 5°C is projected for Bugesera and Kigali under both emission scenarios. These extremes show that Rwanda is expected to warm substantially, with fewer warm extremes and complex spatial shifts in temperature patterns that may pose substantial risks to

agriculture, water resources, public health, and biodiversity, and underscoring the need for targeted and region-specific climate adaptation strategies.

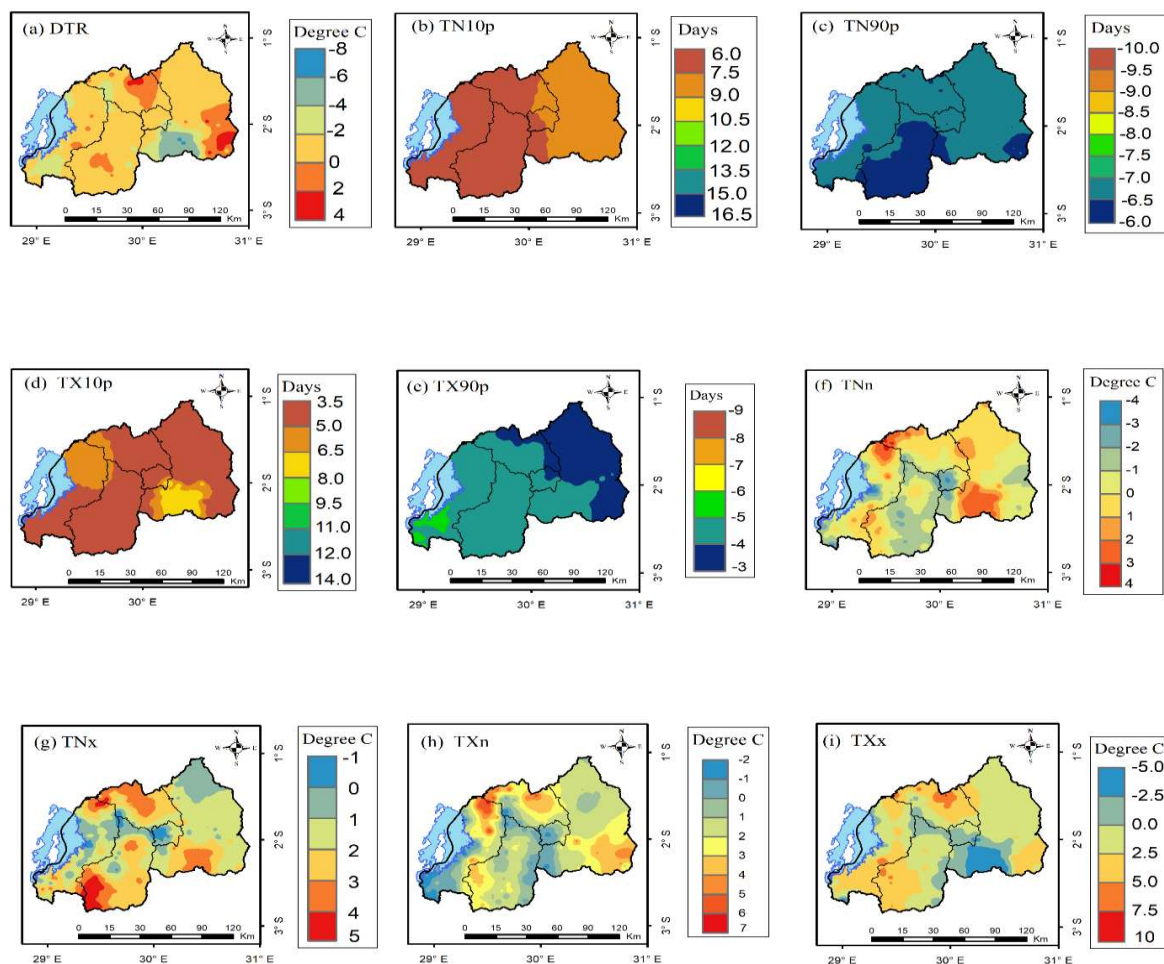


Figure 50: Projected changes in temperature extreme indices over Rwanda for the period of 2024-2053 under RCP4.5

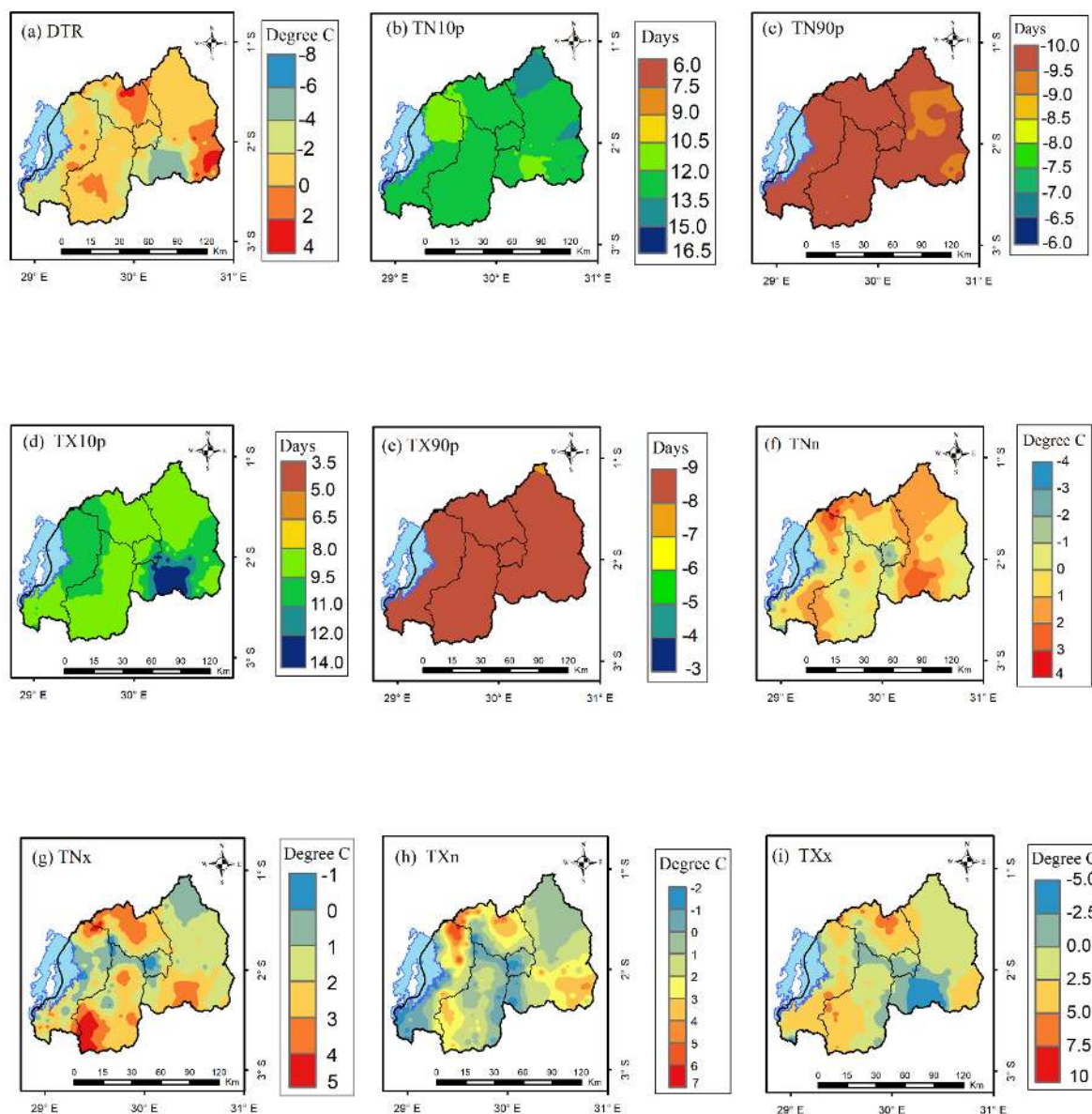


Figure 51: Projected changes in temperature extreme indices over Rwanda for the period of 2024-2053 under RCP8.5

Projection of Rainfall Extreme Indices

Figure 53 and 54 presents extreme rainfall indices projected changes under RCP4.5 and RCP8.5 for the period 2024-2053. Between 2024 and 2053, projected changes in Rwanda's rainfall extreme indices show distinct spatial patterns under both RCP4.5 and RCP8.5 scenarios. For CDD, under RCP4.5, increases of 5 to 20 days are expected over the extreme eastern, southwestern under both emission scenario, in the central parts of the country under RCP4.5 a reduction of 15 to 25 days is anticipated in the in the central region under RCP4.5 and north-western highlands under both RCP4.5 and RCP8.5. For CWD, under both RCP4.5 and RCP8.5, increases of 5 to 12.5 days are expected over the south, extreme southeast of Lake Kivu, and central-western regions, up to 5 days increase in the southeast under RCP4.5 and most parts of the eastern

lowland under RCP8.5, while a reduction of 5 days is projected in the northern areas of the country under both emission scenarios. For R10mm, under both emission scenarios, an increase of 15 to 25 days is projected in the extreme southeast of Lake Kivu and eastern lowland and in the southern region while the eastern areas and central parts of the country are anticipated to experience an increase of up to 15 days. The northern and western highlands and the regions of Lake Kivu are projected to reduce by 0 to 15 days and by 20 to 25 days western Nyungwe National Park with more magnitude under RCP8.5 than RCP4.5. For R20mm, both RCP4.5 and RCP8.5 show reductions of 0 to 10 days around Kigali and into the central-east, as well as in parts of the western highlands. The extreme southwest and northern highland are expected to increase by 15 to 25 days and by 15 days in the southern and south-eastern. R25mm also shows similar patterns under both scenarios, with a slight projected reduction of up to 5 days in central areas while other areas of the country are expected to experience an increase with high magnitude of 15 to 25 days in the extreme southwest and northern highland, and 5 to 15 days in remaining regions.

For Rx1day, under RCP4.5, strong increases of 40 to 80 mm are projected in the southwest, while increases of 0 to 40 mm are expected in the southeast, northern regions, and most of the southern and western areas, with 20 to 60 mm reductions elsewhere. Under RCP8.5, the Amayaga region, extreme north, and north-eastern areas are projected to increase by 0 to 20 mm, while the rest of the country reduces by 0 to 20 mm. For Rx5day, under RCP4.5, increases of 30 to 60 mm occur in the extreme southeast and northern regions, and 60 to 90 mm in the southwest, while most southern, western, and northern highlands reduce by 0 to 60 mm and the rest reduce by 30 to 60 mm. Under RCP8.5, increases of 30 to 90 mm are projected in the extreme southeast, northeast, and northern highlands, with a reduction of 0 to 30 mm elsewhere. For SDII, under both RCP4.5 and RCP8.5, strong increases of 4 to 8 mm/day are expected in the extreme southwest and northern regions, with 0 to 4 mm/day increases across remaining parts of the southern and western regions, Amayaga, northern areas and extreme South-eastern. The central areas are anticipated to reduce by 0 to 2 mm/day.

For R95pTOT, under RCP4.5, the entire country is projected to decrease, with 0 to 100 mm reductions in the southwest, Amayaga, and southeast, and 100 to 200 mm reductions elsewhere. Under RCP8.5, the whole country is projected to increase, with the strongest increases (400 to 600 mm) in the southwest, followed by 200 to 400 mm increases in the extreme southeast, northern regions, Amayaga, and central-to-southern western areas, and 0 to 200 mm increases elsewhere. For R99pTOT, under RCP4.5, Kigali City and central-to-north-eastern regions increase by 0 to 60 mm, southern areas around Akagera National Park and the north-western highlands increase by 60 to 120 mm, while the southern, extreme northern, and southwestern regions increase by 120 to 210 mm. Under RCP8.5, Kigali City and the central-east are anticipated to reduce by 0 to 30 mm, while the southwest is projected to increase by 180 to 240 mm, the south and west by 60 to 120 mm, and the rest of the country by 0 to 60 mm. Lastly, for PRCPTOT, under both RCP4.5 and RCP8.5, most of the country is projected to experience increased total rainfall (100 to 500 mm), except for the central to north-eastern eastern region, which may reduce by 0 to 300 mm.

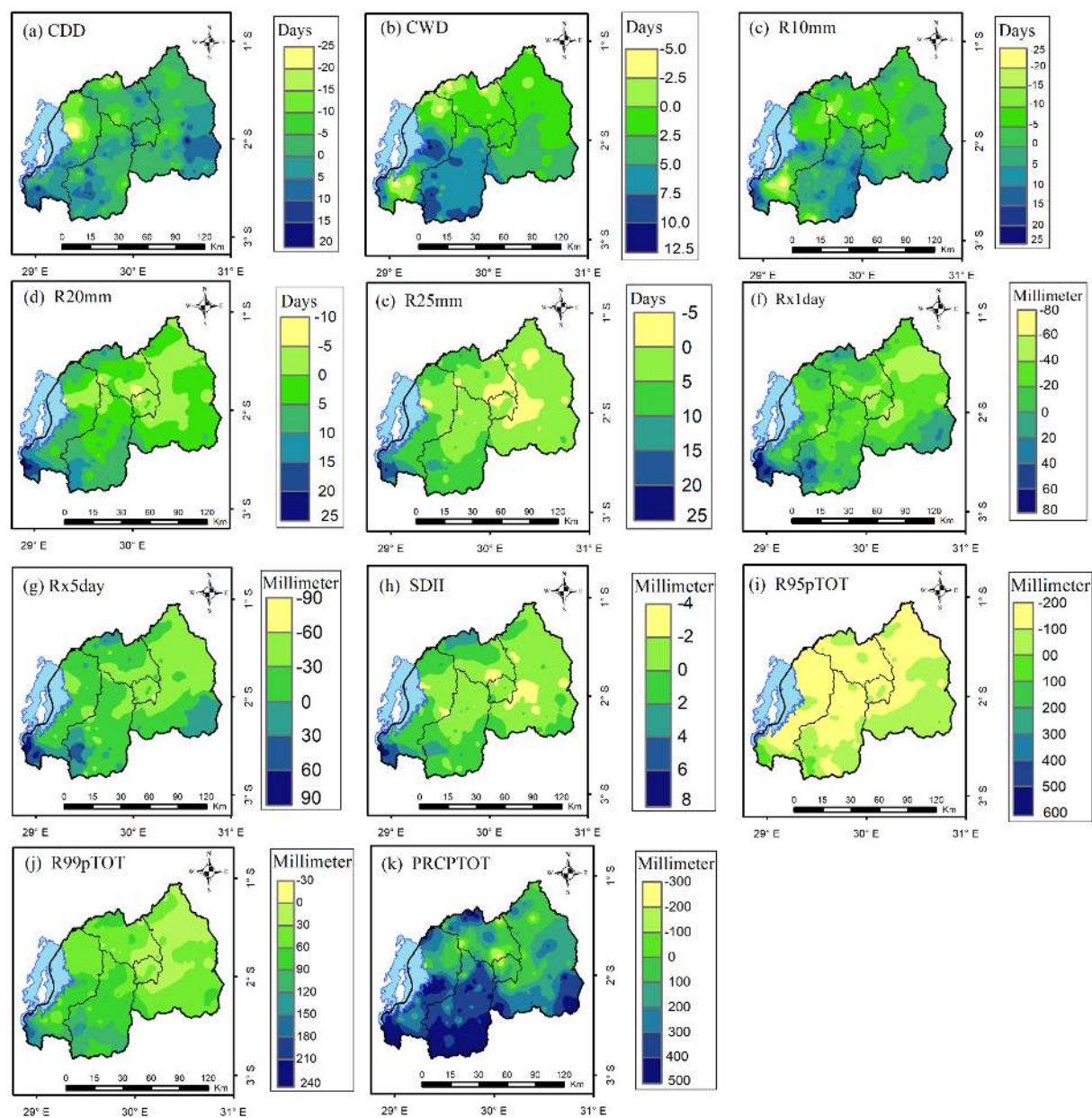


Figure 52: Spatial Projected changes in extreme rainfall indices under RCP4.5 for the period 2023-2053

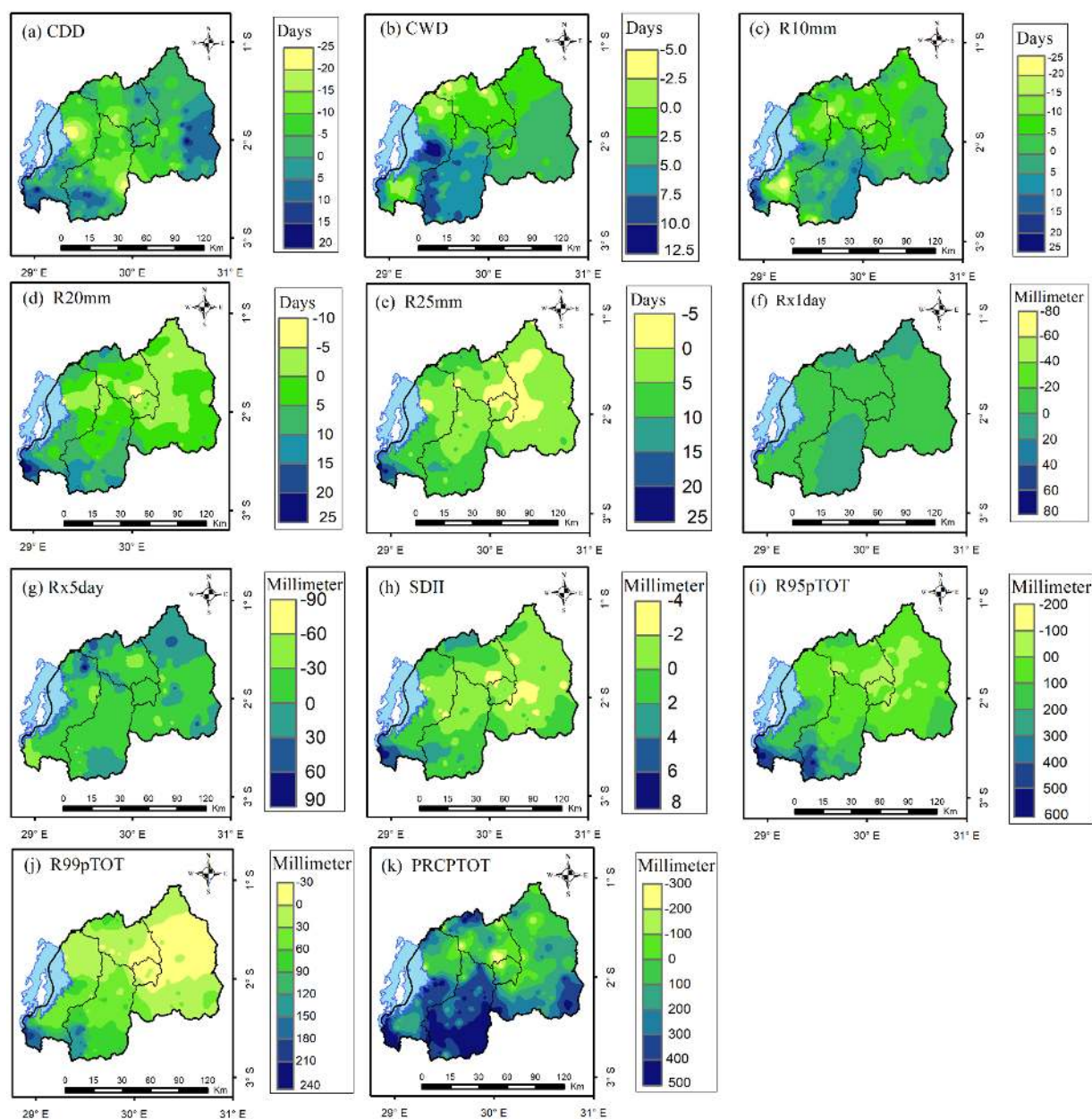


Figure 53: Spatial Projected changes in extreme rainfall indices under RCP8.5 for the period 2023-2053

4.2. VULNERABILITY ASSESSMENT AND ADAPTATION OF THE KEY SOCIO-ECONOMIC SECTORS OF RWANDA

4.2.1. Energy Sector

Energy demand is projected to increase more than sixfold by 2050, with industrial growth and transport driving consumption, while traditional fuels decline, Rwanda's Net Zero 2050 scenario envisions all-renewable electricity, widespread electrification, modern cooking fuels, and electric mobility, leading to reduced wood and fossil fuel use, improved efficiency, and declining emissions after 2040, while the Vision 2050 scenario projects sustained growth in industrial and transport energy demand.

