# Republic of Kiribati

## Third National Communication (NC3) to the United Nations Framework Convention on Climate Change

**March 2025**

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## Foreword

**Kam na Mauri!**

I am pleased to present this Third National Communication Report (NC3) for Kiribati and to share update that concerns the people of Kiribati to face the increasing risks to their environment, social economic and livelihood from Climate change.

The Third NC Report provided a thorough overview of the state of the national circumstances and measures undertaken, including constraints toward fulfilling Kiribati obligations under the UNFCCC. The third report unequivocally demonstrates Kiribati's continued vulnerability as a Least Developed Country and its limited ability to stop the current loss and damage being suffered by the nation. This also shows our faith in the UNFCCC, the only global organization in charge of preserving environmental integrity and averting catastrophic climate change effects.

As a UNFCCC State Party, Kiribati has met its national obligations by submitting its Nationally Determined Contributions (Kiribati – NDCs) and the Initial and Second National Communications. Kiribati is currently finalizing its first Biennial Update Report (BUR1) and Third National Communication.

In a nutshell, I would like to express my gratitude to all those involved in the Third National Communication report that Kiribati submitted to the UNFCCC, and I would like to extend an invitation to development partners to carefully consider the actual issues raised in this report and to consider offering immediate support for them in the not too distant future.

Health, Peace and Prosperity (Te Mauri, Te raoi ao te Tabomoa)

**Honourable Minister Tokaibure Rabaua**
**Minister of Environment, Lands, and Agricultural Development (MELAD)**

**18th March 2025**

## Acknowledgements

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Kam bati n rabwa ao kam a aitau !

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## Abbreviations and Acronyms

| Abbreviation | Definition |
|---|---|
| % | Percentage |
| $^0C$ | Degrees Celsius |
| AD | Activity Data |
| ADO | Automotive Diesel Oil |
| AFOLU | Agriculture, Forestry and Other Land Use |
| AKA | Airport Kiribati Authority |
| AR5 | Fifth Assessment Report |
| AR6 | Sixth Assessment Report |
| AUD | Australian Dollar |
| BAU | Business as Usual |
| BIA | Bonriki International Airport |
| BOD | Biological Oxygen Demand |
| BUR1 | First Biennial Update Report |
| C | Carbon |
| cap | capita |
| CBFM | Community Based Fisheries Management |
| CCA | Climate Change Adaptation |
| CCP | Climate Change Policy |
| CFL | Compact Fluorescent Light |
| Ch | Chapter |
| $CH_4$ | Methane |
| CMA | Conference of the Parties serving as the meeting of the Parties to the Paris Agreement |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| $CO_2$ e | Carbon Dioxide Equivalent |
| COF | Carbon Oxidation Fraction |
| COP | Conference of Parties |
| CORVI | Climate and Ocean Risk Vulnerability Index |
| COVID-19 | Coronavirus Disease 2019 |
| CSO | Civil Society Organization |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CXI | Cassidy International Airport |
| dm | Dry Matter |
| DRM | Disaster Risk Management |
| DRMCCA | Disaster Risk Management and Climate Change Act |
| DRR | Disaster Risk Reduction |
| e | equivalent |
| E | Emission |
| ECD | Environment and Conservation Division |
| EE | Energy Efficiency |
| EEZ | Exclusive Economic Zone |
| EF | Emission Factor |
| ENSO | El Nino Southern Oscillation |
| FAO | Food and Agriculture Organization |
| FAOSTATS | FAO Statistics |
| FBO | Faith Based Organisation |
| FI | Input Factor |
| FLU | Land Use Factor |
| FMG | Management Factor |
| FTC | Fisheries Training Centre |
| GCM | General Circulation Model |
| GDP | Gross Domestic Product |
| GEF | Green Environment Fund |

| Abbreviation | Definition |
|---|---|
| Gg | Gigagram |
| GHG | Greenhouse Gas |
| GHGIMS | Greenhouse Gas Inventory Management System |
| GIS | Geographic Information System |
| GL | Guideline |
| GOK | Government of Kiribati |
| GWh | Gigawatt hour |
| GWP | Global Warming Potential |
| ha | Hectare |
| HFC | HydroFluoroCarbon |
| HWP | Harvested Wood Products |
| ICT | Information and Communication Technology |
| IE | Included Elsewhere |
| IMB | International Marine Bunkers |
| INDC | Intended Nationally Determined Contribution |
| IPCC | Intergovernmental Panel on Climate Change |
| IPPU | Industrial Processes and Product Use |
| ISO | International Organization for Standardization |
| ITCZ | Inter Tropical Convergence Zone |
| KCA | Key Category Analysis |
| KCCP | Kiribati Climate Change Policy |
| KDP | Kiribati Development Plan |
| kg | Kilogram |
| KIEP | Kiribati Integrated Environment Policy |
| KIER | Kiribati Integrated Energy Roadmap |
| KJIP | Kiribati Joint Implementation Plan |
| KLTA | Kiribati Land Transport Authority |
| km | kilometre |
| $km^2$ | Square Kilometre |
| KMS | Kiribati Meteorological Services |
| KNEG | Kiribati National Expert Group |
| KNEP | Kiribati National Energy Policy |
| KNSL | Kiribati National Shipping Company |
| KOIL | Kiribati Oil Company Limited |
| KPA | Kiribati Ports Authority |
| KRCS | Kiribati Red Cross Society |
| KSO | Kiribati National Statistics Office |
| KTC | Kiribati Teacher College |
| KV20 | Kiribati 20-year Vision |
| KWMRRS | Kiribati Waste Management and Resource Recovery Strategy |
| LDC | Least Developed Country |
| LED | Light Emitting Diode |
| LMD | Lands Management Division |
| LPG | Liquefied Petroleum Gas |
| LTL | Linear Tube Light |
| m | metre |
| M | Million |
| M&E | Monitoring and Evaluation |
| $m^3$ | cubic metre |
| MCF | Methane Conversion Factor |
| MCIC | Ministry of Commence, Industry and Cooperatives |
| MEAs | Multilateral Environmental Agreements |
| MELAD | Ministry of Environment, Lands and Agricultural Development |
| MFED | Ministry of Finance and Economic Development |
| MFMRD | Ministry of Fisheries and Marine Resources Development |