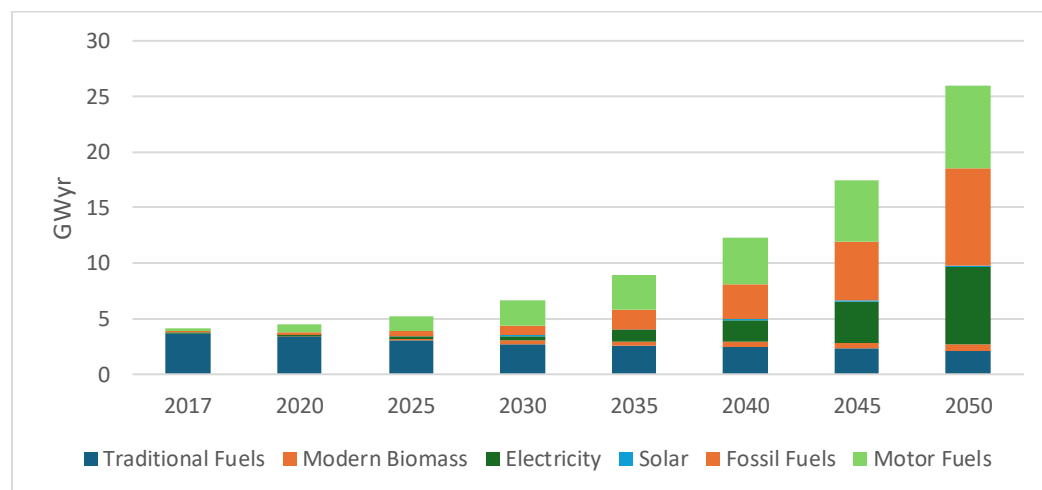


Figure 54: Final Energy Demand by Energy Form

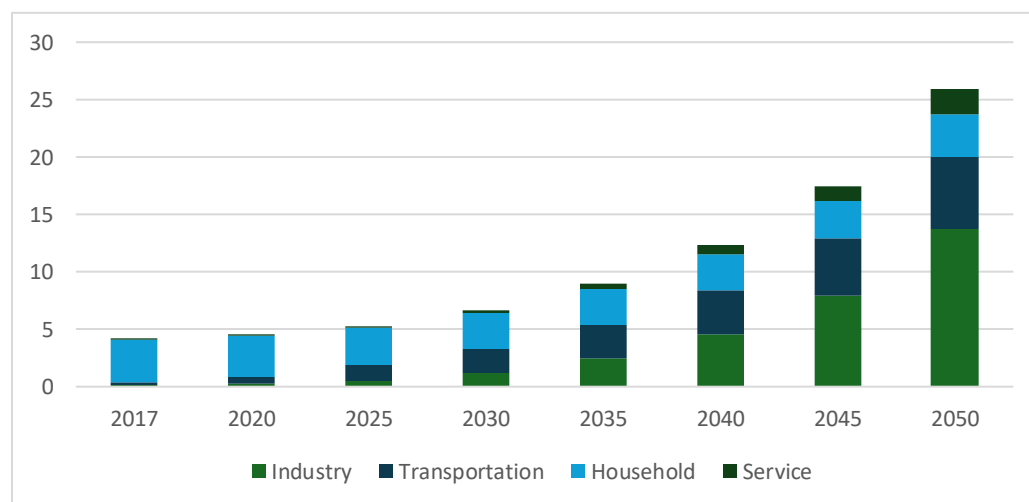


Figure 55: Final Energy Demand by Sector

Assessment of Energy Sector Vulnerability due to Climate Change

In Rwanda, the energy sector contributes to and is affected by climate change. Heavy reliance on biomass, particularly wood fuel, drives deforestation and emissions, while the use of fossil fuels such as peat, oil, and gas add significant carbon dioxide and methane to the atmosphere. At the same time, climate change poses major risks to Rwanda's energy system: extreme weather events threaten infrastructure, shifting rainfall patterns undermine hydropower generation, and rising temperatures increase cooling demands for thermal plants and buildings.

In response, Rwanda has pursued renewable energy expansion (hydropower and solar), promoted off-grid solutions to reduce biomass dependence, and implemented energy efficiency measures across sectors. The country has also strengthened climate adaptation efforts, developed robust policy frameworks like the National Strategy for Climate Change and Low Carbon Development, and engaged in international cooperation such as the Paris Agreement.

Despite these initiatives, the sector remains vulnerable to rainfall variability, sedimentation, and increased energy demand driven by warming, highlighting the need for continued investment in resilience and sustainable, low-carbon growth.

Vulnerability of Electricity Infrastructure

Climate change is expected to impact Rwanda's electricity infrastructure, affecting generation, transmission, and distribution, which may increase system failures, threaten energy security, and hinder economic development. Rising maximum and minimum temperatures create stress on thermal power systems and increase cooling demands, while prolonged dry spells in the west reduce hydropower output from key rivers. Conversely, heavy rainfall in mountainous areas can boost hydropower potential but also heighten risks of flooding and erosion, damaging infrastructure. To address these challenges, opportunities lie in expanding solar energy where solar resources are abundant, and strengthening transmission grids in flood-prone areas. Overall, building a diversified and climate-resilient energy system is essential to secure Rwanda's energy future.

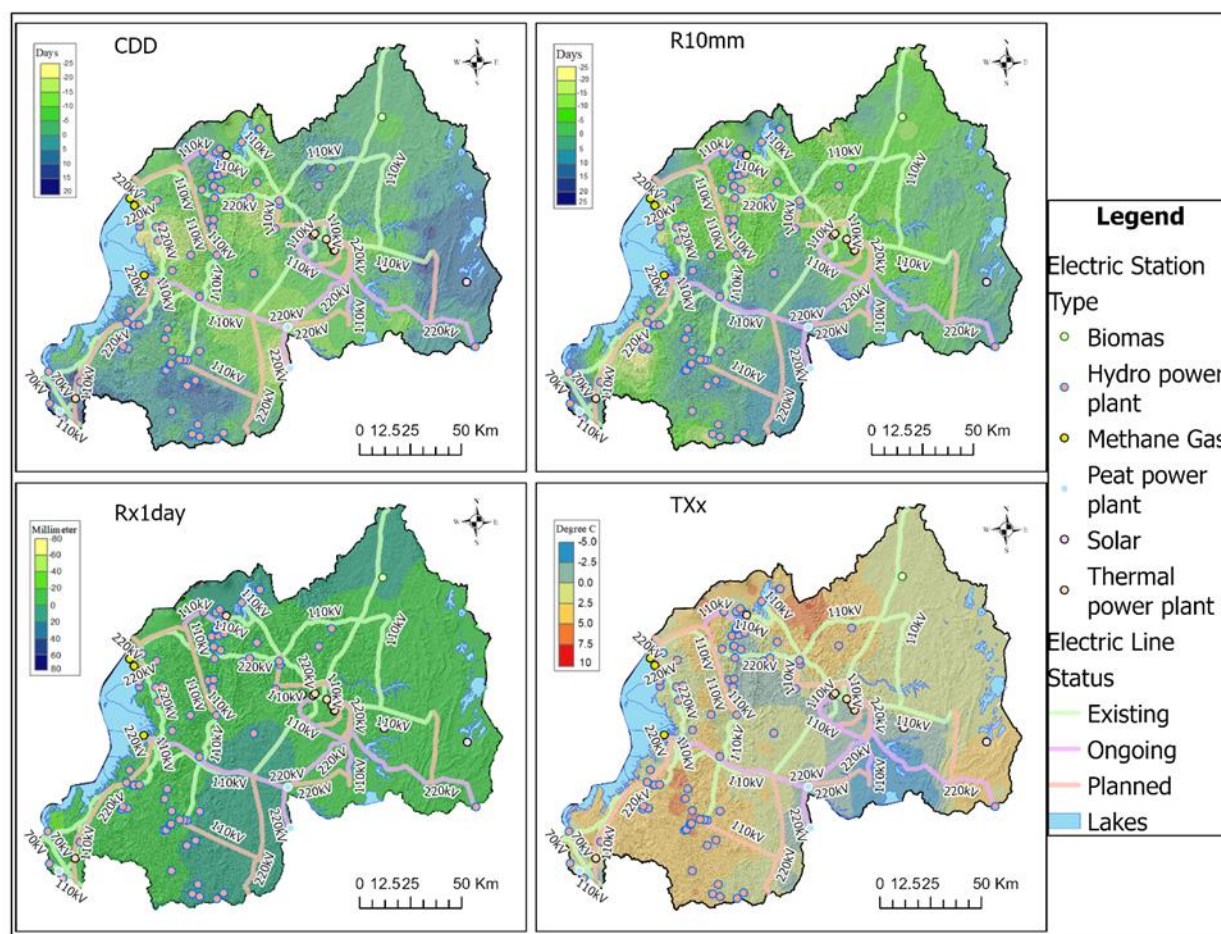


Figure 56: The Influence of Climate Extremes on Rwanda's Energy Systems

Vulnerability of Renewable Energy Resources

Rwanda's renewable energy resources mainly hydropower, alongside solar and developing geothermal are all vulnerable to climate change, though to varying degrees. Hydropower, the country's primary renewable source, is especially affected by siltation and unstable river flows, driven by unsustainable catchment protection, wetland conversion to agriculture and encroachment buffer zones around water bodies. These factors reduce soil water retention and river discharge stability, particularly during dry seasons. An assessment of hydropower catchments revealed issues of erosion, weak protection, and the need for stronger interventions. While measures such as terracing, agroforestry, afforestation, and gully or buffer zone protection have been introduced, they remain limited in scale, leaving many catchments insufficiently safeguarded against climate variability and change.

Climate Projections and their Impact on Hydropower Production

The modelling framework assessed how climate change may affect Rwanda's hydropower sector, given its dominance in the national grid. It analysed eight key hydropower plants (REG, 2023 - 2050) both impoundment and run-of-river types including Nyabarongo I & II, Mukungwa I & II, Rwaza, Nyundo, Ntaruka, and the Rusumo Regional HPP. These plants face varying degrees of vulnerability to sedimentation, erosion, and inadequate catchment protection, which influence their efficiency and long-term sustainability.

The assessment shows that 36 plants fall under medium sediment/erosion impact with moderate catchment protection, six have low sediment/erosion impact but still require stronger protection, and ten face high sedimentation and erosion risks due to weak catchment management. Well-protected sites like Rukarara I demonstrate the benefits of integrated landscape restoration including afforestation, terraces, agroforestry, tea plantations, and gully rehabilitation which ensure clean water flows and improved plant performance. Overall, targeted interventions in catchment restoration, sediment management, and infrastructure reinforcement are essential to secure Rwanda's hydropower resilience against climate change.

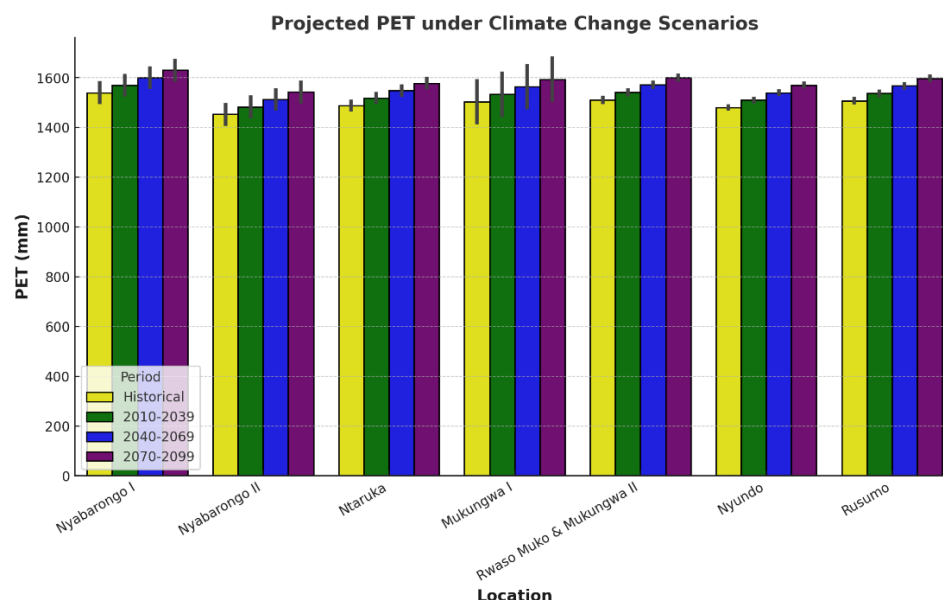


Figure 57: The changes in Potential Evapotranspiration (PET) for all basins

Source: Rwanda LCPDP

Other Renewable Energy Resources

Climate change impacts the vulnerability of Rwanda's renewable energy resources differently:

- **Renewable energy in general:** Solar energy output is directly affected by changing weather, causing variability that can impact grid stability. The effect depends on the variability's correlation with demand, forecasting accuracy, and backup generation costs.
- **Biomass:** Biomass resources like firewood and charcoal are vulnerable to extreme weather (droughts, floods, fires), which can reduce feedstock growth and supply. Inefficient biomass combustion emits significant greenhouse gases, including harmful incomplete combustion products like CO and methane, contributing to global warming.
- **Methane gas from Lake Kivu:** The large methane reserves offer potential for power generation, though extraction efficiency is currently below expectations. Climate change-induced rising water levels and extreme weather threaten offshore methane infrastructure and equipment performance.

Overall, climate change poses risks through weather variability, extreme events, and environmental changes, affecting renewable energy supply stability and infrastructure.

Energy from Agricultural, Forest, and Urban Wastes

Climate change issues and vulnerabilities related to farm, forest, and urban waste as energy sources include:

- **Farm and Forest Waste:** These are important rural energy sources but are vulnerable to climate change impacts on agriculture and forestry. Water availability changes, such as droughts or floods, can reduce biogas production in household units that depend on consistent water supply.
- **Urban Waste:** Urban organic waste (like paper, wood, yard waste) is a renewable energy resource but often ends up in dumps that emit methane, a potent greenhouse gas. Designing these dumps as landfills to capture methane can serve as both a global mitigation and local adaptation strategy, providing alternative energy for homes and industries.

Adaptation Strategies for the Energy Sector

Building on the vulnerabilities highlighted in the previous sections, Rwanda's energy sector faces growing climate related risks including variability in rainfall, rising temperatures and extreme weather events that threaten energy demand and security. The implementation of robust adaptation strategies is imperative to strengthen resilience to adapt, withstand and recover from the impacts of climate-related events and mitigate risks associated with climate-induced disruptions to ensure energy security. Building resilience requires strengthening critical infrastructure like hydropower dams, retaining walls, resilient sand traps as well as strong transmission lines that withstand to extreme weather conditions, variability in water resources and hazard risks.

Diversifying the energy mix and investing in renewable energy sources including solar reduces reliance on single-source dependency. This supports energy security, economic stability, and environmental sustainability. Effective adaptation also depends on supportive policies and institutional frameworks that integrate climate risk into energy planning and establish early warning systems. Collaboration among government agencies and stakeholders improves coordinated climate-response efforts. Capacity-building and public awareness enhance energy-efficient practices, reduce vulnerability and strengthen local communities' adaptive capacity.

Adaptation Strategies for Hydropower

The main climate impacts on hydropower are primarily due to changes in water availability and hydrological patterns, which are influenced by climate change.

Adaptation strategies for hydropower in the face of the above vulnerabilities include:

- **Incorporating climate resilience into the design of hydropower projects** can help ensure their long-term viability in a changing climate;
- **Design more robust dams and infrastructure for heavier flooding** and extreme events and Upgrading infrastructure to withstand extreme weather events and improving hydrological conditions can improve the resilience of hydropower systems;

- **Improved reservoir management strategies** can help regulate water flow, ensuring a more reliable supply for hydropower generation, especially during periods of low flow and Develop basin-wide management strategies that consider the full range of downstream environmental and human water uses;
- **Modify spillway capacities** and install controllable spillway gates to flush silted reservoirs;
- **Modify the number and type of turbines** that are better suited for expected water flow rates and more resilient to performance reductions and turbine lifetime due to higher suspended sediment loads;
- **Restore and better manage upstream** land including afforestation to reduce floods, erosion, silting, and mudslides;
- **Enhancing operational flexibility**, such as by adjusting water release schedules based on changing conditions, can help optimize hydropower generation under varying circumstances;
- **Adopting integrated water resource management** approaches that consider the needs of both energy production and other sectors can help optimize water use and reduce conflicts over water resources.

Adaptation Strategies for Photovoltaic (PV) Power Generation

The main climate impacts on photovoltaic systems are likely to be due to temperature increases, increased cloud cover, and extreme events. Adaptation measures include the following (ADB, 2012):

- **Assure PV structures are resilient** to withstand higher winds (although roof-mounted structures cannot be more robust than the building on which they are located).
- **Use designs that improve passive airflow** beneath photovoltaic mounting structures, reducing panel temperature and increasing power output.
- For locations where temperature increases or significant heat waves are expected, **choose modules with more heat-resistant photovoltaic cells** and module materials designed to withstand short peaks of very high temperatures.
- High temperature could also be overcome by **combining a photovoltaic module with a cooling system** in the so-called photovoltaic-thermal (PVT) systems.
- **Consider distributed systems** (rather than feeding power into a single part of the grid), which can **improve grid stability** (although mobile repair teams may be needed to repair damage from extreme events).
- Where solar energy is likely to become more diffuse with changes in cloud cover, **rough-surfaced photovoltaic modules are more efficient**, and output can be improved under overcast conditions by selecting an appropriate tilt angle.
- Where clouds are likely to pass over modules more quickly, **consider micro-inverters for each panel** (in place of small numbers of large, centralized inverters) to improve stability and increase power output.

Adaptation Strategies for Electricity Transmission and Distribution Infrastructure

The main climate impacts on Electricity Transmission and Distribution (T&D) Infrastructure are primarily due to extreme weather events and temperature-related stresses, which affect the physical assets and operational reliability.

The main adaptation measures for Electricity transmission and distribution infrastructure include the following:

- Reinforce existing transmission and distribution structures and build underground distribution systems.
- Require higher design standards for distribution poles (usually wood) and towers (steel).
- Change routes of overhead lines along roads away from trees, rigorously prune trees, and use covered and/or insulated conductors and more underground cables, especially in wooded areas.
- Where higher temperatures may occur, specify more effective cooling for substations and transformers, including retrofitting measures, improved shading, and choice of cooler locations where possible.
- Where lightning strikes may increase, include lightning protection (earth wires, spark gaps) in the distribution network.
- Design more flexibility into transmission and distribution networks, allowing increased rerouting during times of disruption.
- Forbid the construction of power lines near dikes and ban "permanent" trees such as eucalyptus next to existing dikes.

Adaptation Strategies for Biomass

The main climate impacts on biomass are primarily due to changes in temperature, precipitation, and extreme weather events, which directly affect the growth, availability, and quality of biomass feedstocks. The main adaptation measures include:

- Improving the sustainability of charcoal production requires [enforcing regulations](#) to stop illegal activities, increasing the efficiency and yields of legal charcoal production using plantation-grown materials, and establishing new plantations on degraded land to reduce pressure on natural forests. These measures should be carried out alongside broader adaptation actions that support sustainable livelihoods and protect natural ecosystems. Diversification of household and community energy generation sources to reduce reliance on biomass as an energy source and thus reduce pressure on natural systems. Examples include solar energy or small-scale hydropower generation.

Adaptation Strategies for Thermal Energy

- Climate proofing of thermal power including [retrofitting of existing infrastructure](#) and design of future infrastructure. Measures can include strengthening of infrastructure against storm events or wind, protection of infrastructure against flooding with dykes or berms, or construction of new infrastructure in areas unlikely to be affected by future flooding, salinity, or storm events.
- Disaster Preparedness and Emergency Response.
- Including extreme heat concerns in air quality improvement plans.
- Conduct a heat vulnerability assessment.

Adaptation Strategies for Electricity End Use

Adaptation measures to cope with increased energy demand are of three types:

- **Increasing generation capacity to meet increased demand:** The diversification of power sources will continue to reduce reliance on single energy sources vulnerable to climate change impacts (e.g. fossil fuels) by diversifying into renewables (solar, wind, hydro) and incorporating energy storage technologies. This will reduce the use of expensive and polluting diesel generation and will enable the Government to lower the long-term cost of service and work towards a cost-reflective consumer tariff.
- **Improving the efficiency of energy supply (generation, transmission, distribution system improvements); and improving end-use efficiency:** Mechanisms for improving energy efficiency should be improved further to adapt to climate change-induced demand. Enhancing energy efficiency in buildings, industries, and transportation can reduce overall energy demand and make the energy sector more resilient to supply disruptions. Various Initiatives will be undertaken to reduce the amount of electricity required to meet the needs of households and industry.

4.2.2. Agriculture Sector

Agriculture sector overview Rwanda's agriculture sector is the cornerstone of its economy, driving social transformation and poverty reduction with nearly 69% of households involved in agriculture (NISR, 2023). Despite challenges posed by the COVID-19 pandemic, global shocks, and climate change impacts, agriculture remains a key sector, contributing significantly to GDP and exports. The sector faces unique challenges like soil erosion, limited arable land, and water management issues, necessitating adaptive strategies such as terracing and organic farming. Rwanda's initiatives, including the Crop Intensification Programme, have led to increased crop yields (Republic of Rwanda, 2020) and improved agricultural practices (REMA, 2021). However, climate change poses a substantial risk, influencing temperature extremes, unpredictable weather patterns, and extreme events that threaten agricultural productivity. Targeted adaptation measures, including irrigation, drought-tolerant crops, and soil conservation practices, are crucial for ensuring food security and sustaining Rwanda's agriculture sector amidst evolving climate conditions.

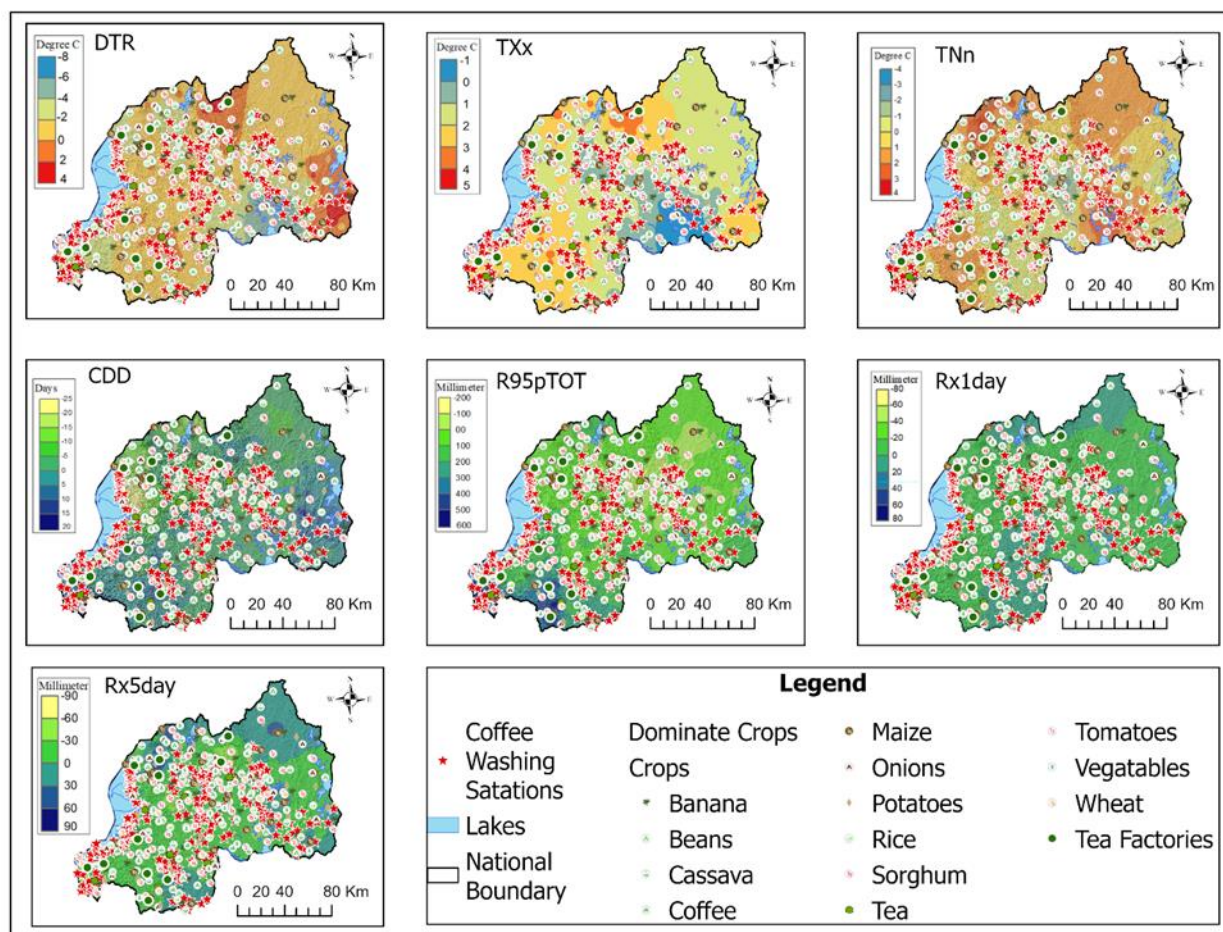


Figure 58: Climatic Extremes and Crop Sensitivity Across Agro-Ecological Zones in Rwanda

Assessment of Agriculture Sector Vulnerability Due to Climate Change

The agriculture sector is highly sensitive to climate change, with temperature shifts, altered rainfall, and extreme weather events disrupting crop production and reducing yields, thus threatening food security—especially in already vulnerable tropical and subtropical regions. Increased frequency of floods, droughts, and storms causes direct damage to crops, livestock, and infrastructure, leading to significant economic losses (IPCC, 2019). Water scarcity worsened by climate change further undermines agricultural productivity, with sub-Saharan Africa and South Asia being particularly at risk (World Bank, 2019).

In Rwanda, climate impacts like higher temperatures, drought, and increased evapotranspiration are altering suitable farming areas and growing seasons, affecting key crops such as tea, coffee, maize, and beans (USAID, 2019). Floods and landslides cause substantial agricultural and infrastructure losses, costing the country millions annually. Rainfall variability has shifted sowing dates and caused seasonal crop failures (RAB, 2015). Soil erosion and nutrient loss from heavy rains challenge productivity, while dry conditions in eastern Rwanda increase drought sensitivity and crop losses (RAB, 2016).

Table 17 below summarize the impacts of climate change on agriculture and food security in Rwanda and related adaptation strategies.

Table 17: The impact of climate change and key adaptation strategies on agriculture

Index	Spatial Patterns	Agricultural Impact	Key Adaptation Strategies
Consecutive Dry Days (CDD)	Increases projected over the eastern, southwestern, and central plateau regions indicate longer dry spells.	Extended dry periods exacerbate drought stress, reducing water availability for rain-fed crops such as maize and beans, and necessitating cultivation of drought-resistant varieties.	Expand irrigation infrastructure; adopt drought-tolerant crops; improve water harvesting and soil moisture retention practices.
Very Wet Days (R95pTOT/VWD)	Highest frequency in the southwestern highlands (e.g., Nyungwe, Rusizi) with lower extremes in central and eastern areas.	Excessive rainfall can lead to flooding, waterlogging, and soil erosion. This affects sensitive crops (beans, maize, potatoes) and perennial crops (coffee, tea) by damaging root systems and reducing yields.	Enhance drainage systems; implement terracing and soil conservation measures; deploy erosion control practices in high-risk areas.
Max 5-Day Precipitation (Rx5day)	Extreme 5-day rainfall events are more frequent in western and northwestern regions (e.g., Nyamasheke), with lower intensities in central and eastern areas.	Short-term intense rainfall may overwhelm soil absorption, causing waterlogging and increased soil erosion. This disrupts crop growth, delays planting/harvesting, and reduces productivity.	Improve drainage and flood management; adopt soil conservation techniques such as contour plowing and cover cropping; establish early warning systems to manage peak rainfall events.
Diurnal Temperature Range (DTR)	Higher DTR values (up to 8°C) are evident in eastern and southeastern regions, while lower values occur in the western highlands and near water bodies.	Large temperature fluctuations can lead to moisture loss from soil and induce heat stress in crops, affecting processes like transpiration and nutrient uptake. In contrast, low DTR may reduce photosynthetic efficiency in some perennial crops.	Develop and deploy heat-tolerant crop varieties; introduce agroforestry to provide thermal buffers; optimize irrigation scheduling and improve soil management to retain moisture.

Adaptation Strategies for the Agriculture Sector

Rwanda faces challenges in agriculture due to unpredictable rainfall, rising temperatures, and extreme weather. To build resilience, several strategies are being implemented:

- **Drought-resistant crop varieties:** Promoting crops bred to withstand drought, flooding, and temperature fluctuations helps stabilize yields and food security, reduces reliance on weather, and lowers the need for harmful inputs.
- **Crop diversification:** Growing a variety of crops spreads risk from climate threats, improves soil health, boosts biodiversity, and supports long-term sustainability.
- **Improved irrigation efficiency:** With water scarcity increasing, efficient irrigation is critical, especially during dry seasons. Rwanda invests in solar-powered irrigation systems (e.g., Nasho project), which are cost-effective, clean, and boost productivity for small-scale farmers (Akinagbe & Irohibe., 2014).
- **Afforestation and agroforestry:** Projects like Green Gicumbi promote tree planting, soil conservation, organic fertilizers, and sustainable land management to enhance resilience and food security (FONERWA, 2021).
- **Hydroponic farming:** To reduce climate impact, Rwanda is adopting soil-less crop cultivation using nutrient solutions and recycled water, which saves space and reduces water use drastically. This method is supported by government and private sector initiatives, showing promise in transforming agriculture toward more sustainable, market-oriented production.

These strategies collectively aim to adapt Rwanda's agriculture to climate variability, ensuring productivity and sustainability.

Table 18 below outlines the main challenges faced by the agricultural sector, climate change impact and the proposed adaptation strategies. Implementing these strategies can help improve the resilience, productivity, and sustainability of agriculture in Rwanda.

Table 18: Climate impact, development challenges, and proposed adaptation strategies for agriculture

Sector	Climate Scenarios	Climate change Impact	Proposed Adaptation Strategies
Agriculture	Warmer temperature	▪ Increased heat stress on crops and livestock ▪ Reduced agricultural productivity ▪ Increased evapotranspiration, leading to water shortage.	▪ Promote drought resistant crops and heat tolerant livestock breeds ▪ Enhance water storage systems (e.g.: rainwater harvesting) ▪ Promote agroforestry to promote microclimates.
	Prolonged drought	▪ Water scarcity for drinking and irrigation	▪ Develop and disseminate drought-resistant crop varieties

Sector	Climate Scenarios	Climate change Impact	Proposed Adaptation Strategies
		▪ Reduced agricultural output ▪ Livestock deaths due to lack of water	▪ Implement efficient irrigation techniques ▪ Develop drought resilient farming practices ▪ Diversify crops to include drought tolerant varieties.
Agriculture	Higher evapotranspiration	▪ Increased water loss from soil and plants ▪ Reduced soil moisture ▪ Affecting crops growth.	▪ Improve soil conservation practices. ▪ Introduce water efficient irrigation system
	Change in rainfall timing and amount	▪ Disrupted planting and harvesting cycles. ▪ Increased flooding risk or drought depending on the region. ▪ Reduced water quality from runoff and flooding.	▪ Implement weather based early warning system for agriculture. ▪ Train farmers on adjusting planting times according to the rainfall patterns. ▪ Improve water management and flood control infrastructure.
	More frequent and intense flooding.	Soil erosion and loss of arable land.	▪ Strengthen flood management infrastructure (eg: dams) ▪ Promote reforestation and sustainable land management to reduce soil erosion. ▪ Develop Early warning system
	Increased risk of land slides	▪ Loss of fertile topsoil and reduction of agricultural productivity. ▪ Destruction of fields and crops during landslides ▪ Damage to terraces, irrigation channels, and access paths.	▪ Implement and maintain bench terraces on steep slopes to reduce runoff and soil erosion. ▪ Planting trees and shrubs alongside crops to stabilize soils and improve water retention.

Sector	Climate Scenarios	Climate change Impact	Proposed Adaptation Strategies
			- Use of ground cover plants to protect the soil from erosion. - Build stone bunds, check dams, and ridges to hold soil in place.
	Increased pests and disease outbreaks	- Decreased crops yield due to pest infestation. - Spread of disease affecting both crops and livestock.	- Promote Integrated Pest Management practices. - Enhance monitoring system for pests' diseases. - Encourage the use of resistance crops varieties.

4.2.3. Forestry Sector

Forestry Sector overview Rwanda is actively pursuing economic transformation and poverty eradication through its Green Growth and Climate Resilience Strategy (GGCRS), recognizing the crucial role forests play in sustainable development. Despite challenges, Rwanda has developed strategic documents and policies to address these issues. Initiatives such as the Rwanda Forest Investment Plan (FIP) of 2017 and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) Readiness Proposal aim to enhance sustainable forest management and combat deforestation. The country's commitment to international agreements like the Paris Agreement and efforts to restore forest ecosystems demonstrate Rwanda's dedication to climate change mitigation and biodiversity conservation. However, challenges persist, including the need to understand and harness the full carbon sequestration potential of Rwanda's forests to leverage carbon markets for community incentives and alternative livelihoods. The main (proximate) and underlying drivers of deforestation and forest degradation as described in the FIP are presented in Table 18.

Table 19: Identified drivers of deforestation and forest degradation

Drivers deforestation and forest degradation			
Main (Proximate)		Underlying	
i.	Agriculture, with 95% of households practicing traditional subsistence agriculture on small plots,	i.	High population growth, with 72.1% living in rural areas and 27.9% in cities, the increasing pressure on forests from agriculture, urbanization, and exploitation of forest resources are linked to the high
ii.	Infrastructure development, including development of roads		

iii.	Urbanization including the growth of built-up area, which increased by over 300% in the period from 1990 to 2016,	population with limited land to sustain their livelihoods;
iv.	Artisanal mining practices, with no restoration of abandoned mining sites,	ii.
v.	Forest product extraction, mostly firewood, charcoal, and timber	Lack of awareness and alternatives, which has led to the failure of different projects aiming to promote sustainable forest management and full engagement of local communities.
vi.	Limited forestry extension services.	

Source: Adapted from FIP,2017, NISR, 2022

Assessment of Forestry Sector Vulnerability due to Climate Change

Forest vulnerability assessment in Rwanda was done using rainfall, temperature, and climate extremes data combined with GIS modelling.

- Forest cover showed a modest increase, bare land decreased (indicating some restoration), while built-up areas expanded due to urbanization.
- Climate extremes, especially rainfall intensity and temperature variability, significantly impact forest health:
 - Heavy rainfall causes waterlogging, erosion, and landslides, especially in western forests like Nyungwe National Park.
 - Prolonged dry periods and heatwaves, particularly in eastern forests, increase fire risk, vegetation stress, and reduce natural regeneration.
- Prolonged dry days raise wildfire risks as dry vegetation becomes highly flammable, and moisture stress impedes seedling survival.
- These findings help identify priority areas for reforestation, fire management, and biodiversity conservation to reduce habitat fragmentation and boost carbon sequestration.
- The study highlights the need for climate-smart forest management using spatial and climate data to support effective policy and land-use planning.

The findings from these analyses demonstrate that Rwanda's forests are increasingly vulnerable to climate extremes, particularly prolonged dry spells (CDD), heavy rainfall (Rx1day, R95pTOT), and temperature variability (DTR, TXx). These events exacerbate forest degradation risks, including wildfires, landslides, biodiversity loss, and declining carbon sequestration

Adaptation strategies for the Forestry sector

Overall, the modelling underscores the urgent need for climate smart forest management, combining spatial data with climate projections to guide effective policy, conservation and land use planning efforts. As such, Rwanda's forest adaptation strategy must integrate climate data and spatial analysis to prioritize climate-smart forest management and restoration interventions.

Key adaptation strategies include:

- **Climate-informed Forest and Landscape Restoration (FLR):** Using GIS data, areas prone to drought stress or flood-related degradation, such as the eastern drylands and western highlands, should be prioritized for restoration, erosion control, and fire management. Restoration efforts should aim to enhance ecosystem integrity, biodiversity, and resilience.
- **Integrated Forest Planning and Early Warning Systems:** Incorporating climate risk mapping into national and district-level forest management plans will help prevent and respond to climate hazards such as landslides and forest fires. Early warning systems can support preparedness in vulnerable forested areas like Nyungwe and Gishwati.
- **Agroforestry and Sustainable Land Use:** Promoting agroforestry in buffer zones and degraded lands supports forest connectivity, enhances carbon storage, and diversifies community livelihoods. These efforts should align with existing frameworks such as the National Forest Policy, Agroforestry Strategy, and PSTA 4.
- **Participatory and Landscape-based Approaches:** Forest adaptation should engage local communities and stakeholders through inclusive planning processes. Landscape-level approaches are essential to address the mosaic of land uses (forests, farms, wetlands) and ensure coordinated management across watersheds.
- **Alignment with Green Growth Priorities:** These strategies reinforce Rwanda's Green Growth and Climate Resilience Strategy (GGCRS), particularly under programs supporting ecosystem conservation, sustainable biomass energy, and payment for ecosystem services (PES).

4.2.4. Water Resources Sector

The Rwandan's hydrographic system is split into two basins divided by the Congo-Nile ridge, with water systems to the west of the ridge flowing into the Congo basin, whereas those to the east of the ridge discharge into the Nile basin. For better management of the Rwandan water resources; this hydrographic system was split into 9 catchments level 1 namely: Kivu (CKIV), Rusuzi (CRUS), Akagera Lower (NAKL), Akagera Upper (NAKU), Akanyaru (NAKN), Mukungwa (NMUK), Muvumba (NMUV), Nyabarongo Lower (NNYL), Nyabarongo Upper (NNYU).

The country's hydrologic network covers 8% of the national area equivalent to about 2143 km², on which 101 lakes cover about 8% of Rwanda's total area, which means 1300 km² (RNRA, 2015), 861 rivers occupy about 72.6 km² with 6,462 km in length while the water of 860 wetlands and valleys covers 770 km² (REMA, 2009).

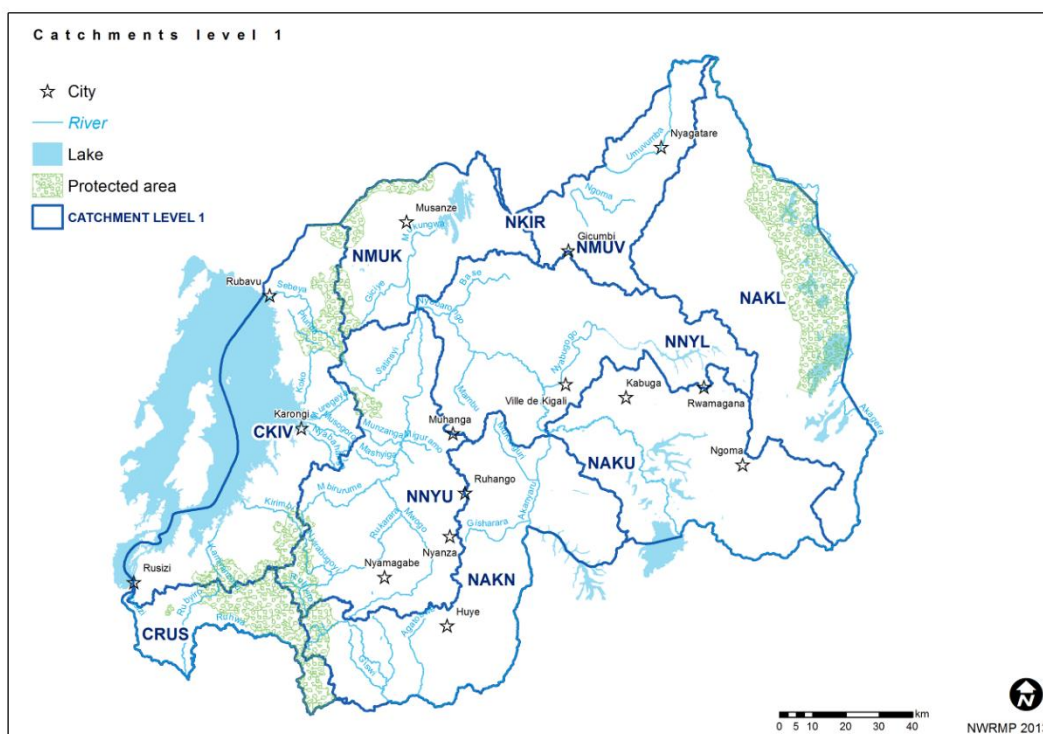


Figure 59: Catchments level 1 and hydrological network

Source: (RNRA, 2015)

Climate change is increasingly impacting Rwanda's water resources through erratic rainfall patterns, prolonged droughts, and more intense flooding events. These shifts have affected the reliability of both surface and groundwater sources, affecting water availability for domestic use, ecosystem stability, and hydropower generation. Inconsistent precipitation disrupts aquifer recharge and lowers river and reservoir flows, further stressing national water security. Water quality is also threatened by climate extremes; heavy rains accelerate erosion and sedimentation, reducing reservoir capacity and increasing turbidity. Floodwaters often carry contaminants like waste and chemicals into water bodies, while rising temperatures encourage the growth of harmful algae and pathogens, compromising water safety. The hydropower sector, which provides a significant share of Rwanda's electricity, is vulnerable to decreased water flow during dry spells and faces infrastructure risks from flooding, particularly concerning dam stability and downstream safety. Additionally, wetlands and aquatic ecosystems, which play vital roles in water filtration, flood control, and biodiversity support, are under growing pressure due to changes in water quantity and quality, making them increasingly fragile.

To address these challenges, effective adaptation strategies such as integrated water resource management (IWRM), wetland conservation, and climate-resilient infrastructure planning are essential for safeguarding Rwanda's water sector against mounting climate risks. Using the WEAP model, an analysis evaluated the impacts of climate change on groundwater recharge and surface runoff under two future climate scenarios, RCP 4.5 and RCP 8.5. This analysis compared a baseline period (2000–2019) to a future period (2040–2059) to assess changes in monthly averages. Under the RCP 4.5 scenario, some catchments, particularly CKIV and NAKU, showed minor reductions in precipitation and actual evapotranspiration, leading to decreases in

groundwater recharge by up to 7.5% and surface runoff by 8.6% (Table 4-5). Other catchments like NMUK experienced minimal changes, with precipitation varying between -3.0% and +1.6%, and evapotranspiration changes ranging from -1.6% to +1.8%. Overall, while the RCP 4.5 scenario indicates limited climate impacts on water resources, certain regions are more vulnerable to declines in water availability, underscoring the need for targeted water management and conservation efforts to build resilience in Rwanda's water sector.

Table 20: Relative change to baseline for both scenarios for each key water balance variable

% change Baseline	Precipitation		ETa		GW Recharge		Surface Runoff		Baseflow	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
CKIV	-3.0	-12.2	-1.0	-7.2	-7.5	-20.8	-8.6	-27.2	-6.9	-20.2
CRUS	-1.5	-4.4	-0.2	-2.2	-5.3	-9.9	-5.7	-12.7	-5.0	-9.6
NAKL	-1.2	3.7	-0.4	3.3	-5.4	2.6	-3.5	5.3	-5.0	3.0
NAKN	-1.8	-3.3	-0.2	-1.2	-4.9	-7.3	-5.5	-8.8	-4.7	-7.1
NAKU	-2.8	-4.9	-1.6	-3.2	-7.7	-11.1	-5.5	-8.7	-7.6	-11.0
NMUK	1.6	-4.2	1.8	-2.1	-1.4	-10.2	1.4	-12.2	-0.5	-9.4
NMUV	0.4	2.6	0.8	2.5	-2.6	0.8	-1.6	3.2	-2.6	0.9
NNYL	0.1	-3.9	0.9	-1.8	-2.6	-8.8	-1.7	-9.8	-2.6	-8.7
NNYU	0.1	-7.7	1.0	-4.3	-2.6	-14.4	-1.9	-21.0	-2.1	-14.0

Under the RCP 8.5 climate scenario, Rwanda is projected to experience substantial drying, with the most severe impacts observed in the CKIV region. Here, rainfall is expected to decrease by 12%, and evapotranspiration (ETa) by 7.2%. These changes will significantly reduce groundwater recharge and surface runoff by 21% and 27%, respectively, indicating a substantial decline in the availability of renewable groundwater supplies. Similar, though slightly less severe, impacts are projected for the NNYU region. These findings suggest that the wetter regions in the west of Rwanda, under baseline conditions, will face significant challenges due to reduced water availability and increased stress under climate change. In contrast, the eastern region of NAKL is expected to experience an increase in precipitation by 3.7%, accompanied by increases in ETa, groundwater recharge, and surface runoff by 3.3%, 2.6%, and 5.0%, respectively. This positive trend is also observed, though less pronounced, in the NMUV region in the north of Rwanda. These regional variations highlight the differential impacts of climate change across Rwanda under the RCP 8.5 scenario.

The projected relative changes in groundwater recharge, surface runoff, and baseflow under both climate scenarios. The maps reveal that CKIV is the most impacted region across all scenarios and hydrological variables, with one exception: under the RCP 4.5 scenario, NAKU experiences the highest negative impact on baseflow, with a reduction of 8.4%. In contrast, NAKL appears to be the least affected region under both

climate scenarios, particularly under RCP 8.5, where the positive effects are most pronounced. These figures underscore the significant regional disparities in hydrological impacts due to climate change in Rwanda.