| Abbreviation | Definition |
|---|---|
| MHMS | Ministry of Health and Medical Services |
| MIA | Ministry of Internal Affairs |
| MICTD | Ministry of Information, Communication, Transport and Tourism |
| MICTTD | Ministry of Information, Communication, Transport and Tourism Development |
| MISE | Ministry of Infrastructure and Sustainable Environment |
| MJO | Madden-Julian Oscillation |
| MLHRD | Ministry of Labour and Human Resource Development |
| mm | millimetre |
| MOE | Ministry of Education |
| MOU | Memorandum Of Understanding |
| MPA | Marine Protected Areas |
| MPG | Modalities, Procedures and Guidelines |
| MPWU | Ministry of Public Works and Utilities |
| MRV | Measurement, Reporting and Verification |
| MSW | Municipal Solid Waste |
| MTC | Marine Training Centre |
| MW | Megawatt |
| MWh | Megawatt-hour |
| MWp | Megawatt peak |
| MWYSA | Ministry of Women, Youth and Social Affairs |
| N | North |
| $N_2O$ | Nitrous Oxide |
| NA | Not Available |
| NC | National Communication |
| NC1 | First National Communication |
| NC2 | Second National Communication |
| NC3 | Third National Communication |
| NCCHAP | National Climate Change Health Action Plan |
| NDC | Nationally Determined Contribution |
| NE | Not Estimated |
| NGO | Non Governmental Organization |
| NIIP | National Inventory Improvement Plan |
| NMVOC | Non Methane Volatile Organic Compound |
| NO | Not Occurring |
| $NO_X$ | Other oxides of nitrogen |
| NSO | National Statistics Office |
| OB | Office of Te Beretitenti |
| PA | Paris Agreement |
| PCCSP | Pacific Climate Change Science Program |
| PET | Polyethylene terephthalate |
| PFC | PerFluoroCarbon |
| PIPA | Phoenix Islands Protected Area |
| PUB | Public Utility Board |
| PV | PhotoVoltaic |
| QA | Quality Assurance |
| QC | Quality Control |
| RA | Reference Approach |
| RCP | Representative Concentration Pathways |
| RE | Renewable Energy |
| SA | Sectoral Approach |
| SEP | Strategic Environment Plan |
| SF6 | Sulphur Hexafluoride |
| SIDS | Small Island Developing State |
| SLIMPA | Southern Line Islands Marine Protected Area |
| SME | Small and Medium Enterprises |

| Abbreviation | Definition |
|---|---|
| $SO_2$ | Sulphur Dioxide |
| SOE | State Owned Enterprise |
| SPCZ | South Pacific Convergence Zone |
| SPI | Standard Precipitation Index |
| SPREP | Secretariat of the Pacific Regional Environment Programme |
| SST | Sea Surface Temperature |
| SWDS | Solid Waste Disposal Site |
| t | ton |
| TACCC | Transparency, Accuracy, Completeness, Consistency and Comparability |
| TJ | Terajoule |
| ULP | Unleaded Petrol |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USD | United States Dollar |
| V&A | Vulnerability and Adaptation |
| Vol | Volume |
| W | West |
| WHO | World Health Organization |
| WMO | World Meteorological Organization |
| WW | Wastewater |
| yr | Year |

# Executive Summary

## ES 1. National Circumstances and Institutional arrangements

As a signatory Party to the United Nations Framework Convention on Climate Change (UNFCCC), Kiribati is obliged to submit national communications under Article 4, paragraph 1(a), and Article 12 of the Convention to fulfil its obligations. It is within this context that Kiribati has prepared and submitted this Third National Communication (NC3). The NC3 is highly regarded by the government of Kiribati (GOK) as it is a Small Island Developing State (SIDS), as well as a Least Developed Country (LDC) country.

Office of Te Beretitenti (OB) (Office of the President) has the overall responsibility to coordinate climate change policy issues. The legal framework regarding climate change in Kiribati falls under the Environment Act 2021 and the Disaster Risk Management and Climate Change Act (DRMCCA) 2019. The Ministry of Finance and Economic Development (MFED) through its newly established Climate Change Division, is responsible for climate change finance. The multi-sectoral Kiribati National Expert Group (KNEG) on Climate Change and Disaster Risk Management, comprising representatives from government, the private sector and the Civil Society has been established under the DRMCCA 2019 as the principal strategic coordination and technical advisory body for disaster risk management and climate change. The Ministry of Environment, Lands and Agricultural Development (MELAD) is the lead agency responsible for climate change science and technical implementations / interventions including environment and climate change nationally and externally funded interventions to address inter-linked climate change impacts on the atolls' environment (land, sea, and air) of Kiribati at the national level through the Environment and Conservation Division (ECD). Kiribati is comprised of 32 low-lying atolls and 1 uplifted limestone island scattered in the central Pacific over the four hemispheres, on latitude 1° 52' 15.31" North and longitude 157° 21' 45.36" West. It has a land area of 811 $km^2$, a coastline of 1,296 km and an Exclusive Economic Zone (EEZ) of 3.5 million $km^2$.

Due to its location, Kiribati experiences hot and humid conditions throughout the year. It has two main seasons, a wet one extending from November to April and a dry one lasting from May to October. The mean temperature is around 28-29°C all year round while the maximum temperature varies around 31-32°C except for Kiritimati where it is slightly lower (29-31°C). The minimum temperature is around 24-25°C (Kiritimati, Tarawa and Beru), except for Butaritari which is cooler by a few degrees due to its position relative to the Inter Tropical Convergence Zone. The rainfall for Kiribati Islands varies according to their geographical location, Butaritari: 160-320 mm, Tarawa: 110-250 mm, Beru: 60-180 mm and Kiritimati: 25-200 mm. Kiribati is strongly influenced by El Niño when the climate becomes warmer and rainier than normal while with La Niña, it becomes cooler and drier, leading to recurrent droughts, which in these atolls devoid of streams, can cause major problems. Being practically at the equator, Kiribati is outside the cyclonic area but, being flat islands, they sometimes receive abnormal swells, especially when these are combined with high tides.

The 2020 census recorded a total population of 119,438, of which 70,441 (59%) were urban dwellers and 48,997 (41%) rural. 58,904 (49%) were males and 60,534 (51%) females. The population growth during the period 2010 to 2020 was 16%. The Wholesale and retail trade, including repair of motor vehicles and Agriculture, Forestry and Fishing accounted for 52% of the occupation of the workforce. The unemployment rate of 11% did not change between 2010 and 2020.