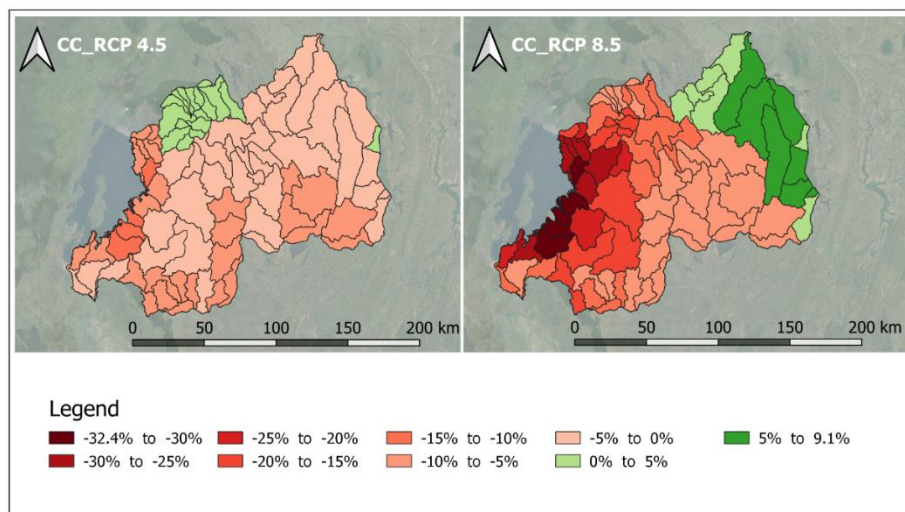


Figure 60: Groundwater Recharge: Relative difference for RCP 4.5 and 8.5 between 2010 and 2050 for each level 2.5 sub-catchment

Source: (FutureWater, 2023)

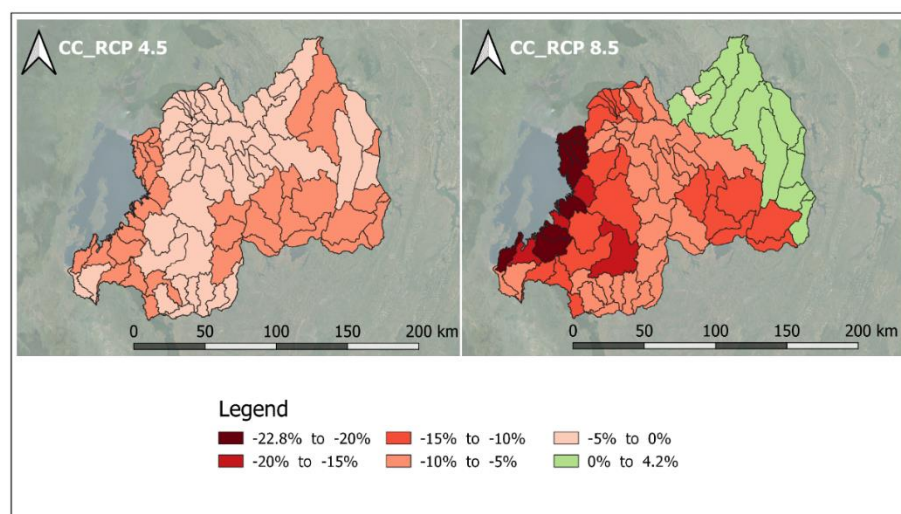


Figure 61: Surface Runoff: Relative difference for RCP 4.5 and 8.5 between 2010 and 2050 for each level 2.5 sub-catchment

Source: (FutureWater, 2023)

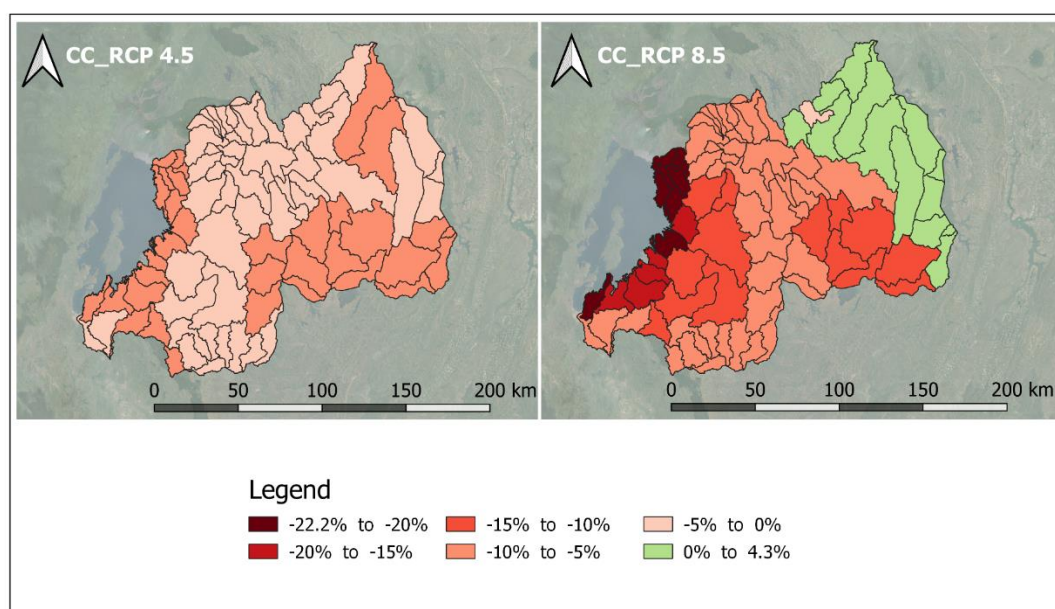


Figure 62: Baseflow: Relative difference for RCP 4.5 and 8.5 between 2010 and 2050 for each level 2.5 sub-catchment.

Source: (FutureWater, 2023)

CKIV appears to be the most affected region under both climate scenarios, with significant changes in hydrological variables impacting the overall water balance at the catchment level. Under the RCP 8.5 scenario, most level 1 catchments experience decreased rates of groundwater recharge, baseflow, and surface runoff compared to the RCP 4.5 scenario. An exception is NAKL, which shows a marginal increase in these rates. Precipitation decreases for all catchments except NAKL under RCP 8.5. In terms of evapotranspiration (ETa), both NAKL and NMUV exhibit slightly higher rates under this scenario. These variations highlight the differential impacts of climate change on water resources across Rwanda's catchments.

Adaptation Strategies for Water Sector

The projected spatial distribution of climate extremes—maximum temperature (TXx), minimum temperature (TNn), and precipitation-related indices (R95pTOT, Rx1day, R10mm)—overlaid with Rwanda's Level 1 catchments, rivers, dams, and lakes. This multi-index assessment provides crucial insights into how climate extremes affect both the availability and distribution of water resources across the country.

The spatial distribution of climate extremes in Rwanda reveals distinct regional vulnerabilities impacting water resources. Northern and eastern catchments, such as Muvumba and Lower Akagera, are projected to face intense heat and high minimum temperatures, increasing evapotranspiration, reducing soil moisture, and lowering river base flows, thereby heightening drought and water scarcity risks. These areas require rainwater harvesting, drought-resilient infrastructure, and aquifer recharge measures. In contrast, western catchments like Rusizi, Kivu, and Upper Nyabarongo are prone to extreme rainfall events, raising risks of flooding, landslides, and water pollution that threaten dams, reservoirs, and water systems, necessitating flood control infrastructure and watershed management.

The overlap of climate extremes with critical water infrastructure such as dams and lakes, particularly in basins like Akagera, highlights threats to hydropower, water supply, and ecosystems due to altered flow regimes. To build resilience, Rwanda must invest in catchment-level early warning systems, climate-informed dam operations, sustainable groundwater development through managed recharge and borehole planning, and ecosystem-based adaptations like wetland conservation and reforestation. Currently, Rwanda's surface water storage is critically low—less than 30 million cubic meters—and is further reduced by erosion and sedimentation. Upgrading dams and implementing integrated sediment management plans are crucial to restoring and enhancing storage capacity.

Multipurpose dams are vital to ensuring water security by balancing dry spell supply and flood mitigation. Groundwater represents a largely untapped resource with an estimated storage capacity of 81 billion cubic meters, offering advantages over surface reservoirs due to lower evaporation losses and localized access. However, sustainable extraction must balance recharge rates and preserve baseflow to maintain surface water availability and ecosystem health.

Climate change is expected to increase the frequency and intensity of extreme weather events, particularly flooding, which is exacerbated in degraded landscapes prone to erosion. Since the 1960s, Rwanda's eastern region has experienced frequent droughts, while northern and western provinces face shorter, more intense rainy seasons and higher erosion risks. Projections indicate increased rainfall intensity (+3% to +17%) and frequency (+9% to +60%) by century's end, mainly during the December-April rainy season, with drier spells from July to September.

To mitigate these risks, Rwanda must strengthen technical capacity for flood prediction and invest in flood-mitigating infrastructure such as detention dams, levees, and drainage systems. Equally important are nature-based solutions, including forest and grassland conservation and restoration, which naturally absorb runoff and reduce flood impacts. Integrating these natural buffers into flood management strategies will enhance long-term resilience and environmental sustainability in the face of climate variability.

4.2.5. Infrastructure Sector (Roads and Housing)

Infrastructure Sector Overview

Rwanda is committed to developing sustainable infrastructure for sustainable economic growth and socio-economic development for quality of life. The key infrastructures include transport (roads and bridges, airport), energy production and supply, water production & supply, sanitation, housing and human settlement (MININFRA, 2021). However, the infrastructure need for Rwanda remains vast in line with Vision 2050 and the Green Growth and Climate Resilience Strategy (World Bank, 2022). This assessment focuses on transport infrastructure, housing infrastructure, water infrastructure, and energy infrastructure.

Assessment of Transport Infrastructure Vulnerabilities due to Climate Change

The Second National Communication (NC2) of Rwanda did not assess infrastructure vulnerability to climate change. The Third National Communication (NC3), however, focused on transport and housing infrastructure, identifying that 2748 km of national roads and 2,003 km of district roads are vulnerable to landslides and floods, particularly in western, northern and southern provinces. Rwanda's Transport Policy, Green Growth and Climate Resilience Strategy (GGCRS), and reports from the Ministry of Emergency Management highlight frequent damage to roads and bridges from climate hazards over the last decade.

To address these challenges, the Rwanda Transport Development Agency (RTDA), commissioned a study (2019–2022) on climate-resilient road transport infrastructure. This included:

- Vulnerability assessment of national and district roads through multi-criteria analysis (social, environmental, engineering, and climate factors).
- GIS mapping and ground surveys of 776 hotspots assessing factors like flooding history, slope stability, soil type, drainage, and climate projections.
- Climate modeling using 9 regional and global models (RCP 2.6 and 8.5 scenarios), analyzing temperature and rainfall changes.
- Hydrological analysis to generate IDF curves for drainage design.

The study showed that high vulnerability concentrated in Western, Northern, and Southern provinces, with moderate levels in Eastern Province and Kigali. Out of the 776 hotspots studied, 8.2% very high, 17.8% high, 72.7% moderate, 1.4% low vulnerability. Future projections (2024–2053) under climate scenarios (RCP 4.5 and 8.5) show increased heavy rainfall (Rx1day, Rx5day, R99p indices), likely worsening landslide and flood risks.

After the identification of vulnerable spots, they were ranked based on scores. The methodology used was a multi-criteria analysis (MCA) and the main objective was to rank the surveyed road sections based on eight different risk categories and identify those sites that are more vulnerable. Cumulated risk points (maximum of 158 points) were further converted to risk percentage to sort the hotspots.

Once the ranking methodology was developed, a script in the R script language was written to apply the methodology on all evaluated spots automatically. The aggregated risk points of each analysed hotspots were ranked according to the total risk points scored. Further to the ranking done, the analysed hotspots were divided in four categories according to the risk levels reflected by the scored risk points namely Hotspots of every high vulnerability which scored above 70% of the total points, Hotspots of high vulnerability which score above 60% but not exceeding 70% of total points, Vulnerability which scored above 30% but not exceeding 60% of total points, and Hotspots of low vulnerability which scored 30% and less of total points.

The assessment validates previous findings and underscores the need to integrate future climate projections into infrastructure planning, design standards, and investment to enhance resilience.

Adaptation Strategy for Transport Sector

The Vulnerability Assessment report included the “Length of national paved roads” as one of the 37 indicators of the national climate vulnerability index. The report indicated that a strong focus on climate-proofing local infrastructure is a key component of adaptation. In the previous communication to the United Nations Framework Convention on Climate Change (UNFCCC) and the Climate Risk Country profile report, the following were identified as key adaptation measures in the transport sector:

- i. Integration of climate information in transport infrastructure planning and design
- ii. Catchment management / Integrated Water Resources Management (IWRM)

- iii. Institutional capacity development on adaptation mechanisms
- iv. Application of climate adapted material and technologies
- v. Regular maintenance and upgrading of road and drainage infrastructures (Improved transport infrastructure)
- vi. Real time awareness and intervention during transport failure

The GGCRS recommended climate responsive design, improved runoff management and drainages, diversion of runoff from roads into channels/canals and then distributed into ditches / basins or farmlands; the greening of grey infrastructure such as ridging, erosion control near culverts outlets, etc. Therefore, to reduce the vulnerability of road network, environmental and engineering guidelines were recommended and now under development. Following the vulnerability assessment of road network, Rwanda Transport Development Agency has developed the following guidelines which shall be followed during the design of new roads & maintenance or upgrading of existing roads: i) Technical assessment and recommendations for improved roads and bridge planning; ii) Road Material Recycling and stabilization; iii) Seals technology for low volume roads; iv) Gravel roads inspection and maintenance; v) Emergency bridges, emergency response to landslides and flooding as well as erosion and control measures; vi) Quarry and borrow pit exploitation and restoration; vii) Improved performance indicators for environmental management; viii) Best practices for erosion control in the right of way; ix) Build back better guidelines for bridges and other structures; x) Specifications for floating pontoons bridges (to be used in case of bridge collapse by floods). In addition, the following existing manuals are being upgraded to ensure integration of climate change and disaster risk reduction: i) Geometric Design Manual; ii) Bridge Design Manual; iii) Drainage Design Manual; iv) Pavement Design Manual; etc. These manuals will need to be implemented and planning (and budgeting) for road construction, upgrading, and maintenance shall be done accordingly.

The identified adaptation measures include, among others:

- An integrated catchment management and coordination among key stakeholders across sectors (transport, water, agriculture, mining),
- Consideration of peak flows from the increased intensity as well as the sedimentation rate for the design of new bridges,
- Use of Intensity Duration Frequency (IDF) curves from projected climate during the design of drainages,
- Proper maintenance of infrastructure, particularly before rainy seasons
- Use of climate adaptive material for road construction & maintenance
- Integration of nature-based solutions in road design & construction
- Proper management of road reserves (land-use along road network)
- Public awareness and engagement in infrastructure design
- The Ministry of infrastructure has identified the need of considering climate resilience on all components of road infrastructure, namely slopes, embankments, drainage systems, structures (bridges and culvert), road structure (paved & unpaved roads). The ministry has also insisted on proper monitoring of construction activities as well as appropriate emergency response to disasters. For urban areas, sustainable urban design shall consider permeable pavement,

infiltration basins and integration of natural landscape (nature-based solutions) to reduce runoff, prevent road flooding and support groundwater recharge.

Investment in the resilience of transport network is a priority for mid-term strategy (2020-2030) to fight against localized floods and landslides and the cost for reducing vulnerability of road network to landslides up to 2050 was estimated at USD 4,469 million. The RTDA vulnerability assessment which is more precise in terms of vulnerable road sections has identified 833.24km of road sections which are highly vulnerable to landslides, erosion and flooding.

Assessment of Vulnerabilities of the Built Environment

The housing sector in Rwanda is overseen by the Ministry of Infrastructure (MININFRA) through the Rwanda Housing Authority (RHA) and consists of urban and rural housing (Republic of Rwanda, 2018). Rwanda has 3.31 million private households (71% rural), with the highest concentration in the Eastern Province. Private households have grown by 38% since 2012 and more than tripled since 1978. Most households are nuclear (62%), and 65% live in clustered rural settlements. Owner occupation has declined (now 72%), while tenant occupation has risen (22%).

Across all Rwanda, about 93% of the 3.31 million private households live in housing with walls made of sun-dried bricks with or without cement (about 36% and 31% respectively), or wood/mud with or without cement (about 8% and 18% respectively). Durable building materials, such as cement blocks, concrete, burnt bricks with or without cement, stone with or without cement and timber, are used in the walls construction only by 6% of the households in Rwanda. While sun-dried bricks remain the most prevalent construction material for walls, when the data are disaggregated by area of residence, the percentage is higher in urban areas about 74% (including 57% with cement and 17% without cement) than in rural areas about 65% (including 28% with cement and 37% without cement). Households with walls built of wood/mud remain the second largest group in both areas of residence, the percentage observed in rural about 31% (including 8% with cement and 23% without cement) is around two times higher than the one observed in urban about 13% (including 7% with cement and 6% without cement).

Infrastructure Faces Vulnerabilities:

Over the past decade, housing and social infrastructure have been frequently damaged by rainstorms, windstorms, landslides, and floods. Climate projections (RCP 8.5) indicate that Southern, Western, and parts of Northern provinces will face increased intense rainfall and temperature extremes, exacerbating landslide, erosion, and flooding risks. Poorly built structures and public facilities in these regions are especially vulnerable to structural damage and service disruptions.

The findings emphasize the urgent need for climate-resilient housing and social infrastructure, including:

- Implement Kigali Informal Settlement Upgrading Project (KISUP)
- Implement RUDP 2 settlements upgrading in CoK and SCs
- Carry out programs to address climate vulnerability
- Ensure new urban development projects include unplanned settlement

- Upgrading component that integrate climate resilience planning and
- Design principles, livelihood improvement interventions, as well as improved access to public socio-economic facilities & public open space
- Provide technical support for the community-led upgrading initiatives

Adaptation Measures for the Built Environment

Climate change is expected to put increasing burdens on the community and its supporting infrastructure in the future decades. In recent years, the government of Rwanda has made different intervention to promote safe, suitable and well-kept building infrastructures as well as services which has positively contributed to the national socio-economic development.

In this regard, a number of building documents regulating the construction sector especially buildings have been developed such as design manuals for construction, guidelines, codes, National Urbanization Policy , National Human Settlement Policy, Green Building Minimum requirements guideline and standards including the "Building control regulations" and "policies concerning human settlement, Urban housing and construction in Rwanda., guidelines for harvesting and management of rainwater from buildings, etc..."

In the housing sector, the following climate change adaptation measures were given high priority for Rwanda during the Third National Communication:

- I. Establish climate resilient infrastructure
- II. Developing green model cities
- III. Relocate households from high-risk zones
- IV. Establishment of an early warning system for disaster response plans
- V. Mapping of vulnerability areas before construction

To ensure decent settlements that adapt to the changing climate and associated hazards and impacts (death, injuries, etc. associated with floods, landslides, etc.), the Government of Rwanda has constructed 6,089 social Housing Units to facilitate relocation from High-risk zones and it is targeting to construct more.

Other measures are also in place to adapt to climate change in housing infrastructure: Nature-Based Solutions (Nbs) & Ecosystem-based adaptation (EbA): Ecosystem-based adaptation (EbA) is an approach to climate change adaptation that involves using natural ecosystems to help people and communities cope with the impacts of climate change. Nbs & EbA are considered effective for flood and landslide management while ensuring resilient settlement. Nature-based solutions (NbS) and ecosystem-based adaptation (EbA) are gaining importance in Rwanda, with projects like the National Adaptation Planning Process (NAP) and the Second Rwanda Urban Development Project (RUDP II) focusing on flood and landslide resilience and sustainable infrastructure development. The integration of climate change adaptation into master plans is another strategy for adapting housing infrastructure to climate change.

4.2.6. Tourism Sector

In the past decade, Rwanda has made significant strides in promoting tourism, particularly showcasing its rich flora and fauna in national parks through initiatives like the 'Visit Rwanda' campaign. These efforts have

yielded positive results with tourism revenues reaching US \$498 million in 2019, contributing significantly to service exports (RDB, 2021). However, the COVID-19 pandemic in 2020 severely impacted the tourism sector, leading to a 76% decline in revenues (Durydiwka, Zajadacz, & Duda-Gromada, 2022). The government's Economic Recovery Fund (ERF) has been instrumental in supporting the sector's recovery, with a substantial portion allocated to tourism and hospitality. Despite challenges, Rwanda's tourism sector has been a key driver of economic growth, supported by sustainable practices, infrastructure investments, and conservation efforts. The diverse offerings across nature-based, cultural heritage, and community-based tourism have attracted visitors worldwide, contributing to the country's economy and socio-economic development.

Vulnerability of Tourism Sector Due to Climate Change

Climate change significantly impacts tourism in Rwanda by altering ecosystems, biodiversity, and infrastructure essential to the sector. Rising temperatures, shifting rainfall patterns, and extreme weather events affect natural attractions, wildlife habitats, and visitor experiences.

Tourism hotspots (Volcanoes National Park, Akagera National Park, Nyungwe National Park, Gishwati-Mukura National Park and Lake Kivu) face heightened risks:

- **Heat Stress:** Increasing maximum temperatures reduce visitor comfort, impact outdoor activities (e.g., gorilla trekking), and alter animal behavior, lowering wildlife visibility.
- **Heavy Rainfall:** More frequent very wet days damage infrastructure, trigger erosion and landslides, and hinder access to parks.
- **Prolonged Dry Spells:** Consecutive dry days threaten wetlands, water resources, and biodiversity, affecting scenic and nature-based tourism activities.

Key vulnerabilities include:

- **Biodiversity Loss:** Shifting habitats and deforestation reduce species populations, diminishing Rwanda's ecotourism appeal.
- **Habitat Degradation:** Wetland and forest ecosystem decline threatens wildlife and iconic attractions like mountain gorillas.
- **Climate Hazards:** Floods, landslides, and droughts damage roads, lodges, and parks, disrupting tourism and deterring visitors.
- **Socio-economic:** Communities reliant on tourism face reduced income and employment opportunities, potentially driving unsustainable coping strategies (e.g., poaching).

To ensure sector sustainability, Rwanda needs climate-resilient infrastructure, improved road access, effective water management, seasonal activity planning, early warning systems, and eco-lodges adapted to climate extremes. These measures are critical to safeguarding tourism's ecological assets and supporting local livelihoods.

Adaptation Strategies for Tourism Sector

- As climate variability and extreme weather threaten Rwanda's tourism sector, targeted adaptation measures are crucial to protect biodiversity, infrastructure, and livelihoods while sustaining eco-tourism.