In 2020, 93% of the urban population aged 15 years and above had attended school up to class 3 compared to 87% in rural areas. In that same year, 87% of the urban population aged 12 and above were literate compared to 76% in the rural areas.

Kiribati's economy performed well with an average annual real GDP growth of 4.75% during the period 2015 to 2019. The COVID-19 pandemic affected the economy and a decline of 0.5% was recorded in 2020. Real GDP per capita increased from AUD 1,612 in 2015 to AUD 1,749 in 2019.

Kiribati is highly dependent on petroleum imports for electricity generation, transportation, and domestic uses. In 2019, the Kiribati (Gilbert Island Group) total final energy consumption was 1,523 TJ of which 54% was petroleum products and 46% from renewable sources (1% was solar and 45% biomass). The residential sector is the largest energy consumer with 52.0%, followed by the transport sector with 17.6% while marine navigation consumed 16%. More than 80% of household's energy consumption comes from biomass in the form of coconut residue and firewood (87.0%), kerosene (6.2%) and gasoline (2.9%).

Kiribati is serviced by air, maritime and road transportation. Two international airports and seaports service the international and domestic markets. The two airports and 17 more on outer islands fall under the Airport Kiribati Authority (AKA). The Kiribati Ports Authority (KPA) is the institution responsible for seaports, the main one sited on South Tarawa. Kiribati is a big ocean nation and faces an enormous geographical challenge of remoteness, isolation and distance. For example, the distance from the capital island, Tarawa, to the Phoenix Islands is 1,500 km and 3,300 km to the Line Islands. The road infrastructure is quite limited and consists of about 700 km of roadways of which the only tarred main road, in South Tarawa Island, is approximately 50 km long.

Kiribati imports a significant quantity of goods to meet the local population needs. The packaging materials constitute most of the waste of the country. Organic waste accounts for about 60% of national solid waste, making it the highest stream. There are three approved landfills on South Tarawa and Kiritimati Island has one approved dumpsite and on e hazardous cell. Incineration is mainly for treating medical and quarantine wastes. Kiribati practices recycling of lead-acid batteries, aluminium cans, and PET bottles and exported some 376 tonnes of these recyclables between 2005 and 2022. In 2019, about 50,000 litres of used oil were exported for recycling in New Zealand. Another important feature of waste treatment in Kiribati is composting with the compost used for gardening.

There is no treatment system for household sewage collected through the network operated by the Public Utilities Board (PUB) on South Tarawa and Betio. The network discharges it directly into the ocean through five sea outfalls. Moroni High School Compound area has its own system with its own sea outfall. Households that are not connected to the PUB network have their own on-site septic tanks or latrine systems. They are serviced by the PUB vacuum truck to empty their septic tanks when they are full for discharge into the PUB system for final disposal through the outfalls.

Undertaking agriculture, forestry, and livestock rearing in Kiribati is either very challenging or very expensive because of the infertile, very alkaline and coarse-textured soil, the limited land area, and limited fresh water. Surface fresh water is scarce or non-existent in many islands due to the small size, low elevation, and high soil and regolith permeability, except for Tabuaeran in the Northern Line Island Group. In 2018, agricultural land accounted for 42% of the total land area. The main crops cultivated in Kiribati are coconut, breadfruit, banana and vegetables including cassava, sweet potato and cabbage.

The geography of Kiribati creates significant and unique human development and growth challenges, including access to safe, reliable fresh water and sanitation. Freshwater resources of Kiribati consist of rainwater, shallow unconfined groundwater generally within less than 2 m of the surface, imported water and desalination plants water. The raised island of Banaba uniquely has freshwater pools in subterranean caves that could serve as an emergency source of water in times of severe droughts.

Agriculture and Fisheries are key activities for the country both for subsistence and for commercial purposes. Kiribati's main exports are coconut products and fish, and these products were valued at AUD 11.3 million in 2020, representing 83% of the country's total export value of AUD 13.5 million. Additionally, they are critical because food and nutrition security rank high on the Government agenda. Of the 20,354 households of the country, 15,467 (76%) reported having some type of agricultural activity. 68% of the total households are involved with livestock raising, 44% in crop growing, 47% in fishing activity and 22% practices handicrafts. Many households undertake a combination of these activities.

In Kiribati, high density housing, especially on the capital island South Tarawa, facilitates easy transmission and outbreaks of infectious and vector-borne diseases. Urbanization and lifestyle changes have contributed to erosion of the Kiribati culture with negative effects on health. Almost 80 to 90% of the total population relies on imported food such as rice, flour, and sugar, as their staple food sources. Diabetes prevalence (% of population ages 20 to 79) in Kiribati was reported at 22.1 % in 2021 (https://data.worldbank.org/). The same source reported the cause of death (% of total) in 2019, by communicable diseases and maternal, prenatal and nutrition conditions at 21.62 % and by non-communicable diseases (% of total) at 72.81 %. This abnormally high death rate from non-communicable diseases is attributed to an increased dependence on imported food that are of poor nutritional quality, the inactive lifestyles of the people and a shift towards a more Westernized diet. The number of people reported as being undernourished was at 100,000 in 2020 (https://data.worldbank.org/).

Healthy coastal habitats are important to mitigate global climate change. Mangroves, seagrass beds, and reef ecosystems absorb and store large quantities of the greenhouse gas (GHGs) carbon dioxide ($CO_2$) from the atmosphere. Known as carbon sinks, they contain large stores of carbon accumulated over hundreds of thousands of years. These ecosystems have important roles in the carbon cycle through $CO_2$ sequestration and storage. These ecosystems are protected under the Environment Act 2021.

Under the MELAD environment portfolio, GOK has invested in the establishment of marine protected areas (MPA) at the national and island levels under the Environment Amendment Act 2007, through the PIPA in the Phoenix Islands Group in 2006, the Southern Line Islands Marine Protected Area (SLIMPA) in the Line Islands Group in 2020, and through the community based protected areas in several islands of the Gilbert Group.

Similarly, under the fisheries portfolio of the Ministry of Fisheries and Marine Resources Development (MFMRD), GOK has also equally invested to protect, manage, and sustain the marine resources, including coral reef restoration and economically important marine species, to support the fisheries development at the national and island levels. These complement the protected areas initiatives of MELAD.