Key Strategies:

- **Climate-Smart Infrastructure:** Build resilient roads, trails, drainage systems, and eco-friendly lodges to withstand floods, landslides, and heat.
- **Tourism Diversification:** Expand beyond wildlife tourism by promoting cultural, historical, and urban experiences to reduce climate sensitivity.
- **Ecosystem Conservation:** Strengthen reforestation, wetland rehabilitation, and biodiversity protection with community involvement.
- **Early Warning & Risk Management:** Implement weather alert systems, evacuation protocols, and emergency response plans for visitor safety.
- **Community Engagement:** Empower locals through community-based tourism, training in climate-smart practices, and sustainable livelihoods.
- **Climate-Resilient Activities:** Offer indoor attractions, wellness retreats, and off-season packages to reduce reliance on weather-dependent activities.
- **Policy & Collaboration:** Develop sector-specific climate policies, foster partnerships among stakeholders, and secure financial support for adaptation.

These measures aim to enhance resilience, ensure tourist safety, and maintain Rwanda's position as a leading eco-tourism destination despite climate change challenges.

4.2.7. Health Sector

In Rwanda, the Ministry of Health (MoH) and the Rwanda Biomedical Centre (RBC) manage the health sector, prioritizing the well-being of Rwandans through various initiatives. The government has invested significantly in healthcare infrastructure, focusing on rural areas to ensure universal health coverage. Initiatives like community health workers, the Health Insurance system, and public health programs have enhanced healthcare accessibility, utilization, and financial protection. Challenges persist, including financial sustainability, adequate specialized health professionals, and addressing healthcare access disparities. Technology, partnerships, and collaborations have also bolstered Rwanda's healthcare system, supporting advancements like electronic medical records and drone delivery of medical supplies. Climate change impacts infectious and non-communicable diseases in Rwanda, influencing the spread of diseases like malaria and cholera, as well as mental health disorders. Addressing the complex interplay between health and climate change requires integrated strategies that strengthen healthcare systems while considering climate adaptation and mitigation measures.

Assessment of Health Sector Vulnerability Due to Climate Change

Climate change increasingly threatens Rwanda's public health systems through heatwaves, prolonged dry spells, intense rainfall, floods, and landslides.

- **Heat Risks:** Eastern and southeastern regions (Nyagatare, Kayonza, Kirehe) face rising temperatures and large diurnal temperature variations, heightening risks of heat stress, dehydration, and related illnesses—especially for children and the elderly in urban areas like Kigali.

- **Flood & Disease Risks:** Western and northern highlands (Rubavu, Musanze, Nyabihu, Burera) experience heavy rainfall and landslides, leading to damaged health centers, infrastructure disruptions, and increased waterborne diseases.
- **Historical Impact:** Between 2014–2022, 25 health centers were damaged by climate-induced disasters, aligning with current projections of heatwaves, extreme rainfall, and dry spells in these regions.

Adaptation Needs: Strengthening early warning systems, investing in climate-resilient healthcare infrastructure, enhancing disease surveillance, and providing targeted services for vulnerable groups are essential to protect public health in climate-sensitive zones.

Adaptation Strategies for Health Sector

Climate change significantly impacts Rwanda’s health sector, making the development of a Climate-Resilient Health System essential. Key strategies include:

(i) Healthcare Facility Resilience

- Upgrading infrastructure to remain functional during climate emergencies.
- Expanding and improving health workforce (currently 21,552 professionals and 58,567 Community Health Workers).
- Enhancing water, sanitation, and hygiene (WASH) to prevent waterborne diseases (71% national water supply, only 50% in Eastern Province).
- Promoting medical tourism to strengthen the health system.

(ii) Biodiversity, Agriculture, and Urban Adaptation

- Reforestation, forest conservation, and relocation of vulnerable populations to mitigate landslides and erosion.
- Urban upgrading projects in Kigali for community climate resilience.
- Investments in water resource management, wetland restoration, and climate-smart agriculture to improve food security and nutrition.
- Strengthening mental health services for climate disaster-affected populations.

(iii) Research, Surveillance & Early Warning Systems

- Increasing research and funding to understand climate-health links.
- Developing early warning systems for floods, heatwaves, and disease outbreaks (e.g., malaria, dengue).

(iv) Policy Integration

- Embedding climate adaptation into national health policies and disease programs.
- Establishing climate-related units in health programs to identify risks and coordinate responses.

(v) Community Engagement & Education

- Raising public awareness of climate-related health risks.
- Expanding initiatives like car-free days and community sports nationwide.

- Strengthening collaboration between government and civil society through workshops and local meetings to promote sustainable, resilient behaviors.

4.2.8. Biodiversity Sector

Rwanda's biodiversity is remarkably rich despite its small size (Republic of Rwanda, 2020), shaped by varied landscapes ranging from high-altitude mountains to savannahs and wetlands. The country hosts over 2,150 known plant species, 151 mammal species, around 700 bird species and over 100 reptile and amphibian species. The Albertine Rift region, which includes Volcanoes, Nyungwe, and Gishwati - Mukura National Parks, is recognized as a global biodiversity hotspot, supporting endemic species such as the mountain gorilla and the Rwenzori turaco. Nyungwe National Park, alone, contains more than 1,100 plant species, 13 primate species and about 300 bird species, making it one of Africa's most important montane rainforests. In addition, wetlands cover 10.6% of Rwanda's land area, contributing to freshwater biodiversity and climate resilience. Together, these ecosystems make Rwanda a key conservation area in East and Central Africa.

The collaborative efforts of biodiversity protection and conservation involve government institutions, private sector, NGOs, local communities and international partners. It consists to the protection, management, and restoration of all forms of life and their habitats to ensure healthy ecosystems now and for the future. It aims to develop strategies for conserving and sustainably using biodiversity. Assessing biodiversity vulnerability to climate change involves evaluating factors like temperature and rainfall variations and extreme weather events.

4.2.9. Vulnerability of the Biodiversity Sector to Climate Change

Biodiversity and climate change are tightly linked through feedback loops, where temperature shifts, rainfall changes, and extreme events alter species distribution, ecosystem stability, and habitat quality. Figure 63 below highlights the spatial intersection between climate extremes, such as maximum daily temperatures (TXx), minimum nighttime temperatures (TNn), dry spells (CDD), and extreme rainfall (R95p) and Rwanda's protected areas including national parks, forest reserves, and wetlands.

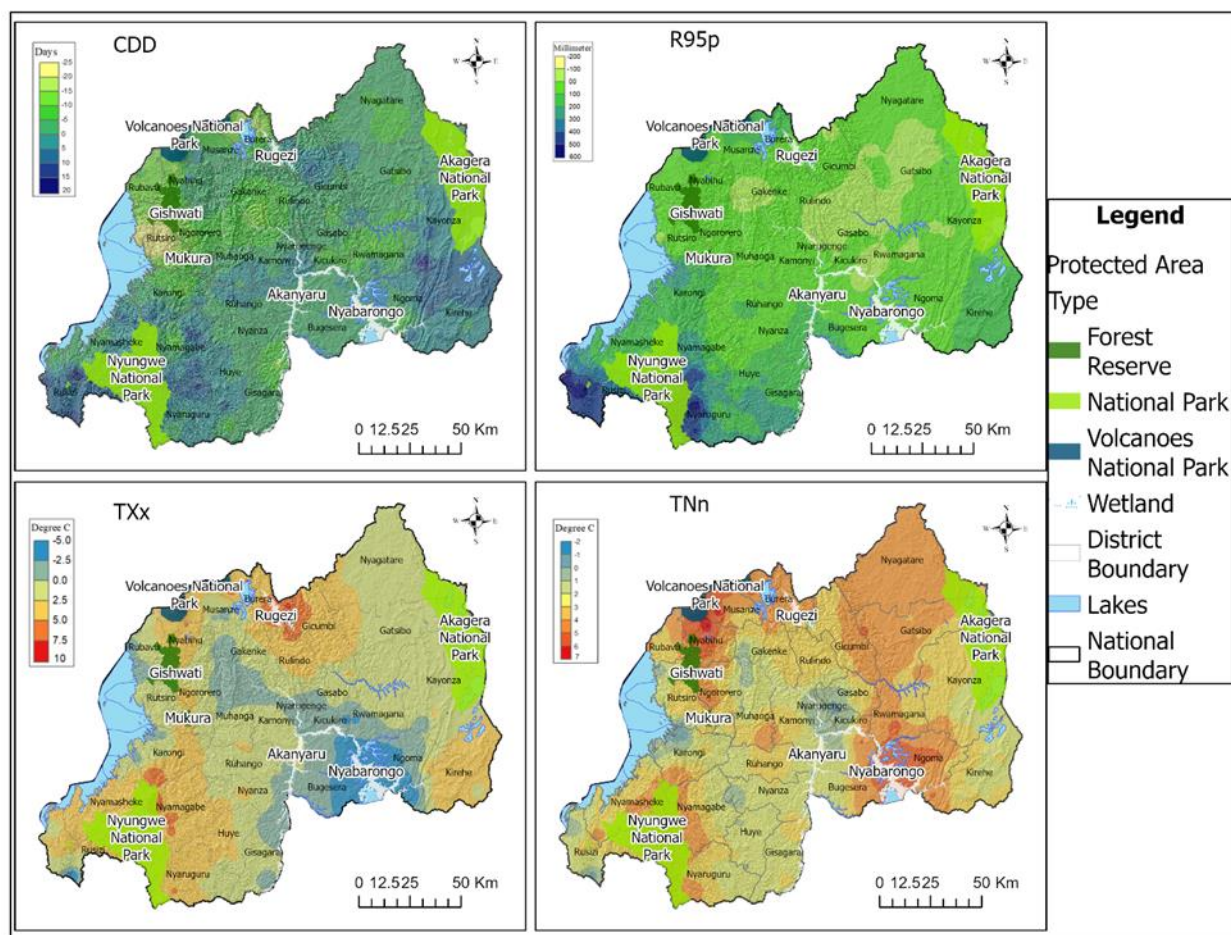


Figure 63: Overlap of Climatic Stressors with Protected Areas in Rwanda

Climate Impacts on Ecosystems

- **Highland ecosystems** (Nyungwe, Volcanoes National Parks) face threats from rising temperatures that disrupt species physiology and migration; and also face the impact of heavy rain, subjected to landslides.
- **Savannah ecosystems** (Akagera NP) are highly vulnerable to prolonged droughts, reducing vegetation and causing food and water scarcity for herbivores.
- **Heavy rains in western regions** (Gishwati, Mukura) trigger landslides, degrading forests and threatening sensitive species.
- **Diverse habitats** (montane, lowland, savannah, wetlands) support ~3,000 vascular plant species and 205 recorded mammal species, many facing climate-related vulnerabilities.

Species at Risk

- **Plants:** 7 critically endangered, 25 endangered, 6 vulnerable; species like *Entandrophragma excelsum* and *Symphonia globulifera* are climate-sensitive.
- **Mammals:** 30 species identified as at risk; previous assessments noted 59 vulnerable species.
- **Birds:** Several species, including Hooded Vulture and Gray Crowned-Crane, are endangered or vulnerable.

- **Other fauna:** Amphibians and small mammals in landslide-prone areas face heightened extinction risks.

Ecosystem Services and Threats

- **Natural forests** (Nyungwe, Akagera) are endangered, reducing carbon sequestration and soil protection.
- **Rising temperatures and heavy rains** increase erosion, turbidity, and contamination in aquatic systems.

Adaptation Strategies for Biodiversity Sector

Climate strongly influences species behavior, abundance, and ecosystem structure, with each species adapted to specific climatic conditions. Climate change threatens species unable to acclimatize or migrate, leading to local or global extinction. Although Rwanda has adaptation policies, current measures may be insufficient, leaving communities and ecosystems vulnerable to extreme weather and altered rainfall patterns.

Biodiversity conservation is crucial because human livelihoods depend on it, and natural habitats act as vital carbon sinks. Effective adaptation strategies include:

1. Climate-Smart Agriculture

- Population growth (projected 23.6M by 2052) and limited farmland increase pressure on ecosystems.
- Promoting sustainable farming practices can reduce habitat destruction, lower greenhouse gas emissions, and support biodiversity conservation.

2. Community-Based Conservation

- Conservation success depends on engaging and benefiting local communities.
- Involves participatory approaches that leverage traditional knowledge, create community-managed reserves, support sustainable livelihoods, and offer conservation incentives.
- Proven effective in national parks (e.g., VNP, NNP, ANP), but since protected areas cover only ~10% of Rwanda, expanding conservation efforts to unprotected regions is essential.

3. Additional Strategies

- Strict law enforcement, ecosystem restoration, reforestation, incentive mechanisms, biodiversity research and monitoring.
- Mainstreaming climate change into biodiversity policies and sensitizing communities.

These approaches aim to strengthen resilience, protect native plant and animal species, and enable ecosystems to adapt to climate change impacts.

4.2.10. Mining and quarrying Sector

Rwanda's mining sector is dominated by artisanal small-scale mining (ASM) and alluvial river mining. It is exposed to climate hazards (intense rainfall, floods, landslides, erosion and drought) especially in hilly areas

of western and northern country. Those hazards damage mine sites and infrastructure, increase environmental degradation, disrupt livelihoods and supply chains, and amplify safety risks for miners and downstream communities.

Main vulnerability impacts

- **Physical hazards to sites and workers:** heavier, more intense rains and flash floods increase risk of pit or wall collapse, mine-site flooding, and landslides that destroy shafts and kill or injure miners. For example, in 2018 recorded 118 deaths related to mine accidents and 85 injuries, 2019 recorded 106 deaths and 69 injuries, 2020 recorded 82 deaths and 48 injuries, 2021 recorded 72 deaths and 46 injuries and 2022 recorded 65 deaths and 32 injuries. So, over 5 years, mining accidents related to collapse of tunnels are totaling 443 deaths and 280 injuries. This is the documented evidence showing how the sector's vulnerability to heavy rains, floods and landslides.
- **Artisanal and small-scale mining (ASM)** is highly exposed: ASM often occurs in informal, steep, riverine or alluvial areas with little engineering or safety measures, making these workers and communities especially vulnerable to flood and landslide events and to water-related contamination. Reports and UN/UNDP notes highlight the severe socio-environmental impacts of ASM amplified by climate effects (UNDP:2022)
- **Erosion, sedimentation and water quality impacts:** Heavier rains increase erosion and sediment runoff from mining sites into rivers, degrading aquatic ecosystems, harming downstream agriculture and increasing flood risk. National environment analyses and sector papers highlight erosion and river impacts as key pathways (Rwanda Environment and Climate Change Analysis: 2019).
- **Infrastructure and operational disruption:** Roads, processing facilities, stockpiles and power and water supply can be damaged by extreme events, interrupting production and transport of minerals (which also affects incomes and export revenues). Climate-sensitivity reviews of major projects flag transport and service interruptions as key risks (MINECOFIN: Consolidated report on climate sensitivity for major projects in the pipeline by sector).
- **Socioeconomic and governance vulnerabilities:** Climate shocks deepen poverty for mining communities, push more people into risky ASM, and strain regulatory/enforcement capacity (making environmental damage and unsafe practices worse). Disaster and sector plans note that large ASM workforces are particularly vulnerable (MINEMA: Disaster risk mitigation plan for mining and quarrying sector).

Key facts

The data analysis across mining and quarrying operations shows that the overall resilience for mining and quarrying sector is 41%. Mining sites alone have the averaged index of 56% that is slightly above 50%. Mining and quarrying combined display 30% of resilience index while quarrying sites are resilient at the rate of 34%.

Further, most mining and quarrying sites (120 out of 187 representing 64%) have Grade E (below 50). Among these sites are 58 quarrying, 32 mining and quarrying combined and 28 mining sites alone.

Recommended Practical adaptation and resilience measures

Short term / low cost

- Formalize and map ASM hotspots, then prioritize safety training, early-warning links, and temporary relocation support for high-risk seasons.
- Install/improve basic drainage, protective bunds and re-vegetation around pits to reduce erosion and sediment flow (community work programmes can help).

Medium term / system changes

- Require simple engineering standards for pit stability, river-setbacks for alluvial mining, and enforced closure/rehab plans for abandoned pits.
- Integrate mining into district climate risk maps and early-warning systems so miners get timely flood/landslide alerts.

Longer term / policy & finance

- Mobilize climate finance for resilient mine access roads, controlled processing sites, and community-level water/sanitation systems to reduce downstream impacts.
- Strengthen governance: improved permitting, ASM formalization, environmental monitoring and transparent traceability so climate shocks do not intensify illegal/risky practices.

Short suggested indicators to monitor

- Number of mining companies complying to sustainable climate compatible mining practices.
- Number of ASM sites mapped & risk-rated.
- % Of mines with basic drainage/slope stabilization.
- Number of miners receiving seasonal early-warning alerts/training.
- Sediment loads in key downstream rivers (baseline + annual).
- Economic losses to mining communities from major climate events (annual).

4.3. Conclusion

This section evaluated the vulnerabilities and adaptation strategies across Rwanda's key socioeconomic sectors to climate change and proposed measures for adaptation. Rwanda's Energy sector is vulnerable to climate change impacts, necessitating strong infrastructure reinforcement and diversified energy sources. The introduction of new technologies and adaptation policies is vital for resilience. The incorporation of climate considerations into project selection and budgeting, integration of climate resilience into hydropower projects, and early warning systems implementation are essential steps. For the Agriculture sector, climate-smart practices, water management improvements, early warning systems, and research investments are key to enhancing resilience. In the Water sector, integrated water resources management, infrastructure investments, nature-based solutions promotion, and flood forecasting enhancements are recommended. Transport infrastructure needs climate-resilient designs, catchment management, and green infrastructure development. Housing sector improvements should focus on climate-resilient housing promotion and informal settlement prevention. Proactive interventions, budget allocations, and enforcement of land use plans are critical for mitigating future climate impacts.



CHAPTER 5

CONSTRAINTS GAPS AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

Chapter 5: CONSTRAINTS GAPS AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

5.1. CONSTRAINTS, GAPS AND RELATED FINANCIAL NEEDS

5.1.1. Financial Constraints, Gaps, Needs and Support received

Financial Support Received

This section discusses financial support received from the 2 major sources: GEF and GCF, with projects' execution period covering the year 2018 and later. Table 20 shows some of the GEF national funded projects:

Table 21: GEF funded projects

No	Title	Agencies	GEF Grant (USD)
1	Building Resilience of Communities Living in Degraded Forests, Savannahs and Wetlands of Rwanda through an Ecosystem-based Adaptation (EbA) approach	United Nations Environment Programme	5,500,000
2	Building the Capacity of Rwanda's Government to Advance the National Adaptation Planning Process	United Nations Environment Programme	6,000,000
3	Ecosystems/Landscape approach to climate proof the Rural Settlement Program of Rwanda	United Nations Development Programme	8,355,638
4	Enabling Activities to Review and Update the National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (POPs)	United Nations Industrial Development Organization	180,000
5	Forest Landscape Restoration in the Mayaga Region	United Nations Development Programme	6,213,538
6	Increasing the Capacity of Vulnerable Rwandan Communities to Adapt to Adverse Effects of Climate Change: Livelihood Diversification and Investment in Rural Infrastructures	African Development Bank	8,824,749
7	Landscape Approach to Forest Restoration and Conservation (LAFREC)	The World Bank	9,532,000
8	Management of PCBs stockpiles and equipment containing PCBs	United Nations Development Programme	886,700
9	Minamata Convention: Initial assessment for Rwanda	United Nations Industrial Development Organization	200,000
10	National action plan on mercury in the artisanal and small-scale gold mining sector in Rwanda	United Nations Industrial Development Organization	500,000

11	Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in Flood Prone Areas	United Nations Environment Programme	3,486,000
12	Rwanda Urban Development Project II	The World Bank	8,072,715
13	Strengthening the Capacity of Institutions in Rwanda to Implement the Transparency Requirements of the Paris Agreement	Conservation International	1,000,000
14	Supporting a Green Economy - Decoupling Hazardous Waste Generation from Economic Growth in Rwanda	United Nations Development Programme	6,300,000
15	Green Amayaga Program	United Nations Development Programme	≈\$18,000,000
16	Accelerating the Transition to Electric Mobility	United Nations Development Programme	1,698,119

Source: (GEF, 2022)

Regarding GCF, 17 projects (USD 119.6 million) have been approved for funding proposal. However, most projects are multi-country, and only 4 of them are specific for Rwanda (GCF, 2023):

- I. [Transforming Eastern Province through Adaptation](#) (USD 33,783,755): This project that is ongoing till 2027, is restoring ecosystems and transform fragile landscapes in this province (one of Rwanda's five provinces) which have been degraded and are unable to sustain livelihoods in the face of climate change. It supports the development of markets and value chains in climate-resilient agricultural and tree products that are sustainably managed. Initial funds in this scalable initiative will be accompanied by financial commitments from local microfinance institutions and investors.
- II. [Strengthening climate resilience of rural communities in Northern Rwanda](#) (USD 32,794,442): This project was closed in 2026, focused in increasing the climate resilience of vulnerable communities in nine sectors of Rwanda's Gicumbi District. It will restore and enhance ecosystems in degraded watersheds and increase the capacity of communities to sustainably manage forest resources. It will follow an integrated landscape management model.
- III. [Green City Kigali: a new model for urban development in Rwanda](#) (USD 27,995,786): This project is under implementation, and will be concluded in 2029. The purpose of the project is to establish a groundbreaking, replicable model of sustainable urban development in Rwanda. It tackles rapid urbanization by seamlessly combining affordable, inclusive housing with climate change mitigation, climate resilience, and eco-friendly technologies, all while preventing environmental degradation.
- IV. [Building Resilience of Vulnerable Communities to Climate Variability in Rwanda's Congo Nile Divide through Forest and Landscape Restoration](#) (USD 39,056,421): This project is under implementation and will be concluded in 2029. The primary aim of this project is to protect Rwanda's ecologically fragile Congo Nile Divide by reversing soil degradation, mitigating deforestation, and safeguarding vital ecosystems. It empowers vulnerable rural communities to

adapt to climate variability by promoting sustainable land management, creating alternative green livelihoods, and building climate-resilient value chains

Apart from the funded projects, Rwanda mobilized several external and internal funding sources for implementing different adaptation programs and projects. Those include:

- I. [Project to develop four of Rwanda's nine catchments management plans](#) within the government's Integrated Water Resources Management (IWRM) framework, financed under the Water for Growth project and rehabilitation of priority degraded areas in five catchments (USD 71 million), funded by the World Bank.
- II. [Nyandungu Urban Wetland Eco-Park](#) (USD 4 million) and the ongoing USD 25 million rehabilitation investment of priority degraded wetlands under the World Bank supported second phase of the Rwanda Urban Development Project (RUDP-II), all in the City of Kigali.
- III. Going forward, the USD 4.6 million World Bank supported Nationally Determined Contribution (NDC) Deep Dive Project implemented by FONERWA aims to [accelerate private investments through the design of Rwanda's Green Investment Facility](#) and support to Rwanda's flagship projects, including the Volcanoes Community Resilience Project under development.
- IV. [Technical Assistance for "Developing Capacity for Climate Resilient Road Transport Infrastructure"](#) worth 4.4 million Euros, including technical Assistance (vulnerability mapping, development of technical manual, technical trainings, student internship, awareness campaign) and implementation of pilot projects. The focus of this project is National and District Roads class 1 (countrywide).
- V. [Technical assistance on geohazard risk management and climate resilient feeder roads](#) in Rwanda. Value worth 1,000,000 USD
- VI. [Landscape Restoration and Integrated Water Resources Management in Sebeya and other Catchments](#), a €15 million project implemented by Rwanda Water Resources Board (RWB).
- VII. [Muhazi Dyke Project implemented by RWB](#), with a value of 3 billion Frw. The project aims to conserve Lake Muhazi and protect its downstream area from devastating floods.
- VIII. [Muvumba Multipurpose Water Resources Development Program](#) with the aim to construct a dam of 30.5m high and impounding 35 million cubic meter of water. The Cost of the first set of activities under the program is to be financed by the African Development Bank and counterpart contribution from the GoR is EUR 124.190 million net of tax and duties.
- IX. [Giciye-Satinsyi-Karago-Mugogo-Ndiza sub Catchments Landscape Restoration Project](#) aims to increase resilience to climate change hazards.
- X. The 35 billion Frw project on [Floods Management in Volcano Area](#) which aims to implement the planned structural measures and non-structural measures with highest possible standard for floods management.
- XI. [Sustainable Agricultural Intensification and Food Security Project](#), funded by the Global Agriculture and Food Security Program in the amount of USD 26.3 Million. The project objective is to increase agricultural productivity, market access, and food security of the targeted beneficiaries in the project intervention areas.