The Kiribati 20 years Vision (KV20) covering the period 2016 to 2036 and shorter more detailed plans running over successive periods of four years are two national plans guiding the development of Kiribati. Both plans recognize the country's vulnerability to climate change as the major constraint for meeting the earmarked targets. All sectoral development plans are aligned with these two main documents which identify specific priority areas to attend to. Other strategies include the Kiribati Climate Change Policy, the Kiribati Joint Implementation Plan (KJIP) 2019-2028 and the Kiribati Waste Management and Resource Recovery Strategy (KWMRRS) 2020-2030 among others.

Being a SIDS and an LDC, Kiribati contributes only marginally to global emissions. Nevertheless, mitigation is ongoing in the key sector energy and livestock. Currently, the Government is working on strengthening the policies, legislations, and institutional arrangements between relevant institutions to strengthen actions on mitigation regarding its NDC. In this vein, the MFED recently established a Climate Change Finance Division to coordinate and secure climate change finance to address mitigation and adaptation. A summary of key features of Kiribati's national circumstances is presented in Table ES1.

**Table ES1: Key features of Kiribati's national circumstances**

| Feature | | Source |
|---|---|---|
| ***Geography and population*** | | |
| Land area (km2) | 811 | Forest Resource Assessment reports (FAO) |
| Area of exclusive economic zone (km2) | 3.5 million | |
| Protected marine area – PIPA (km2) | 408,250 | UNESCO |
| Land use (%) | | |
| Forests and woodlands | 12,150 | World Bank and Forest Resource Assessment reports (FAO) |
| Cropland | 65,800 | |
| Settlements | 1,000 | |
| Wetlands | 4 | |
| Other land | 2,046 | |
| Population | | |
| Total in Year 2020 (Individuals) | 119,438 | Kiribati National Statistics Office (KNSO) – Census 2020 |
| Female | 60,534 (51%) | |
| Male | 58,904 (49%) | |
| % Urban | 59% | |
| % Rural | 41% | |
| ***Human development*** | | |
| Life expectancy | 59.4 | World Health Organisation |
| Infant mortality rate (Under 5-year-old deaths per 1000 births) | 51.4 | UNICEF |
| Literacy rate (Age 15 years and above) – Year 2020 | 91% | KNSO – Census 2020 |
| Urban population connected to main sewage system | 6% | |
| Unemployment rate – Year 2020 | 11% | |
| Human development index (Year 2020) | 0.623 | UNDP |
| Poverty rate (Year 2020) | 21.9% | KNSO |
| Gini index | 27.8 | World Bank |
| ***Economy – Year 2019*** | | |
| GDP – Million AUD | 203.1 | Kiribati National Statistics Office |
| GDP per capita (AUD/capita) | 1,749 | |
| Annual GDP growth | 3.9% | |
| Importation (million AUD) | 160.6 | |
| Exportation (million AUD) | 17.585 | |
| Share of Agriculture in GDP | 15.9% | |
| Share of fishing in GDP | 10.0% | |
| ***Energy*** | | |
| Total energy consumption (TJ) – Year 2019 | 1,523 | Ministry of Infrastructure and Sustainable Energy – Energy balance 2019 |
| Share petroleum products | 54% | |
| Share renewable sources | 46% | |

## ES 2. National greenhouse gas inventory

Under Article 4.1 (a) of the Convention, each Party must develop, periodically update, publish, and make available to the Conference of the Parties (COP), in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the COP.

This present inventory provides information on GHG emissions by sources and removals by sinks for the period 2010 to 2019. Improvements over the previous inventory consisted in the coverage of additional categories, creation of a consistent time series and foremost the adoption of the IPCC 2006 Guidelines as methodology to be in accordance with COP decisions.

Kiribati does not have an operational GHG Inventory management system (GHGIMS). Development of a robust GHGIMS has started to enable the country to prepare GHG inventories in a sustainable manner.

This GHG inventory covers the whole territory of the Republic of Kiribati with estimates made at the national scale.

The national GHG inventory includes estimates for the four IPCC sectors Energy, Industrial Processes and Product Use (IPPU), Agriculture Forestry and Other Land Use (AFOLU) and Waste. It includes emissions of the direct GHGs carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$).

Estimates of GHG emissions have been compiled using the IPCC 2006 Guidelines for National GHG Inventories (IPCC, 2007) to ensure that the GHG emission estimates are Transparent, Accurate, Complete, Consistent and Comparable (TACCC) and i n accordance with Decision 18/CMA.1.

All categories were treated at the Tier 1 level using default IPCC emission factors. Global Warming Potentials (GWP) of the IPCC Fifth Assessment Report (AR5) have been used to convert $CH_4$ and $N_2O$ to their $CO_2$ equivalent as prescribed in Decision 18/CMA.1.

The tool available within the IPCC inventory software (Version 2.69) was adopted for making the Key category analysis for both the level and trend assessments. 11 key categories in the level (2019) and 12 in the trend (2010 to 2019) assessments were identified with Forestland remaining Forestland as the most important one.

Quality Assurance (QA) and Quality Control (QC) procedures were not implemented due to lack of capacity and a QA/QC plan. However, the international consultants performed a QA/QC as defined in the 2006 IPCC Guidelines (IPCC, 2007) as far as practicable.

The Uncertainty Assessment was done by the international consultants. Annual uncertainty varied between 20.02% and 23.15% while the trend uncertainty increased from 29.51% for the year 2010 to 34.97% for the year 2019 indicating that further improvements are needed to enhance the quality.

The inventory still lacks completeness even when considering the improvements on the second national communication (NC2).

Methods and sources of data have been kept consistent for all years, categories and gases covered. A consistent time series for the period 2010 to 2019 was built with a good level of confidence and comparability between years in the trend of the emissions.

Gross national emissions increased from 94,797 t $CO_2$ e in 2010 to reach 127,283 t $CO_2$ e in 2019. Removals from the AFOLU sector decreased slightly, by 439 t $CO_2$, from 28,206 in the year 2010 to 27,767 t $CO_2$ in 2019. Net emissions were estimated at 99,516 t $CO_2$ e in the year 2019, representing an increase of 49% over the year 2010 (Figure ES1).