- XII. [Rural Community Support Project](#), funded by the Korea International Cooperation Agency (KOICA) and the Government of Rwanda the amount of USD 10 Million.
- XIII. [Rwanda Dairy Development Project \(RDDP\)](#)” that covered 12 districts across the country. It aimed to increase the dairy sector's competitiveness and profitability through the provision of quality products from small-scale producers to domestic and regional consumers, thus improving their livelihoods, food security and nutrition while building overall climate resilience. The project cost the amount of about 70.14 Million USD funded by IFAD.

To achieve its conditional target, Rwanda intends to use different climate finance sources including international market mechanisms and cooperative approaches under Article 6 of the Paris Agreement, where appropriate, building upon the experience of the CDM.

In total, over 1.6 million carbon credits have been issued in Rwanda from the CDM. Rwanda hosts 4 CDM projects (1 lighting, 2 solar water disinfection, 1 solar lamp) and 12 Programmes of Activities (PoAs) (8 energy efficient stoves, 2 hybrids renewable, 1 solar PV, and 1 water purification), with a total of 56 Component project Activities (CPAs) (EAACMCF, 2022).

Rwanda has 85 registered VCM (Voluntary Carbon Market) activities that have issued over 3.1 million carbon credits. All these projects are certified under the Gold Standard and focused on improved cookstove activities (87% of total Certified emission reductions (CERs), while lighting and solar together account for 9% and 4% respectively).

Gaps in Financial Support

Existing financial constraints and gaps for implementing climate change activities include:

- [Insufficient funds](#) to ensure effective mitigation and adaptation strategies.
- [Limited budget allocation](#): limited allocations of public funds for implementation of environment and climate change activities in districts’ budgets.
- [Limited financing opportunities](#) for flagship projects implementation.
- [Low involvement of private sector](#) in environment and climate change activities.
- [Current trend in the climate finance market](#) clearly shows a shift from the traditional model of financing: grant financing is becoming rare, actors are embracing private financing such as guarantees, loans, equity;
- [Limited technical skills and capacity](#) for successful resources mobilization

Those constraints and gaps are still relevant, as identified in (REMA, 2022). Limited financial resources for the implementation of all proposed strategic actions related to environmental protection and climate resilience has been identified as one of the major weaknesses for climate change sub-sector.

Financial Needs

Rwanda's NDC 3.0 (2025) estimated total financing needs of USD 12 billion with USD 5.7 billion for adaptation and USD 5.3 billion for mitigation. To date, approximately USD 4.8 Billion, or 38% of that total, has been mobilised for both adaptation and mitigation efforts. The remaining gap is attributed to slow international disbursements, limited direct access for national institutions, fragmented project-based funding, and constrained domestic fiscal space.

Over the 2025–2035 period, Rwanda has identified adaptation financing needs of around USD 7 billion to deliver the priorities above, of which 23% (USD 1.6 billion) is anticipated to come from domestic budgets (unconditional), and 77% (USD 5.4 billion) is contingent on external financing (conditional). Agriculture (35% of the total) and Water Resources (33%) represent the largest shares of the financing needs, reflecting their critical roles in food security and water security, followed by WASH (9%), Transport (9%), Urbanisation and Human Settlements (6%) and Cross-Cutting (4%) Land and Forestry, Health and Mining together account for the remaining 4%.

The funding requirements associated with all NDC mitigation options, estimated at 5 billion USD through 2035. These represent the incremental capital investment costs required for example for new plant, technology, infrastructure and equipment as well as items such as programme set-up, training and other implementation costs.

5.1.2. Constraints, Gaps and Related Technical and Capacity Needs

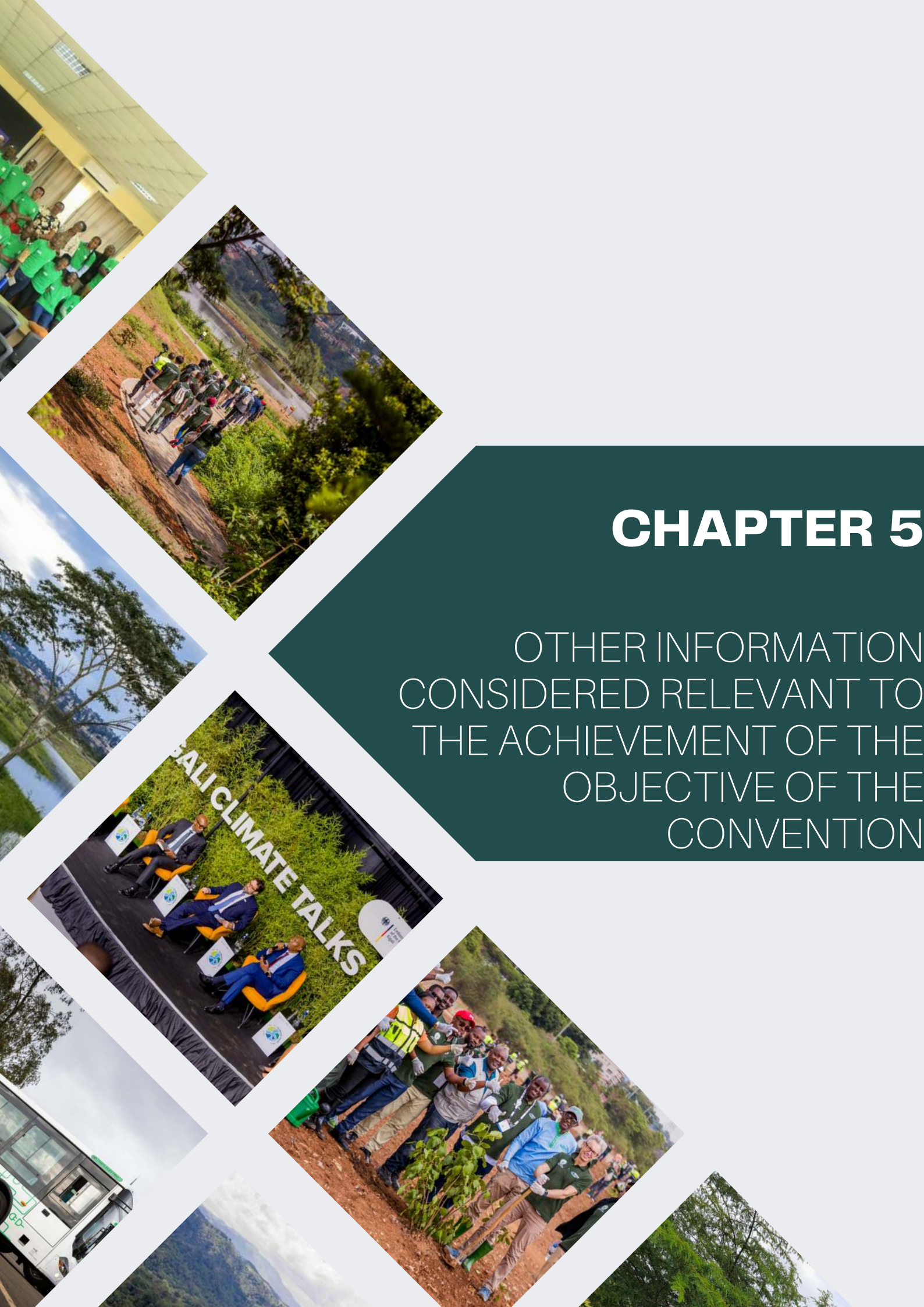
The process of the preparation of the NC4 for Rwanda to the United Nations Framework Convention on Climate Change (UNFCCC) has revealed some technical and capacity constraints, gaps and needs that should be adequately addressed, per sector.

Table 22: Identified constraints, gaps, and related technical and capacity needs

Sector	Constraints and Gaps	Needs
Energy -GHG Inventory	High uncertainties due to the use of default emission factors and assumption in fuel consumption activity data	There is a need for a regular survey on fuel consumption in households and institutions/commercial buildings should be conducted. In addition, the development of country-specific emission factors should be considered.
		Enhancing capacity for estimating fuel combustion emissions using the reference approach and report the difference between the Reference Approach and Sectoral Approach
AFOLU - GHG Inventory	The uncertainties for the activity data are high, due to the lack of data from research studies at national level	The studies need to be conducted on the following areas:
		The area of cultivated organic soils (which is currently not disaggregated in agriculture statistics)
		The volume of peat produced (in airdried weight) as well as the inventory of the existing peat-producing enterprises

Sector	Constraints and Gaps	Needs
		The extent and volume of seasonal burning of agricultural residues
		The proportion of fertilizer type and quantity used per crop vs annual rates and proportion of farmers using fertilizer on each crop
		Changes in soil N and C after Land Use change and their dynamics (longer-term research on soil restoration)
		Reporting emissions from land use transitions/change to allow development of a consistent time series and monitoring of drivers of land use change
		Develop land use change maps with increased frequency and shorter time intervals of monitoring across time
		Estimate non-CO2 emissions arising from wildfires
Waste - GHG Inventory	Limited data and information on wastewater from Coffee, Dairy products, Beer and Malt, Meat and Poultry, and Sugar refining.	There is a need for a regular survey to cover the wastewater use in industries and cover the improvement of the methodology for data collection and consider other types of industrial wastewater such as vegetables, fruits, juices, soap, and detergents, etc
IPPU - GHG Inventory	Lack of data on paraffin wax use at national level	It is important to conduct surveys on the different uses of paraffin wax at the national level.
GHG Inventory - Crosscutting	The uncertainties in activity data and emissions factors are high.	There is a need to enhance national capacity for uncertainty analysis including developing country-specific uncertainty estimates for activity data and emission factors based on the category and/or country-specific circumstances together with the data provider
		Enhancing national capacity for collecting data and addressing data gaps, including comparing with international data sets
		Develop and apply tier 2 or tier 3 methodologies for key categories across all IPCC inventory sectors
		Enhancing the technical capacity of staff involved to prepare inventories for NOx, NMVOC, CO and SOx emissions.

Sector	Constraints and Gaps	Needs
		Enhance national capacity to use greenhouse gas inventory tools for preparing and reporting GHG inventory at the sectoral and national level and undertaking key category analysis (KCA), uncertainty analysis and trend analysis
		Enhancing the technical capacity for undertaking QA/QC activities in the emissions calculation and NIR preparation.
Mitigation Assessment	There are gaps in assessing the mitigation potentials and tracking the emission reductions from the NDC measures	This gap will be addressed by conducting intensive capacity building programme for sectors to have the skills to tracking the emissions reduction impacts from the measures
		Training to enhance the mainstreaming of mitigation actions into national development priorities and planning processes
Support Tracking	There are gaps in tracking the support channelled to the private sector and NGOs	Enhancing national capacity for reporting information on financial support received for climate change activities, including BTR preparation
		Building national capacity for reporting information on technology support needed and received



CHAPTER 5

OTHER INFORMATION
CONSIDERED RELEVANT TO
THE ACHIEVEMENT OF THE
OBJECTIVE OF THE
CONVENTION

CHAP 6: OTHER INFORMATION CONSIDERED RELEVANT TO THE ACHIEVEMENT OF THE OBJECTIVE OF THE CONVENTION

6.1. ENVIRONMENT AND CLIMATE CHANGE MAINSTREAMING

Rwanda prioritizes integrating climate change mitigation and adaptation into national policies to strengthen the resilience of its people and environment (Republic of Rwanda, 2015). Vision 2050 commits the country to sustainable development, improved natural resource management, and a high quality of life supported by a healthy environment. Rwanda has advanced climate and environmental mainstreaming through strong laws such as the 2018 Environmental Law and strategies like the updated Green Growth and Climate Resilient Strategy (2023) and its regularly updated NDC3.0. The government has embedded climate action across national plans by revising earlier policies and aligning them with long-term development goals, including achieving upper-middle-income status by 2035 and high-income status by 2050. The National Environmental and Climate Change Policy emphasises the need for practical tools, stronger mainstreaming across sectors, improved infrastructure such as waste management, and better access to global climate finance (Republic of Rwanda, 2019). Subsequent sections elaborate on how climate change is integrated across different sectors in Rwanda.

6.1.1. Energy

Rwanda has integrated climate action into its energy and development agenda by promoting renewable energy, improving energy efficiency, and advancing cleaner transportation to reduce greenhouse gas emissions from the energy sector. Working with partners such as the Climate and Clean Air Coalition, Rwanda has addressed short-lived climate pollutants and expanded initiatives like landfill-gas-to-energy. NDC 3.0 commits to reducing emissions by up to 53% compared to Business as Usual by 2035 and identifies about USD 12 billion in mitigation and adaptation needs. Key policy frameworks, including the Sustainable Energy for All Action Agenda (2015–2030), the Rwanda Energy Policy (2025), the National Electrification Plan (2018), the Energy Sector Strategic Plan (2018–2024), guide actions such as integrating climate resilience into energy planning, scaling off-grid solar solutions, decarbonizing transport through the 2021 E Mobility Strategic Paper, and promoting cleaner cooking. These efforts are complemented by green urban development initiatives like the Green Building Compliance System and innovations in sustainable construction materials (Republic of Rwanda, 2019). Between 2018 and 2021, household electricity access rose from 46.7% to 64.53%, underscoring progress toward universal clean energy access (REMA, 2022). Together, these measures position Rwanda as a regional leader in building a low-carbon, climate-resilient, and inclusive energy future.

6.1.2. Agriculture

Rwanda has made significant efforts in integrating climate change adaptation and mitigation into its agricultural policies and practices to achieve sustainable intensification of the sector. This transition from subsistence to commercial farming is guided by national strategies that promote climate-smart agriculture (CSA), though adoption rates among small-scale farmers remain relatively low (World Bank; CIAT, 2015). Agricultural research and extension services are supporting farmers with climate-resilient crop varieties, improved management practices, and financial facilities, including credit guarantees, matching grants, and agricultural insurance, to help mitigate risks from extreme weather, pests, and diseases.

To improve resilience, farmers are being provided with drought-tolerant forage seeds, forage conservation training (Republic of Rwanda, 2023), and access to water infrastructure, including 13 valley dams and over 126 solar-powered boreholes in the Eastern Province. The Strategic Plan for Agriculture Transformation (PSTA

4, 2018–2024) emphasizes sustainable resource use, climate-smart technologies, and building resilience to climate impacts. It addresses soil challenges through advanced diagnostics and targeted nutrient management, while promoting efficient land and water management throughout the value chain. Rwanda has developed the PSTA 5 (the 5th Strategic Plan for Agriculture Transformation) with five-year roadmap (2024–2029) designed to revolutionize the nation’s agri-food systems, driving economic growth, enhancing food security, and strengthening climate resilience.

Complementary initiatives include the Livestock Master Plan, which enhances livestock productivity and resilience through improved feeding, breeding, and disease control (International Livestock Research Institute, 2017), and the Rwanda Irrigation Master Plan, which integrates climate considerations into irrigation infrastructure. This plan promotes water-efficient irrigation, renewable energy for pumping, water storage facilities, and sustainable watershed management to protect resources against droughts and floods (RAB, 2020).

Notable achievements based on (REMA, 2022) in mainstreaming environmental and climate considerations (ECC) in agriculture sector include:

- Achieving self-sufficiency in seed supply (maize, soybean, wheat).
- Expanding climate-smart agriculture infrastructure: 131,056.7 ha of radical terraces, 972,055 ha of progressive terraces, 66,840.5 ha under irrigation, and 37,273 ha of marshlands developed.
- Increasing irrigation within an Integrated Water Resources Management framework, with a 4.8% increase from the previous year.
- Scaling fertilizer use to 60 kg/ha and expanding adoption of improved seeds (37.1%), organic fertilizers (67%), and pesticides (22.4%).
- Advancing mechanization (62,207.5 ha) and land consolidation (up to 762,773 ha).
- Disseminating disease-free planting materials and developing pest and disease management technologies.
- Implementing ECC-related projects to accelerate NDC goals and enhance agricultural financing.

Through these comprehensive actions, Rwanda is enhancing productivity, diversifying incomes, and building a climate-resilient agricultural sector aligned with its national climate and sustainability objectives.

6.1.3. Forestry

Improved spatial planning, strengthened sustainable forest management, the establishment of seed banks for reforestation activities, the expansion of the network of protected areas on land and in wetlands, and strategic investments to restore the nation's degraded ecosystems are the main strategic options for adapting forests and biodiversity to climate change.

Rwanda is on its way to restoring 2 million hectares of deforested and damaged lands through the worldwide Bonn Challenge. Rwanda has committed to guaranteeing the use of mixed-species techniques in support of its larger forestry protection and reforestation activities, which helps to accomplish both mitigations aims and adaptation advantages of increased ecosystem resilience and biodiversity. Through this, Rwanda achieved overall 30.4% sustained forest cover of the total national land surface. Additionally, by 2030, Rwanda will implement public private partnerships to sustainably manage all forestry plantations through

multi-year contracts with forests operators (via cooperatives) who will plant and maintain young plantations until they reach their commercial size.

6.1.4. Waste

The waste sector in Rwanda consists of the solid waste and wastewater sub-sectors. The solid waste sub-sector is evolving further in terms of waste management (practices and technology use), and is more advanced in urban areas, rather than rural areas. There are existing solid waste collection services and landfills in Rwanda. The largest services and landfills are in the Kigali area, with the Nyanza landfill closed since 2012, and the current solid waste collected is disposed at the Nduba landfill. The wastewater sub-sector is still developing in terms of practices and technology use.

In the effort towards sustainable waste management, the country undertook various projects mostly related to waste recycling, in partnership with private sector players the efforts are part of implementing Paris Agreement to reduce global temperature to 1.5 degree Celsius by the mid of the century. Rwanda plans to invest \$28 million in extraction and utilization of gas landfills (LFG) for power generation which will then reduce methane gas emissions in the air.

In recognition and consideration of key overarching strategies and policies, Rwanda has also developed the National Circular Economy Action Plan (MoE, 2022) which formulates concrete and clear directions for the transition towards a circular economy in Rwanda. Rwanda aims at decoupling economic growth and resource consumption through the application of circular economy to its priority sectors, which are agriculture, waste, water and construction. The vision of the National Circular Economy Action Plan is that “by 2035, the economy of Rwanda is envisioned to have placed the circular economy at the core of economic decision making and practice, ensuring the retention of resource, eliminating waste and pollution while regenerating natural systems”. In order to realize this vision, the Action Plan proposes 17 policy interventions and concrete activities split across the priority sectors as well as cross-cutting themes that tackle capacity building and collaboration, and some include the following (MoE, 2022):

- Enhance the valorization of organic waste from MSW and decrease post-harvest losses.
- Establish waste collection and transfer centres in every district that allow most appropriate waste treatment.
- Install a systemic data collection system for waste.
- Develop a national regulation that facilitates waste characterization and treatment.
- Improve the planning of water resources management, supply and wastewater treatment in urban and rural areas.
- Promote a cleaner, more efficient and circular water use in agriculture, industry and service sector.
- Improve and enforce high- quality wastewater treatment and prevent degradation of the environment.
- Regarding e-waste, Rwanda developed a national E-Waste Management Policy in 2018 (Republic of Rwanda, 2018). The E-waste policy provides comprehensive direction and framework to the efficacious management of E-waste through appropriate legal, regulatory and strategic instruments. The policy comes into place to complement the existing environment protection policy and legal

framework. It addresses the unforeseen challenges and issues brought by economic development, modernization and the digital transformation.

- Currently, the municipality is responsible of the management of general waste and citizens are only required to pay for collection and disposal services. However, E-waste cannot be handled in the same way as general wastes because of its unique composition, which include non-biodegradable materials that can be harmful to the environment. This requires specialized disposal methods, skills and special facilities. In effort to the reduce the E-Waste generation in the country, Ministerial Guidelines related to importation of used electronics/ICT equipment's were published (MINICT, 2011), aimed to restrict and regulate importation of used computers and electronic parts, to minimize potential adverse effect on human health and the environment.

6.1.5. Industry

The integration of climate change in industry in Rwanda involves various measures aimed at reducing the carbon footprint of industrial activities and promoting sustainable industrial development. The industry sector encompasses construction, manufacturing, quarrying and mining. Greenhouse gas (GHG) emissions are linked to the energy needs to transform raw materials into final products through kilns, steam boilers, drying and toasting process equipment. (REMA, 2019) outlines relevant policy actions that include:

- Energy efficiency improvement s in the food industry
- Eco-Industrial Parks / Green Industries Complex
- Climate compatible mining
- Increasing efficiency in manufacturing processes in different industries
- Increased proportions of Pozzolana in cement
- Gradual substitution of F-gases by less polluting substitutes by putting in place different plans and actions to curb HFCs.

6.1.6. Health

Rwanda is committed to improving its healthcare system, service delivery and resilience to climate change. Rwanda's national health policies and programs are designed to increase the sectors adaptative capacity and increase cross-cutting information sharing and risk assessments. To achieve this, institutional structures, systems and tools used in the health sector need to be adapted to the risks associated with extreme weather conditions, disrupted seasonal trends and accelerating climate variability (Sayinzoga & Bijlmakers, 2016).

The health sector is also collaborating on strengthening protection mechanisms for preservation and conservation in order to promote environmental health and mitigate adverse effects of climate change on the population, including contributing to increased sensitization to reduce the air pollution in households (Ministry of Health, 2017).

6.1.7. Water Resource

To address the concerns of the country's water resources sector, Rwanda Water Resources Board was established in 2020 to address the country's water concerns. Rwanda also established a national framework for Integrated Water Resource Management (IWRM) which establishes clear roles, responsibilities, and decision-making processes for all water-related activities across the relevant sectors for improved

coordination. Additionally, Rwanda has integrated management of water resources at the district and community levels, defined catchment wide responsibilities, clustered catchment partner-districts according to sub-catchment regions, and is working to improve understanding of water users within districts and catchments. As part of its wider adaptation agenda, Rwanda is also developing a National Water Security Plan to improve water harvesting and storage techniques and improve irrigation efficiencies. Water resources management strategies will be supported through the mandating of rainwater harvesting, building codes and construction of dams by 2030 (World Bank, 2021)

6.2. Framework of ECC Sectoral Integration

The Government of Rwanda has developed a framework for mainstreaming environment and climate change into sector strategic plans and district development plans (currently known as District Development Strategies).

According to the 2022 Public Expenditure and Financial Accountability (PEFA) Climate Assessment which covers the financial years of 2018/2019, 2019/2020, and 2020/2021, Rwanda has successfully enacted various reforms which contributed to successful achievement of various procedures and processes that support climate change activities as outlined in (Republic of Rwanda, 2022). These include:

- I. Development of a framework for mainstreaming environment and climate change into sector strategic plans and district development plans.
- II. Use of Performance-Based Budgeting (PBB) approach to implement the National Strategy for Transformation 2017-2024 (NST1). The PBB reforms are expected to provide the desired linkage between resource allocation and the expected results in climate-related programs and activities.
- III. Development of budget execution reports with a narrative on the achievements in implementing environmental protection and climate change-related programs.
- IV. Alignment of climate related sector medium-term strategic plans, medium-term budgets and annual budgets with climate change strategies.
- V. Existence of rule-based allocation of resources among climate-related projects on the basis of climate-responsiveness.
- VI. Progress monitoring by Rwanda Environment Management Authority (REMA) on implementation of environment and climate change policies and regular production and publication of progress reports on state of environment in the country.

Additionally, Various sectoral policies comprise provisions that are related to climate change, environment and natural resources.

Key relevant policies include:

- I. **Agriculture Policy:** seeks to make agriculture and livestock more productive and at the same time ensure proper utilization of natural resources and sustainability for future generations (MINAGRI, 2018).
- II. **Biodiversity Policy:** considers the rehabilitation of degraded ecosystems in Rwanda as an urgent and major task that requires the commitment of significant resources from both national budgets and other sources (Republic of Rwanda, 2011).
- III. **Energy Policy:** recognizes the need to shift consumption from biomass-based energies to clean energies like electricity and Liquefied Petroleum Gas (LPG) to reduce pressure on forest resources.

It also focuses on renewable energy infrastructure as one strategy to fight global warming through reductions in greenhouse gas emissions (MININFRA, 2015).

- IV. **Forestry Policy:** recognizes the need to manage forest resources to support the country's development goals for sustainable, low-carbon and climate resilient growth to improve livelihoods of present and future generations (MINILAF, 2018).
- V. **Land Policy:** stresses that agroforestry should be part of the agricultural landscape on hills, given its contribution to soil protection (MoE, 2019).
- VI. **National Industrial Policy:** stresses that waste produced by industrial processes is harmful to the environment and needs proper management and disposal strategy (MINICOM, 2011).
- VII. **Sanitation Policy:** aims to ensure sustainable, equitable and affordable access to safe sanitation and waste management services for all Rwandans as a contribution to poverty reduction, public health, economic development and environmental protection (MININFRA, 2016).
- VIII. **Water Resource Management Policy:** considers managing and develop water resources in an integrated and sustainable manner to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations (MINIRENA, 2011).
- IX. **Water Supply Policy:** aims to ensure sustainable, equitable, reliable and affordable access to safe drinking water for all Rwandans, as a contribution to improving public health and socio-economic development (MININFRA, 2016).
- X. **Wildlife Policy:** acknowledges that Rwanda's wildlife protected areas significantly contribute to the production of global public goods and services, such as protection of biodiversity, climate stabilization, carbon sequestration and global waters. It also stresses that any adverse impacts on the ecosystems can dramatically and negatively alter humans' capacity to survive (MINICOM, 2013).
- XI. **Revised Green Growth and Climate Resilience :** with three strategic objectives - (a) to achieve Energy Security and Low Carbon Energy Supply that supports the development of Green Industry and Services and avoids deforestation; (b) to achieve sustainable Land Use and Water Resources Management that results in Food Security, appropriate Urban Development and preservation of Biodiversity and Ecosystems Services; (c) to ensure Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change impacts (Republic of Rwanda, 2022).

6.3. Climate Research and Systematic Observations

Climate research and systematic observations in Rwanda are important for understanding the impacts of climate change on the country's environment, economy, and society. The outcomes are important for developing strategies to mitigate and adapt to these impacts. Some ways in which climate research and systematic observations are being conducted in Rwanda include weather monitoring by Meteo Rwanda, climate modelling by different researchers, etc.

6.3.1. Climate Research

In 2021, REMA, in collaboration with the University of Rwanda (UR) and the Higher Education Council (HEC) launched a research program that will provide 50 fully funded scholarships to 25 scholars and 25 lecturers at the University of Rwanda to conduct research on nature-based solutions that harness biodiversity and ecosystem services to reduce Rwanda's vulnerability and build resilience to climate change in Rwanda. The program aims also to enable the country to make informed policy decisions about long-term climate change adaptation and forge new partnerships with research institutions.

With support from the Global Environment Facility (GEF) through the United Nations Environment Program (UNEP), the program is intended for full-time master's scholars at the University of Rwanda College of Science and Technology (CST) and College of Agriculture and Animal Sciences and Veterinary Medicine (CAVEM). Interested research fellows or associates from the University of Rwanda and Centres of Excellence submit research proposals on Ecosystem-based Adaptation approaches (EbA). Financial support is provided to the best research proposals in fields such as soil management and agroforestry, soil and water engineering, renewable energy, water resources and environmental management as well as biodiversity conservation and natural resource management.

Other areas of ongoing research include climate risk vulnerabilities. In 2019, the International Centre for Tropical Agriculture conducted a study to assess climate risk for selected value chain commodities in Rwanda (Mwongera, et al., 2019). These findings indicate that climate hazards that represent key vulnerabilities for the six value chains (cassava, sweet potato, beans, maize and banana) are drought, moisture stress, flooding, heat stress and strong winds.

Additionally, REMA, through the Capacity Building Initiative for Transparency (CBIT) project, initiated research for the development of country-specific emission factors. It has developed 8 country-specific emission factors in the sectors of Energy, Industrial Process and Product Use, Agriculture and Waste sectors. The research aims to improve the accuracy of the Rwanda National Greenhouse Gas Inventory calculations through computation of national data and emission factors.

6.3.2. Systematic Observations

Rwanda Climate Change Observatory (Rwanda Space Agency)

Rwanda has significantly advanced its atmospheric and climate observation capabilities. The Rwanda Climate Observatory, backed by Massachusetts Institute of Technology's (MIT) Medusa system is now managed by the Rwanda Space Agency (RSA) since 2022 (Space in Africa, 2022). Much of the RSA's activity involves earth observation. This includes greenhouse gas monitoring, disaster management, and economic and social development (UN Rwanda, 2023). Rwanda's first satellite, RWASAT-1, monitored soil moisture levels and provided data for crop yield estimates as a part of the RSA's economic development initiative (Umuhire, 2021). Its second, nicknamed Icyerekezo, helped provide satellite internet service to the remote Nkombo Island on Lake Kivu (MINICT, 2019).

Through this observatory program, Rwandan researchers are gaining the capability using state of the art computer models to calculate regional greenhouse gas sources and sinks, climate change, and air pollution. The observatory data is also used for University of Rwanda (UR) student thesis projects, and MIT is working with UR faculty on their new Atmospheric and Climate Science Master's degree and undergraduate courses. The Climate Observatory Project is also aiding in development of air pollution measurements for human health objectives, led by the Rwanda Environmental Management Authority (REMA). The Climate Observatory Project is under Rwanda Space Agency. So far, various research papers on treating air pollution and greenhouse gases have been published in international journals.

Meteo Rwanda Observation Systems for Climate and Weather Observatory

Meteo Rwanda maintains a robust, multi-faceted network of weather and climate stations, supported by modern data infrastructure and public-facing tools (Maproom, Climate Data Library). The integration of the ENACTS methodology ensures high-quality, gap-filled historical data critical for climate resilience There are

currently 8 types of observation stations in the country comprising more than 300 installed and operational stations (Table 23); the current status of observational network platform includes manual and automatic weather stations):

Table 23: Status of Meteo Rwanda observation systems for climate and weather observatory

Num	Descriptive type of station	Number of installed and operational stations
1	Surface synoptic stations	5
2	Agro-meteorological stations	9
3	Climatic stations	72
4	Rainfall stations	71
5	Automatic Weather stations	41
6	Automatic Rain Gauges	100
7	Weather Radar	1
8	Automatic Lightning Detector	1

Source: *Data Observation, Quality Control & Processing Division (meteorwanda.gov.rw)*

Further, Meteo Rwanda modernized its network with 25 new weather stations in 2023, ensuring full national coverage and meteorological data collected from weather stations countrywide are checked, managed, processed and archived in Meteorological Databank. Meteo Rwanda uses Climsoft software to manage data processing and archiving, as well as encoding and transmitting relevant messages to Global Telecommunication System (GTS) via Nairobi Regional Telecommunication Centre (RTC).

Historical meteorological data are used to generate climate products to support other sectors, namely transport (air, marine and road), agricultural, infrastructure, health, environmental and disaster management, climate monitoring for sustainable development in safe environment.

Meteo Rwanda hosts a Climate Maproom, which is a collection of maps and other figures that monitor climate and societal conditions at present and in the recent past. The maps and figures can be manipulated and are linked to the original data. Additionally, Meteo Rwanda has a repository of climate data via its Climate Data Library. This library is a powerful and freely accessible online data repository and analysis tool that allows a user to view, analyse, and download climate-related data through a standard web browser. Through this library, the user can (at no cost):

- Access any number of datasets.
- Create analyses of data ranging from simple averaging to more advanced EOF analyses using the Ingrid Data Analysis Language.
- Monitor present climate conditions with maps and analyses in the Maproom;
- Create visual representations of data, including animations.
- Download data in a variety of commonly used formats, including GIS-compatible formats.

Air Quality Monitoring Systems

The Government of Rwanda is committed to preserving air quality, combating air pollution, and is taking important initiatives to identify sources of air pollution and improve national levels of air quality. The government has taken several preventative measures to combat air pollution, in particular since the launching of the Rwanda Air Quality and Climate Change Monitoring project in 2018. This joint project

between REMA and the Ministry of Education has the key objective of establishing an air quality monitoring system in the country.

REMA has set up an air quality monitoring instruments system that provides data (real-time air quality index) on air quality across the country. The data is also accessible on the “Rwanda AQI” application so that users can compare ground observation data with satellite data. The system connects to 23 air quality monitoring stations across the country. These stations measure a range of air pollutants, including particulate matter, carbon monoxide, nitrogen oxide, sulfur dioxide, and ozone. The data collected from these stations is used to monitor air quality and inform decision-making related to air pollution mitigation measures. The system provides real-time Air Quality Index (AQI) for each station in both numerical and colour code format. The system highlights the dominant air pollutant which is responsible for air quality degradation during the reported period for each station. This development has led to tangible improvements in air quality data ultimately supporting law enforcement activities for air pollution control and enhancing expertise in climate change and air quality research in Rwanda.

6.4. Education, Capacity Building and Public Awareness

This section covers detailed information on education, training and public awareness activities implemented to raise awareness for environment management and building resilience to climate change in Rwanda.

6.4.1. Education

Rwanda continues to integrate climate change education across multiple levels through curriculum, policy, and partnerships. Since 2016, the competence-based curriculum has treated environment and sustainability as a cross-cutting theme in K–12 subjects, while the 2019–2024 Education Sector Strategic Plan promotes practical initiatives such as water harvesting, solar panels, biogas systems, and the “one tree per child” campaign (MINEDUC, 2018). The 2019 Environment and Climate Change Policy further embed climate issues into schools, universities, and government performance contracts (Republic of Rwanda, 2019).

The Rwanda Environment Management Authority (REMA) plays a central role by providing guidebooks, teacher training, and awareness programs, while also involving schools in non-formal education, workshops, and campaigns since 2006 (Republic of Rwanda, 2018). At the higher education level, the University of Rwanda offers a master’s program in Atmospheric and Climate Science alongside other climate-related fields, and institutions like RICA, INES Ruhengeri, and UNILAK contribute with specialized programs. Rwandan higher education participates in international sustainability education efforts: Rwanda is listed among the countries in the UNEP-led MESA (Mainstreaming Environment and Sustainability in African Universities) partnership, which works to integrate environmental and sustainability issues into university curricula, research, and community engagement (UNEP, 2022). Non-governmental organizations complement these efforts, including ARCOS’ Eco-Schools programme (ARCOSNETWORK, 2021), UNICEF and World Vision’s Greening of Schools Project (UNICEF Rwanda, 2024), the New York Academy of Sciences’ innovation challenge (NYAS, 2024), and RECOR’s community-based climate adaptation training (RECOR, 2022). Together, these initiatives reflect Rwanda’s holistic approach to building climate literacy, resilience, and environmental stewardship.

6.4.2. Training and Capacity Building

Rwanda’s climate-change capacity-building and training programmes delivered through 2022 were organised around key thematic areas including: (1) policy, planning and reporting (strengthening NAP/NDC

processes, adaptation planning and GHG inventory reporting skills), (2) sectoral adaptation and resilience (climate-smart agriculture, water and flood resilience, community-level adaptation and ecosystem/landscape restoration), (3) monitoring, evaluation and knowledge management (adaptation M&E, data systems and learning), (4) finance and proposal development (climate finance, project preparation and access to funds), and (5) green growth / mitigation technical skills including in low-carbon planning, green economy concepts and stakeholder engagement (REMA, 2022) (Republic of Rwanda, 2023). Trainings typically combined national-level workshops for ministry and REMA staff, targeted technical short courses for sectoral focal points and district officials, and community-level capacity building and demonstrations with strong emphasis on mainstreaming NDC/NAP measures into sector plans, building adaptation M&E skills, and improving readiness to access international finance (Republic of Rwanda, 2023). Notable contributing projects and initiatives include:

- GEF/UNDP-supported NAP project on Building the Capacity of Rwanda's Government to Advance the National Adaptation Planning Process from 2019 – 2025 (GEF, 2022)
- GIZ supported project on Capacity Development for the Implementation of Rwanda's NDCs from 2022 - 2026 (GIZ, 2022)
- The Carbon Transaction Facility (CTF) supported Rwanda Article 6 Readiness and Carbon Market Framework Operationalization project from 2022 - 2026 (GGGI Rwanda, 2023)
- GEF/UNDP supported Ecosystems/Landscape Approach to Climate Proof the Rural Settlement Program of Rwanda project (UNDP, 2022)

6.4.3. Public Awareness

There exist various channels for public awareness on climate action. These include television shows, radio spots documentaries, awareness campaigns, environment related events, community Radios, national district planners training among others. This is done through REMA's responsibilities to prepare, publish, and disseminate education materials relating to guidelines and laws relating to environmental management and protection and reduce environmental degradation risks. Different stakeholders are mobilized and sensitized to join the cause and adherent to the strategic orientation. These include Non-Governmental Organizations both local and international, the civil society, academic researchers, and the media. The latter is expected to play a bigger role in community outreach and engagement.

6.5. Technology Transfer for Adaptation and Mitigation

Technology Needs Assessment

Rwanda has identified several key technologies for climate change mitigation and adaptation. These technologies have been selected based on their potential to contribute to Rwanda's national development priorities, as well as their suitability for the country's local context. These technologies reflect Rwanda's commitment to climate change mitigation and adaptation goals and its recognition of the importance of technology in achieving these goals. According to the Technology Needs Assessment (TNA) report of 2012, different technologies identified to support the energy and agriculture sectors and the country in general, to mitigate or adapt to the effects of climate change are highlighted in Table 24. These two sectors were prioritized based on the fact that they contribute to greenhouse gas (GHG) emissions of the country more than other sectors, and also due to the fact that the energy and agriculture sectors are among the most priority sectors in the country's development plans and programs.

Table 24: Prioritized technologies for energy and agriculture sectors

Sector	Technology	Targets for technology transfer and diffusion	Current developments
ENERGY	Small hydropower technology	a. Promotion of private sector participation in hydropower production at large and small scales; b. The delivery of licenses for small hydropower projects; c. Exploitation of higher number of small hydropower sites; d. Promoting the legal and regulatory frameworks of micro-hydropower and mini grids; e. Financing and investing through IPP (Independent Power Producers) negotiation.	Hydropower has generated the bulk of electricity in Rwanda since 1960s. Current installed generation capacity: 104.628 Megawatts.
	Geothermal technology	a. Assessment of geothermal resources mainly in volcanic northern areas and along the whole portion of Rift Valley from the North to the South-West of the country; b. Identification of private investors and partners for further financial support.	Rwanda's geothermal resource is yet to be proven. However, studies have identified Karisimbi, Kinigi, Gisenyi and Bugarama as promising areas. Further studies, exploration and test sites are required to confirm this. Current installed generation capacity: 58.8 Megawatts.
	Kivu Methane CCGT (Combined Cycle Gas Turbine) with CCS (Carbon Capture Storage and Sequestration)	a. Negotiate and establish agreements with private sector and international investors for funding projects; b. Liquefaction of methane gas for further replacement of biomass and diesel fuels used in households and industry sector.	Kivuwatt has demonstrated the commercial and technical viability of extracting methane from Lake Kivu. Further utilisation of methane resources is planned, with significant investor interest. Current installed generation capacity: 29.79 Megawatts.
	Plug in Hybrid Electric Vehicles (PHEV)	a. Increasing the capacity of transport sector;	Rwanda has seen an increase in major e-mobility investments thanks to the country's friendly

		b. Substituting imported petroleum fuels by methane gas converted into liquid fuels; c. Developing a market based on efficient gasoline cars; d. Introducing the green transport through the use of biodiesel and deployment of electric vehicles.	doing business environment. For example, VW Mobility Solutions, Victoria Autofast Rwanda, Ampersand, Rwanda Electric Motorcycle Ltd and Safi/Gura Ride have all significantly invested in electric cars and motorbikes. Rwanda welcomes investments that support the transition to clean and green mobility. Numerous fiscal and non-fiscal incentives to fast-track the electric mobility transition and attract additional investments are also established.
	Large solar Photovoltaic (PV)	a. Development of a national strategy for operation and maintenance of large solar PV system; b. Exempting all types of solar equipment and components from import duties; c. Basic electrification of all schools, all health centers and all administrative offices in remote rural areas; d. Development of guidelines on sizing and tender for provision of solar systems with high quality standards.	Rwanda's solar radiation varies between 4.3 and 5.2 kWh per m2 per day over all regions. There is high interest from the private sector in on-grid solar power development. Current installed generation capacity: 12.05 Megawatts.
AGRICULTURE	Agroforestry	a. Organizing and directing farmers study tours for better understanding and reception up to activities on actual transfer; b. Production of training materials like the creation of tree seed stands in every district and production of seedlings.	- National agroforestry cover per year: 2018 (2.1%); 2019 (2.1%); 2020 (2.1%); 2021 (2.2%); 2022 (2.3%); 2023 (2.5%) (MINILAF, 2018). - 46.2 of households planted agroforestry trees in their plots.
	Radical terraces	Organizing a series of trainings to agriculture extension agents and the	- The progress for radical terraces establishment in Rwanda is 46.246 ha (18.96% of the

		representatives of farming community which aims at building their capacity in terms of know-how.	potential suitable radical terraces areas). - 9.2% of agricultural households use radical terraces as a type of erosion control measures (Republic of Rwanda, 2021).
	Rainwater harvesting	Organizing and directing technical trainings on rainwater harvesting systems to the action diffusion through provision of subsidies for technology acquisition.	Currently, there are mainly two types of rainwater harvesting commonly used in Rwanda (Republic of Rwanda, 2016): - Roof top rainwater harvesting technologies (including roof water collection using loosely attached corrugated iron gutters on the roof edges, aboveground tanks made of reinforced concrete, bricks, masonry wall and aboveground plastic tanks as well as plastic sheets, underground tanks ...) - Ground water recharge technologies (including multipurpose dams, check dams, gullies plugging, ditches and water ponds).
	Drip irrigation	a. Organizing and directing technical trainings on drip irrigation systems installation and maintenance; b. Installation of small scale solar powered drip irrigation systems in remote areas.	- 0.4% of agricultural households in Rwanda irrigate their lands using drip irrigation technology (Republic of Rwanda, 2021). - The average percentage of the irrigated plots by drip irrigation technology was 2.5% in 2017 to 2021 (Hakiruwizera, Topcu, & Ucar, 2022).
	Seed and grain storage	Construction of demonstration sites to allow the farming community in general and technicians in particular to familiarize with the technology and understand its benefits.	The Ministry of Agriculture and Animal Resources (MINAGRI) has been investing hugely in facilities that enable farmers to enhance their post-harvest handling. MINAGRI has constructed 525 modern drying grounds across the country and provided the farmers

			with more than 100 solar bubble dryers, among others. (MINAGRI, 2023) The systematic assessment of post-harvest infrastructures identified 11 metallic silos, 4 packhouses, 41 cold rooms and 8 charcoal coolers. Total capacity of silos at national level is 56,620MT. The maximum capacities of charcoal coolers, packhouses and cold-rooms are 98MT, 214MT and 889MT respectively (MINECOFIN, 2021).
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In 2022, a TNA was conducted targeting the Urbanization and Industry sectors (MINAGRI, 2023). In order to minimize greenhouse gas (GHG) emissions and/or lessen the vulnerability of sectors and livelihoods to the negative effects of climate change, this report tracks the developing demand for new tools, methods, and practical knowledge. It has the following specified goals:

- I. To assess climate change adaptation and mitigation technology needs for the sectors of urbanisation and industry, identify and prioritize the needed technologies that can contribute to mitigation and adaptation adverse impacts of climate change especially in urban and industrial areas.
- II. To identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies dealing with adverse effects of climate change and or contributing to the reduction of greenhouse gas (GHG) emissions and their enabling framework.
- III. To develop Technology Action Plans (TAP) with specific activities and a framework to overcome the barriers to implement and to facilitate the transfer, adoption, and diffusion of prioritised technologies for the sectors of urbanisation and industry in Rwanda; and
- IV. To develop at least three project ideas and one full project proposal by sector for identified technologies.