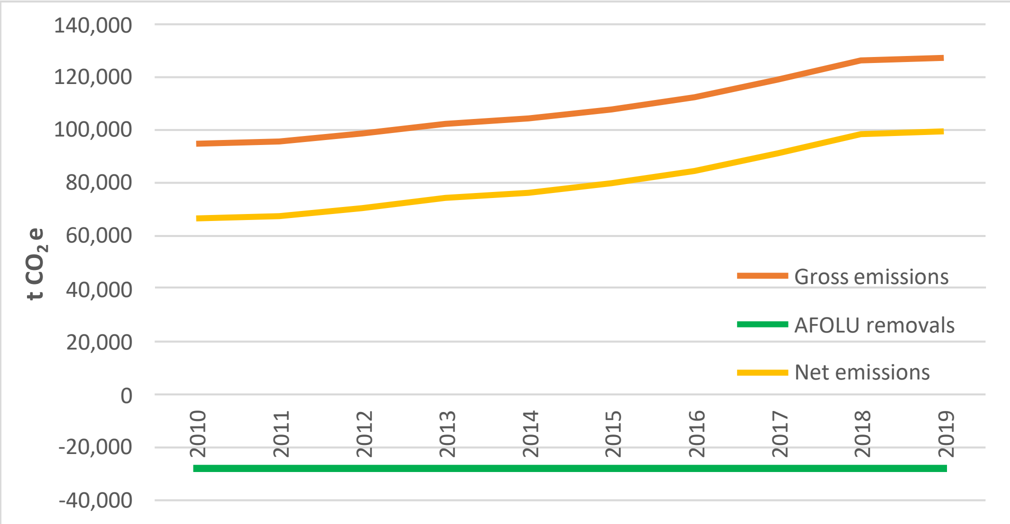



**Figure SE1: Trend of gross emissions, AFOLU removals and net emissions (2010 – 2019)**

Based on the estimates, per capita emissions increased from 0.65 in the year 2010 to 0.84 t $CO_2$ e in 2019 representing an increase of 46.9%.

Total gross emissions increased by 34% over the 10-years timeseries, mainly driven by significant increases in the Energy and Waste sectors. The AFOLU sector emissions decreased gradually to reach 7% from 2010 to 2019. In 2019, the Energy sector was the main emitter with 78,783 t $CO_2$ e followed by Waste (25,602 t $CO_2$ e), AFOLU (22,824 t $CO_2$ e) and IPPU (75 t $CO_2$ e).

$CO_2$ remained the main contributor to national GHG emissions, followed by $CH_4$ and $N_2O$ over the full time series. In 2019, the share of GHG emissions was as follows: 57% $CO_2$, 37% $CH_4$ and 6% $N_2O$.

Numerous challenges were encountered during the compilation of the present inventory, namely, lack of an operational GHG inventory management system, no data collection and sharing network inclusive of appropriate tools for performing same, unavailability of AD for some categories, and limited capacity of stakeholders and national experts.

## ES 3. Information on mitigation actions and their effects, including associated methodologies and assumptions

Article 4 paragraph 1 (b) of the UNFCCC requires Parties to "*Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol*". Kiribati promoted mitigation towards meeting this requirement and the ultimate objective of the Convention to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

BAU scenario emissions are projected to increase from 102,384 t $CO_2$ e in 2013 to 135,960 t $CO_2$ e in 2030 from the base year 2013, which represents an increase of 33%.

**Mitigation potential**

Implementation of all the mitigation measures retained for all the sectors (Table ES 2) have an emissions reduction potential of 88,085 t $CO_2$ e representing 65% of the BAU scenario. Of these 65%, Energy will contribute 52% (70,135 ), Waste 8% (11,200) and AFOLU 5% (6,750 ).

**Table ES2: National mitigation potential (t $CO_2$ e) for year 2030 compared to the BAU scenario**

| Parameter | Year 2030 | % of national BAU emissions |
|---|---|---|
| National mitigation potential | 88,085 | 65% |
| Energy | 70,135 | 52% |
| IPPU | - | - |
| AFOLU | 6,750 | 5% |
| Waste | 11,200 | 8% |
| ***BAU Scenario Emissions*** | ***135,960*** | |

**Mitigation status for the Energy sector**

The mitigation status is presented in Table ES 3. INDC actions account for 2,412 t $CO_2$ e presently avoided annually from fully implemented actions, 237 t $CO_2$ e for partly implementated ones and a reduction potential of 25,856 t $CO_2$ e for those planned in 2030. For the KIER report on the Energy sector, emissions reduction from implemented actions amount to 3,711 t $CO_2$ e with another 897 for actions from partly implemented ones and 3,922 t $CO_2$ e for the planned ones. The NDC roadmap projects emissions reduction of 33,100 t $CO_2$ e. All actions from all reports are expected to result in a national mitigation potential of 70,135 t $CO_2$ e.

**Table ES3: Emissions reduction potential (t $CO_2$ e) of assessed mitigation measures**

| Source | Implemented | Ongoing implementation | Planned | Total |
|---|---|---|---|---|
| INDC | 2,412 | 237 | 25,856 | 28,505 |
| KIER | 3,711 | 897 | 3,922 | 8,530 |
| NDC Roadmap | - | - | 33,100 | 33,100 |
| Total | 6,123 | 1,134 | 62,878 | 70,135 |
| Share of national | 8.7% | 1.6% | 89.7% | |

## ES 4. Vulnerability and Adaptation

Signatory Parties to the UNFCCC are expected to communicate to the COP, in accordance with Article 12 paragraph 1 (b), a general description of steps taken or envisaged by the Party to implement the Convention. Kiribati developed its climate change policy and laid more importance on adaptation to climate change because of its high vulnerability.

Annual rainfall in Kiribati is highly variable. It varied between 957 mm to 4055 mm in Tarawa during the period 2001 to 2020. The average annual total rainfall is 2,187 mm for this period with a slight decreasing trend. Kiritimati rainfall is as variable and generally lower, with less than 500 mm in the dry years and more than 3500 mm in the very wet years. The trend over the period 1950 to 2005 indicates an increase of 12.4 mm annually in the annual total rainfall. It is also observed that El Nino years are associated with higher rainfall than the normal and La Nina years with the opposite and resulting in droughts. A study by the World Bank on the occurrence of 1 day precipitation, indicates an increase in the number of days with rainfall above 25mm and 50mm over time. This has serious implications due to the floods arising from those events, especially the above 50mm ones.