In these two sectors, prioritized adaptation and mitigation technologies are presented in Table 25:

Table 25: Prioritized technologies for urbanization and industry sectors

Urbanization sector	Adaptation	Mitigation
	Integrated Early warning systems for disaster prevention and response plans	Vehicle emissions standards control
	Greening the cities	E-mobility
	Improved water storage and supply	CFL and LED lighting in buildings
	Wastewater treatment and recycling	Solar mini-grids
	Storm water management and treatment	Efficient appliances (fridge, air conditioner, fans)

Industry sector		Use of LPG and improved cooking stoves
		Landfill gas utilization (LFG)
	Greening the industrial zones	Energy efficient brick kilns
	Greening the industrial zones	Energy efficient cement production
	Insurance coverage	Energy efficient in agro-processing
	Climate resilient supplies production	Increased Pozzolana use in cement
	Sustainable water supply system	Waste heat recovery system in industries

Some other examples of Climate Change-Related Technologies in Rwanda include:

- **Climate-Smart Practices and Technologies:** Rwanda is promoting climate-smart agriculture practices that help farmers adapt to the impacts of climate change while reducing greenhouse gas emissions. Priority technologies include conservation agriculture and sustainable land management (MINAGRI, 2018).
- **Climate-Resilient Infrastructure and Green Buildings:** Rwanda is investing in climate-resilient infrastructure, including roads, bridges, and buildings that can withstand the impacts of climate change such as floods, landslide. Rwanda is also promoting the use of green building technologies such as energy-efficient lighting, insulation, and passive cooling to reduce energy consumption and greenhouse gas emissions from buildings.
- **Water Management Technologies:** Rwanda is prioritizing the development of water management technologies such as rainwater harvesting, drip irrigation, and water-efficient technologies to improve water resource management and support climate change adaptation.
- **Waste Management:** Rwanda is promoting waste management technologies such as recycling, composting, and biogas production to reduce greenhouse gas emissions and promote a circular economy.
- **Forest Conservation:** Rwanda is prioritizing forest conservation technologies such as reforestation, afforestation, and forest protection to increase carbon sequestration and support climate change adaptation.

Enabling Environment and Mechanism for Technology Transfer

In the Energy Sector, Rwanda has created an enabling environment and mechanisms for technology transfer to promote in the energy sector to promote sustainable development and meet the country's increasing energy demand.

Rwanda has implemented several initiatives to promote the adoption of sustainable energy technologies in the country. The initiatives demonstrate Rwanda's commitment to promoting sustainable energy technologies and reducing reliance on fossil fuels. By focusing on increasing access to electricity and promoting the adoption of renewable energy technologies, Rwanda is working towards a more sustainable and resilient energy sector.

Some of the key initiatives include:

- **Scaling up Renewable Energy Program (SREP):** Rwanda is one of the countries participating in the Scaling up Renewable Energy Program (SREP), which is part of the Climate Investment Funds. SREP is a targeted program that aims to increase the deployment of renewable energy technologies in low-income countries, and Rwanda has received funding for Rwanda Renewable Energy Fund (REF) project through this program (Heltberg, 2022).
- **Energy Sector Strategic Plan:** The Rwandan government has developed an Energy Sector Strategic Plan, which provides a roadmap for the development of the energy sector in the country. The plan focuses on increasing access to electricity and promoting the adoption of renewable energy technologies (MININFRA, 2018).
- **Off-grid Energy Solutions:** Rwanda has implemented several off-grid energy solutions to increase access to electricity in rural areas. For example, the government has partnered with private companies to install solar-powered mini-grids and home solar systems in remote areas.
- **Renewable Energy Feed-in Tariffs:** Rwanda has implemented renewable energy feed-in tariffs (FITs) to encourage investment in renewable energy projects. FITs are a pricing mechanism that guarantees a fixed rate for the electricity generated by renewable energy projects, which can provide a stable revenue stream for investors.
- **Rwanda Green Fund:** Through the Rwanda Green Fund (FONERWA), the Government of Rwanda have mobilized over USD 247 million. Additionally, Intego, Rwanda's NDC implementation facility, has approved RWF 43.6 billion for 10 transformative climate investments. Also, IREME Invest, a green investment facility has been established to support private sector climate action (FONERWA, 2021).

In the AFOLU Sector, Rwanda has implemented several initiatives to promote the adoption of sustainable technologies in the country. These initiatives include:

- **Rwanda Agricultural Board:** The Rwanda Agricultural Board (RAB) was established to promote research and development in the agriculture sector. As its vision states "Improved food security and livelihoods of all Rwandans by transforming agriculture from subsistence into modern farming through generating research and extension innovations that generate sustainable crop, animal husbandry and natural resource management, RAB provides technical assistance and training to farmers and supports the adoption of sustainable agriculture technologies, including improved seed varieties, agroforestry, radical terraces, post-harvest technologies, conservation agriculture, etc.
- **The China-Rwanda Agriculture Technology Demonstration Centre (C-RATDC):** The centre has a mission of developing market-oriented agriculture and land husbandry through research, extension, technologies demonstration and trainings. It is also committed to be an economically viable, cohesive and sustainable diversified demonstration Centre, that uses highly good agricultural practices to produce high quality cultivated rice, mushrooms, grass for feed and silkworm hybrid eggs to improve farmers' livelihoods and food security in Rwanda. According to the agreement signed between China and Rwanda, this C-RATDC has four areas of (1) JUNCAO (mushroom) technology, (2) Rice cultivation, (3) Sericulture, and (4) soil and water conservation (RAB, 2021).
- **Crop Intensification Program:** The Crop Intensification Program (CIP) is a government-led initiative that aims to increase agricultural productivity and food security by promoting the

adoption of improved crop varieties, fertilizers, and other modern farming practices. The program has helped to increase yields and improve food security in Rwanda.

- **Rwanda Climate Services for Agriculture:** Rwanda Climate Services for Agriculture (RCSA) is a government-led initiative that provides weather and climate information to farmers to help them make informed decisions about crop management. The program also provides training on climate-smart agriculture practices, such as drought-resistant crops and soil conservation.
- **Farmer Field Schools:** The Farmer Field School (FFS) program provides training to farmers on sustainable agriculture practices, including integrated pest management and soil conservation. The program is implemented in partnership with local NGOs and has been successful in promoting the adoption of sustainable agriculture technologies.
- **Forest Landscape Restoration Program:** The Forest Landscape Restoration Program (FLRP) is a government-led initiative that aims to restore degraded forest landscapes in Rwanda. The program promotes the adoption of sustainable forest sector technologies, such as reforestation and agroforestry, to restore degraded forest landscapes and promote biodiversity conservation.
- **Land Husbandry, Water Harvesting and Hillside Irrigation Project:** The Land Husbandry, Water Harvesting and Hillside Irrigation Project (LWH) is a government-led initiative that aims to promote sustainable land use practices in Rwanda. The project promotes the adoption of sustainable forest sector technologies, such as agroforestry and sustainable forest management, to promote soil conservation and water management.
- **Forest Certification:** The government has established forest certification schemes to promote sustainable forest management practices in Rwanda. These certification schemes provide standards and certification services for sustainable forest management practices, such as the Forest Stewardship Council (FSC) certification.

In the IPPU Sector, Rwanda has implemented several initiatives to promote the adoption of sustainable industrial processes and production (IPPU) technologies in the country. Some of the key initiatives include:

- **National Industrial Policy:** The National Industrial Policy is a government-led initiative that aims to promote sustainable industrial development in Rwanda. The policy prioritizes the adoption of sustainable IPPU technologies and provides the mechanisms for environmental sustainability to reduce industrial-related environmental impacts.
- **Cleaner Production and Climate Innovation Centre:** The Cleaner Production and Climate Innovation Centre (CPCIC) is a government-led initiative that provides technical assistance and training to industries to help them adopt sustainable production practices. The CPCIC helps industries ensure that all technology, processes, services and choices made embrace the best practices in terms of climate change resilience and cleaner/efficient production.

In the Waste Sector, some key initiatives for sustainable waste management include:

- **National Integrated Solid Waste Management Strategy:** This strategy is a government-led initiative that aims to promote sustainable solid waste management practices in Rwanda. The strategy prioritizes the adoption of sustainable waste sector technologies, such as waste-to-energy, circular materials management approach, and provides incentives for waste reduction and recycling.
- **Single-Use plastic ban:** The government has banned the use of single use plastics in Rwanda to reduce plastic waste. The ban has promoted the adoption of sustainable alternatives, such as paper bags, refillable water bottles and reusable shopping bags.

Capacity Building for Climate Change-Related Technology Transfer

Various initiatives aimed to develop and transfer relevant climate technologies have been implemented.

Such initiatives include the projects of “Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa – Building a Comprehensive National Approach in Rwanda” and “Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in Flood-prone Areas”. These projects contributed to the:

- i. Installation of various weather stations across the country.
- ii. Implementation of a data analysis system, including the provision of material and training related to the analysis of weather data to Meteo Rwanda staff.
- iii. Installation of SADIS software for the downscaling of climate projections; and
- iv. Development of an Early Warning System in a pilot site in the Gishwati area.

For the agriculture sector, five technologies have been particularly selected in order to assist this sector to adapt to the impacts of climate change. Those technologies include Seed and grain storage, Agroforestry, Radical terraces, Drip irrigation and Rainwater harvesting.

In addition, Rwanda has set up the institution frameworks that facilitate the adoption of green technologies for state and non-state actors. Through CPCIC (Cleaner Production and Climate Innovation Centre) the government works to ensure that all technologies, processes, services and choices made by the private and the public sector embrace the best practices in terms of climate change resilience and cleaner/efficient production.

Rwanda is currently putting in place the potential enabling environments for adopting and transfer of environmentally sound technologies. In transport sector for instance, the Government has put in place friendly doing business environment that attracts e-mobility investments, and Rwanda welcomes investments that support the transition to clean and green mobility. The private sector has significantly invested in electric cars and motorbikes

The Government of Rwanda also introduced various incentives to fast-track and enable environment for e-mobility. They include:

- Low Charging Costs at the lowest industrial tariff (which is significantly lower than the residential tariff)
- Tax Breaks on e-vehicles, spare parts, batteries and charging station equipment which were exempted from import and excise duties,
- Provision of land to companies setting up charging stations across the country on a rent-free basis.
- Promoting Local Production to companies manufacturing and assembling electric vehicles in Rwanda and enjoy a 15% Corporate Income Tax rate and tax holiday.

The government has also promoted the clean energy use by households, commercial/institutional buildings by subsidizing the use of LPG in cooking, to phase progressively phasing out the use of biomass use. It has also incentivized the local communities to adopt use of improved cooking stoves. In addition, Rwanda is

establishing low-carbon and climate resilience technologies, such as biogas and rainwater harvesting through the green model village approach.

To diffuse the environmentally sound technology, the Government of Rwanda partnered with the United Nations Development Program (UNDP) in Rwanda and UN Environment through the Poverty-Environment Initiative (PEI) to pilot Green Villages as part of the nation's vision and commitment to transform into a middle-income nation by 2030. The Green Model Villages involve establishment of low-carbon and climate resilience technologies, including rainwater harvesting systems, use of biogas residue as fertilizer, tree planting for climate proofing and terracing. This initiative has proven to be a sustainable solution in rural Rwanda, especially for vulnerable populations that live under difficult conditions (e.g. on very steep slopes prone to landslides or on small islands in the lakes, and generally in poor economic conditions with limited infrastructure and access to public services).

6.6. Information Sharing and Networking Channels

6.6.1. Rwanda Climate Change Portal

The National Climate Change Portal is an online platform that provides information on climate change in Rwanda. It aims to support decision-making and planning related to adaptation and mitigation to climate change. The portal provides access to a range of information, including historical and future climate projections, climate-related risks and vulnerabilities, and information on Rwanda's climate policies and initiatives. It also includes interactive tools such as maps and charts to visualize climate data and information. In addition, the Rwanda Climate Portal has a news section that provides updates on climate-related events and initiatives in Rwanda and around the world.

The portal is intended for a wide range of users, including government officials, researchers, non-governmental organizations and the general public. The Rwanda Climate Change Portal is an essential resource for anyone interested in the impacts of climate change in Rwanda and efforts to address these challenges.

6.6.2. Early Warning System

Rwanda has made important progress in strengthening its early warning systems (EWS) as part of its disaster risk reduction and climate adaptation agenda. By 2024, the government, through MINEMA (the Ministry in Charge of Emergency Management) and Meteo Rwanda, had identified 326 disaster risk hotspots (floods, landslides, strong winds, lightning) across the country, and installed real-time water-level sensors and automated weather stations to monitor these high-risk areas (Africa Press, 2024). Forecasting and alerting capacity has improved with, Meteo Rwanda having built capacity to issue early warnings with a lead time of about 30 minutes, and communicates preparedness information to the public (SOFF, 2023).

In addition, there is a permanent Multi-Hazard Early Warning System (MHEWS) working group led by MINEMA, Meteo Rwanda, and other stakeholders (SOFF, 2023). The May 2023 floods and landslides were a stress test: Meteo Rwanda issued rainfall alerts, and MINEMA carried out evacuations, but post-event analysis shows significant gaps in coverage and clarity of warnings (Idukunda, Henry, Twarabamenye, De Longueville, & Michellier, 2025). Rwanda is also participating in the CREWS East Africa initiative, launched after the 2023 disasters, to develop a Flash Flood Guidance System and strengthen early warning infrastructure (UN Rwanda, 2023). Remaining challenges include: achieving comprehensive coverage (especially in remote and high-risk zones), ensuring early warnings are actionable (i.e., communities trust

and use them), and sustaining financial and technical capacity over the long-term Environment and climate change thematic working group

The Environment and Climate Change Thematic Group Meeting is a regular meeting of government and non-governmental organizations in Rwanda working on environmental and climate change issues. The purpose of the meeting is to provide a platform for stakeholders to share updates, exchange ideas, and coordinate efforts towards achieving Rwanda's environmental and climate change goals. The Thematic Working Group Meeting is convened by and co-chair, World Bank Rwanda REMA twice a year (every six months). It is attended by representatives from government agencies, civil society organizations, academia, and the private sector. Participants in the meeting talk about a range of environmental and climate change concerns that are relevant to Rwanda, including adaptation to and mitigation of climate change, renewable energy, biodiversity preservation, and sustainable land management.

The gathering gives participants the chance to discuss best practices and lessons gained, examine the status of ongoing projects and initiatives, and pinpoint areas that could use more cooperation and support. This meeting is an important forum for stakeholders in Rwanda to come together, share knowledge, and work towards a common goal of promoting sustainable development and environmental conservation.

6.6.3. National Business Leaders' Breakfast

The National Business Leaders Breakfast is an event organized by the Rwanda Environment Management Authority (REMA) in partnership with other stakeholders, including the Private Sector Federation to bring together business leaders and policymakers to discuss environmental sustainability and corporate social responsibility in Rwanda. The breakfast is a platform for business leaders to share best practices and discuss innovative solutions to environmental challenges, while also exploring opportunities for sustainable growth and development. The event provides an opportunity for networking and collaboration between businesses, government agencies, and non-governmental organizations working on environmental issues.

The breakfast typically features keynote speakers, panel discussions, and presentations on topics related to sustainable business practices, such as green technology, energy efficiency, waste management, and sustainable supply chains. It also provides an opportunity for businesses to showcase their sustainability initiatives and projects. Through the Business Leaders Breakfast, REMA and its partners aim to promote environmental sustainability as a key driver of economic growth and development in Rwanda, while encouraging businesses to adopt sustainable practices and contribute to the country's environmental goals, such as accelerating the achievement of Rwanda's highly ambitious target of 53% of emissions reduction by 2035 and building a carbon-neutral and climate-resilient economy by 2050.

6.7. Innovative Projects and Initiatives to Driving Climate Action

Since 2022, (the latest inventory year for this report), Rwanda has advanced climate action through a range of innovative projects, ideas, and initiatives across multiple strategic areas. A summary of these actions is presented in the Table 26, organized by policy and strategic interventions as well as sector-specific actions.

Table 26: Rwanda's Innovative projects and Initiatives since 2022

Areas	Innovative projects and Initiatives
Policy and Strategy	• Rwanda Revised its Green Growth and Climate Resilience Strategy (GGCRS) in 2023, to better reflect the new sector strategic plans • Rwanda has established its Second National Strategy for Transformation 2 that will be implemented from 2024–2029. The NST2 highly integrated climate resilience in its economic transformation pillars and key actions. • Rwanda has updated and revised its NDC under the Paris Agreement, which is referred as Rwanda's NDC3.0 targeting 53% emissions reduction by 2035 • Rwanda has developed its National Biodiversity Strategy and Action Plan with Rwf 399.8 billion finance requirement from 2025–2030
Climate Finance and Investment Vehicles	• Ireme Invest was established and launched at COP27 in 2022 targeting the private sector green investment facility • Intego facility which is Rwanda's NDC Facility was established to support government institutions to deliver to the NDC implementation • Rwanda Green Taxonomy was put in place and launched at COP28 with implementation roadmap launched in 2025, to guide the green investment • Green Exchange Window was established under the Rwanda Stock Exchange platform for green/sustainability bonds in 2025 • To enhance the fund mobilization for Biodiversity, Rwanda Green Fund has created the Biodiversity window for ecosystem protection • To enable the environment for climate finance mobilization, Rwanda has established its Climate and Nature Finance Strategy with the period of 2024 to 2030
Energy	• Rwanda has developed its new Energy Policy for Rwanda in 2025, updating the 2015 policy, to reflect climate issues • Developed the Least Cost Power Development Plan 2024–2050, which indicate the need for solar scale-up • Rwanda's renewable energy have increased with the share of 51% in the energy mix
Forest, Land and Ecosystem Restoration	Forest, land and ecosystem restoration has marked key initiatives and projects such as: • Congo-Nile Divide Restoration Project with \$39.1M funding from GCF started in 2024 • Nyungwe–Ruhango Corridor Climate Resilience Project with \$9M funding started in 2025 • Green Amayaga Project with \$18M GEF grant for ecosystem restoration, Southern Province started in 2025 • Eastern Province landscape restoration cluster (TREPA, COMBIO, DeSIRA, AREECA projects)

Urban	To green and sustain the urban areas, Rwanda initiated the following key projects and initiatives • Green City Kigali (GCK) Project with \$28M financing from GCF grant; target 600-hectare carbon-neutral city on Kinyinya Hill in City of Kigali • Five wetlands rehabilitation projects in Kigali to reduce flood risk, and enhance biodiversity, and support recreation
Transport and Energy	• Rwanda has established a mandatory motor vehicle emissions testing since July 2025, to enhance the control of vehicle emissions • IMOBIS Green Mobility Project started in 2025, to enhance real-time bus systems, and electric buses • Following the Electric vehicle incentives, Rwanda is running the E-mobility rollout, by increasing the electric buses in Kigali public transport • Initiated the rolled out of Dedicated Bus Lane (DBL) across major Kigali corridors since 2025
Circular Economy and Waste Management	• National Circular Economy Action Plan and Roadmap was established in 2022, with 17 policy interventions • Waste to Resources Project was implemented to valorize facilities at Nduba Dumpsite operational since 2024
Carbon Markets and International Cooperation	• To enable the implementation of the Carbon market, Rwanda has established its National Carbon Market Framework, that guide its institutional arrangements, and the manual of procedures • Rwanda and Singapore are implementing the Article 6 Implementation Agreement • GGGI and REMA are implementing the Article 6 readiness project since 2025
Agriculture	• Climate-Smart Agriculture Investment Plan was launched at COP30, that guide the private investment opportunities • Rwanda has developed its 5-year agricultural and food systems strategy running from 2024 to 2029 which referred as PSTA 5 (Plan Stratégique pour la Transformation Agricole). It aims to build climate resilience, boost domestic food production, reduce post-harvest losses, and connect farmers to profitable markets • For climate resilient, area of land under radical terraces reached 142,318, while progressive terraces reached 1,032,282ha by 2024
Water Resource	• Lake Water Use Master Plan (Kivu, Muhazi, Mugesera, Ruhondo, Burera) was launched in 2025, to enhance the resilience of water bodies • Area of land at high risk of soil erosion restored reached 332,861 ha by 2024 • Approved Nature-based flood adaptation project (\$9.4M) to be supported by AfDB, aimed at strengthening climate resilience in the western Rwandan districts of Karongi and Rusizi.

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