Maximum and minimum temperatures vary slightly across the year and between years. Maximum temperature in Tarawa averaged 31.6°C annually over the period 2001 to 2020 while the minimum was 25.9°C. Kiritimati is slightly cooler with an average yearly maximum temperature of 30.8°C and minimum of 24.2°C. A study by CSIRO-SPREP indicates that Kiribati has warmed by about 0.6°C to 0.7°C compared to the pre-industrial period 1850 to 1900 while the global increase (land and ocean) is 1.1°C.

There is clear evidence of a sea level rise averaging 3.6 mm annually based on observations from the Tarawa gauge for the period 1993 to 2023.

For the Gilbert group of islands, the short term 2030 temperature increase is projected to be 0.8°C. Under the high emissions scenario projections are at 1.5°C in 2050 and 2.3°C in 2070 while under the low emissions scenario it is 0.9°C for both timesteps. The average annual temperature increase projected at the different time frames are slightly lower, by 0.1°C for the Line group of islands.

Irrespective of emissions scenario and time step, a slight increase in rainfall, varying between 4 and 13% is projected for the Lines group compared to a more significant 15 to 48% for the Gilbert group. Overall, the average annual rainfall increases with time and intensity of emissions of GHGs.

Under the lowest emissions scenario, the mean sea level rise is projected to be 13, 22 and 47 cm in 2030, 2050 and 2100 for a range of 9 to 65 cm. The worst expectations are at 13, 27 and 88 cm under the highest emissions scenario with a range of 9 to 122 cm.

The Kiribati Joint Implementation Plan, 2019-2028, (KJIP) has been developed within the framework of the Climate Change policy (CCP) to address climate change mitigation, adaptation, cross-cutting issues, and disaster risk management. The KJIP presents the vulnerabilities of the thematic areas or sectors Environment, Economic development, Trade and commerce, Infrastructure, Fresh water and sanitation, Fisheries and food security, Agriculture and food security, Health, and Education and human resources. The Stimson Center used its Climate and Ocean Risk Vulnerability Index (CORVI) to assess the coastal cities of Tarawa. CORVI uses about 100 indicators falling under 10 risks categories, which are grouped under Ecological, Financial, and Political risk areas. CORVI rates each category under low, medium, medium-high and high risks. The financial risk is highest followed by the ecological and political risks.

The KJIP prioritises 104 climate mitigation, adaptation and disaster risk reduction actions under 12 key strategies. Additionally, the KJIP identifies clear results with indicators for each action to support appropriate monitoring and evaluation. CORVI makes 3 recommendations, namely Implement Integrated Flood Management and Mitigation, Move Towards a Circular Economy and Diversify Kiribati's Economy. Adaptation will be funded as per the present strategies with some funds coming from the national budget topped up with international development assistance notwithstanding additional climate finance, compensation for losses and damage and disaster-related humanitarian aid.

## ES 5. Other information considered relevant to the achievement of the objective of the Convention

Transfer of technologies has been minimal. Adoption of the PV technology can be considered as a successful one. There still exists a significant gap to fill to achieve readiness for implementation of the actions identified in the NDC. Some of the mitigation technology needs are conversion of biomass to electricity, latest road transport technologies, low emissions urbanization, solid and liquid waste treatment and waste conversion to energy. Regarding adaptation, key needs are technologies for water resources management, integrated coastal zone management and fisheries sectors.

Kiribati, as a LDC and SIDS nation is very limited in capacity for in-depth research on climate change and its impacts. Systematic observations must be strengthened to manage risks and prevent damages through the implementation of early warning systems are primordial to promote resilience of the population.

A significant portion of the population lacks awareness of climate change impacts they are exposed to, notwithstanding their role in mitigation. This stems from lack of resources to cover the widely distributed islands constituting the territory and a limited number of national experts to effectively deliver on this issue. It is planned to enhance public awareness programmes to maximize outreach through awareness raising campaigns and public education, development of public awareness materials in local languages, facilitate access of information to the public and promote their participation, with emphasis on gender.

Technical capacity is still limited to enable Kiribati to smoothly implement NDC mitigation and adaption actions. Building human and institutional capacity to address climate change will be a fundamental component of the NDC implementation. Capacity building for climate change will thus include further development and strengthening of personal skills, expertise and capacity of relevant institutions and organizations on adaptation, mitigation and reporting.

Kiribati has identified some key actions on the international and national fronts on information sharing. They are strengthening and enhancing international collaboration, improve linkages and network among stakeholders, namely the Pacific Island nations; par ticipation in regional and international cooperation programmes and activities; organization of a data and information sharing platform and creation of a national database on climate change for use by scientists, government, the private sector and students.

## ES 6. Constraints and gaps, and related financial, technical and capacity needs

UNFCCC reporting requirements have evolved significantly. Kiribati still faces significant challenges for reporting at the required standards as they are very ambitious and require meaningful financial, technical, and human resources.

Enhancement of the reporting requirements, namely the enhanced transparency framework of the PA in accordance with its Article 13, now demands for a permanent framework to facilitate the production of these reports. Kiribati seeks to develop and strengthen existing institutional arrangements for reporting in accordance with the MPGs of Decision 18/CMA.1.

Kiribati has progressed in the compilation of its GHG inventory, to be in line with the TACCC principles. The country has addressed new categories and improved its timeseries which is now more consistent. However, there is still room for improvement to meet the new reporting standards.

Kiribati has implemented numerous mitigation actions despite the multiple constraints and gaps encountered at the legal, institutional, and procedural levels. There is a need to improve the enabling environment, the technology assessment and transfer for mitigation, notwithstanding capacity building of national experts and timely funding. Barriers must be removed to speed up implementation of mitigation actions and prepare project proposals for mobilizing funds.

The pace at which adaptation is being implemented is too slow for the country to build its resilience to climate change. Support from the international community is needed to boost implementation.

Kiribati requires technical and capacity building support to implement its NDC mitigation and adaptation actions. Some of the capacity building areas identified are mainstreaming of climate change in development plans; preparation of UNFCCC reports; compilation of GHG inventories; wastewater treatment; disaster risk reduction; development of educational and awareness materials; International market mechanisms and mobilization of resources.

Over and above all, Kiribati needs significant amounts of funds to develop and implement mitigation and adaptation projects. Funding implementation of mitigation actions as estimated in the First NDC is around 210.5 M USD for mitigation and 69.0 M USD for adaptation based on the 2015 NDC. Updated needs for the short term is estimated at around 77 M USD.

# 1. National circumstances and institutional arrangements

## 1.1. Introduction

The submission of the Third National Communication (NC3) by the Government of Kiribati is mandatory for the country to fulfil its obligations under Article 4, paragraph 1(a), and Article 12 of the Convention. The development and submission of the NC3 is highly regarded by Kiribati as a Small Island Developing State (SIDS), as well as a Least Developed Country (LDC) country. Kiribati is still predominantly rural with a subsistence-based economy (GOK, 2014).

## 1.2. Institutional arrangements

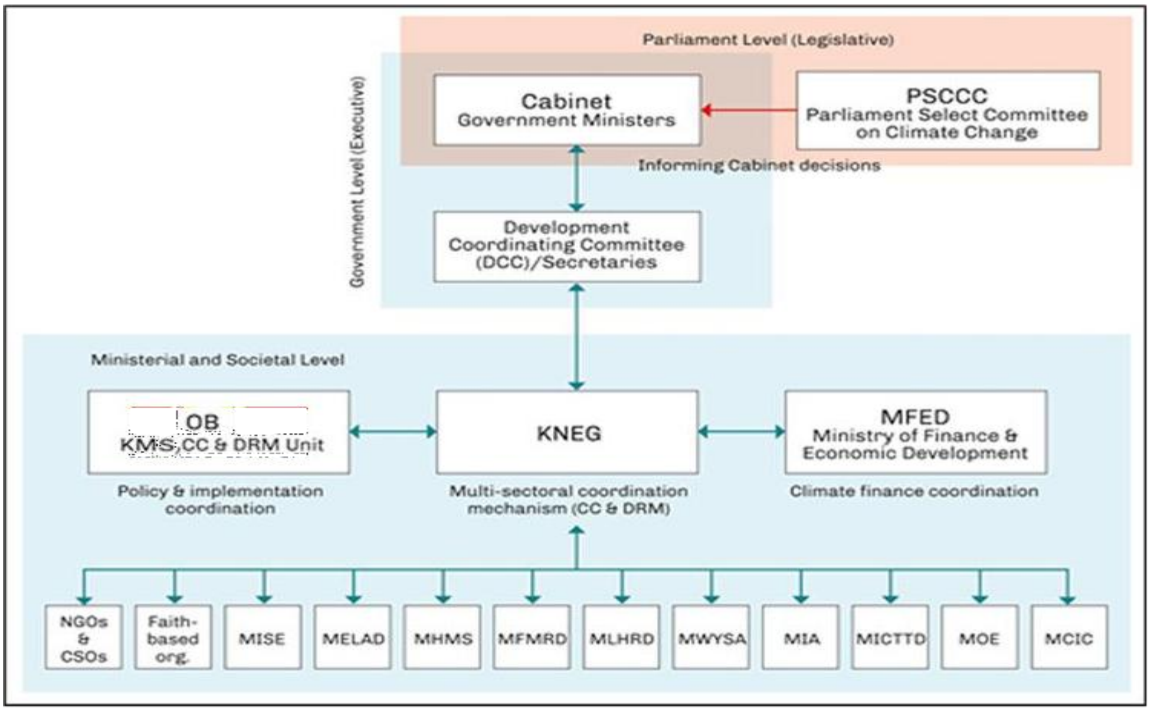
The legal framework overseeing climate change in Kiribati falls under the Disaster Risk Management and Climate Change Act 2019 (DRMCCA) and the Environment Act 2021 which defines the governing structure. The key principles of the DRMCCA guarantee mainstreaming of climate change in the activities of all socio-economic sectors within the sustainable development agenda of the country. These principles are:

i. Climate change and disaster risks affect all individuals, communities and the environment, and action to address them must be mainstreamed and integrated across all sectors and levels of government and society.
ii. Climate change and disaster risks should be managed within an overall framework of sustainable development and in line with the sustainable development goals.

Te Beretitenti, Office of the President (OB), acting upon advice of the Cabinet, has the overall responsibility for climate change programmes to safeguard people and places in the country from disasters and climate change impacts. The Kiribati National Expert Group (KNEG) on Climate Change and Disaster Risk Management, established under the DRMCCA is the principal strategic coordination and technical advisory body for disaster risk management and climate change. KNEG comprises Directors from each ministry plus the Ministry of Environment, Lands and Agricultural Development (MELAD) that is responsible for the administration of this Act, Kiribati Meteorological Service (KMS), Kiribati Police Service, Kiribati Red Cross Society (KRCS), relevant non-government and civil society organizations representing vulnerable groups and others as specified in the Regulations to this Act.

MELAD has the important mandate to provide and update information and data for all Multilateral Environmental Agreements (MEAs), national reporting obligations and to offer technical advice on climate change, particularly from the Environment perspective. The main roles and responsibilities of the Environment and Conservation Division (ECD) of MELAD include the coordination and planning of climate change actions for government and various organizations. These include needs assessments, resource mobilization, logistics and other common services such as implementing the UNFCCC and reporting and strengthening national capacity, including initiating trainings and drills at government and community levels.

A schematic representation of the institutional and governance structure of Kiribati is depicted in Figure 1.1.

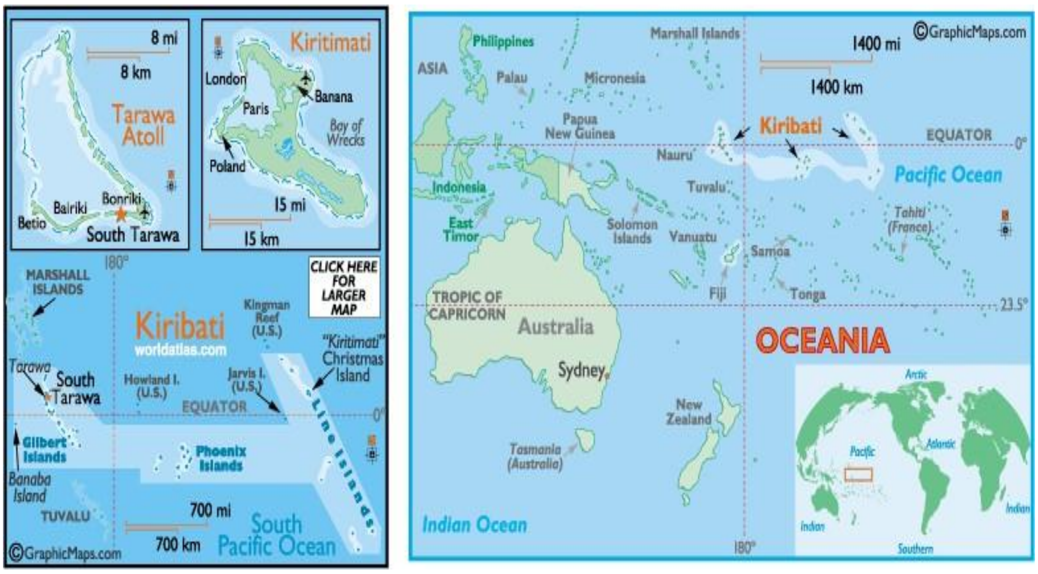



**Acronyms: KMS, CC, DRM – Kiribati Meteorological Services, Climate Change, Disaster Reduction Management; MISE – Ministry of Infrastructure and Sustainable Environment; MHMS – Ministry of Health and Medical Services; MFMRD – Ministry of Fisheries and Marine Resources Development; MLHRD – Ministry of Labour and Human Resource Development; MWYSA – Ministry of Women, Youth and Social Affairs; MIA – Ministry of Internal Affairs; MICTTD – Ministry of Information, Communication, Transport and Tourism Development; MOE – Ministry of Education; MCIC – Ministry of Commence, Industry and Cooperatives**

**Figure 1.1: Institutional and governance structure of Kiribati**

## 1.3. Geographic profile

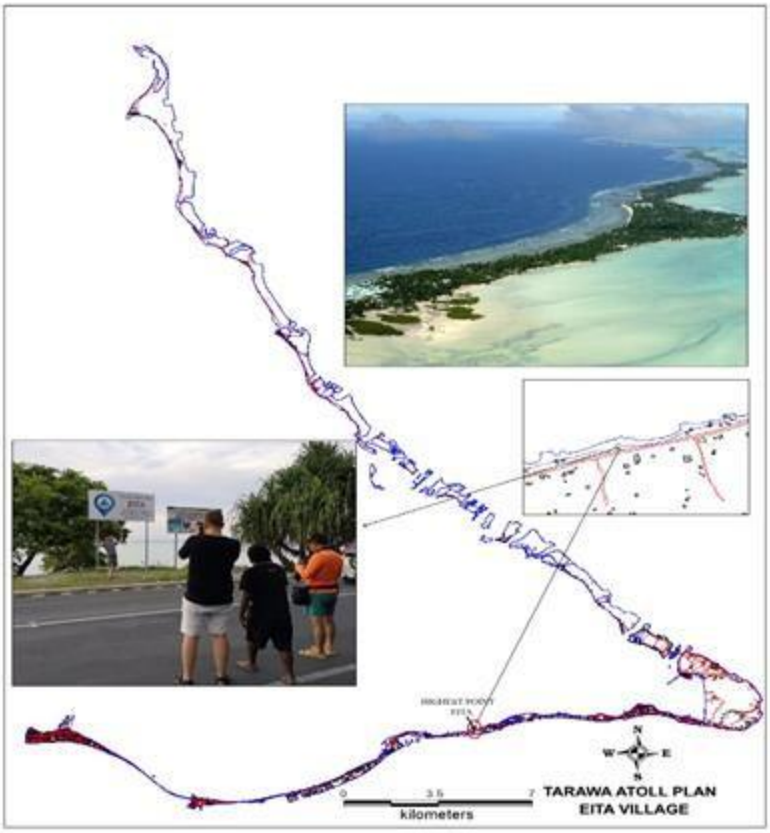
Kiribati is a small island state in the central Pacific, comprised of 32 low-lying atolls and 1 uplifted limestone island scattered over the four hemispheres, on latitude 1° 52' 15.31" North and longitude 157° 21' 45.36" West. The atolls fall under 3 main clusters, namely the Gilbert, Phoenix and Line Islands groups as shown in Figure 1.2.




**Source: KiriCAN 2014 "Kiribati and Climate Change"**

**Figure 1.2: Coordinates and geographical situation of Kiribati**

Kiribati main islands are characterised as tiny low-lying coral atolls (Figure 1.3) only a few metres above sea level. For example, Eita village, the highest point in the capital Tarawa is about 3 metres above sea level. Kiritimati in the Line group is the largest atoll that extends dozens of kilometres over the North Pacific Ocean whereas Banaba is the only limestone island in the Gilbert group that has the highest elevation culminating at 81 metres above sea level.




**Source: MELAD 2020**

**Figure 1.3: Eita Village – Highest point on Tarawa Atoll**

Seven of the islands in the Phoenix group commonly known as the Phoenix Island Protected Area (PIPA) which comprises 8 islands (Kanton, Enderbury, Mckean, Birnie, Manra, Orona, Rawaki, and Nikumaroro) are uninhabited except Kanton with an administrative population of less than fifty people. The PIPA, demarcated as a Marine Protected Area (MPA) since 2006 by the Kiribati government and the UN-Convention on Biological Diversity, was a UNESCO world heritage site famous for its productive and diverse marine biodiversity. The total management area of PIPA is 408,250 $km^2$ enclosed by a 60 nautical mile boundary around each atoll. The islands themselves comprise 11 square miles of low-lying land, in many cases rising no more than 2 metres above sea level.

## 1.4. Climate profile

Kiribati is the only country known to be situated within the four hemispheres. Its islands are scattered to the Northern, Eastern, Southern and Western hemispheres (Figure 1.2). Due to its location, Kiribati experiences hot and humid conditions throughout the year (PCCSP Report, 2011).

Kiribati has two main seasons, namely the Wet and Dry seasons. The Wet season is from November to April and the Dry season is from May to October (Figure 1.4), but this varies according to location and movement of the climate drivers known as the Inter-Tropical Convergence Zone (ITCZ) and the South Pacific Convergence Zone (SPCZ). The ITCZ is very active during the wet season (Salinger J, NIWA. 2007). This is due to the amount of solar radiation received (latent heat – evaporation), which is much higher compared with the dry season. Since the sea surface temperature (SST) at the equator varies by only a few degrees, the ITCZ deflection from the Northern Hemisphere to the equator also varies. On the other hand, the SPCZ may influence the weather and climate of the Southern part of the Kiribati Islands.

The monthly average rainfall for Kiribati Islands ranges according to their geographical location, Tarawa: 125-250 mm, and Kiritimati: 40-200 mm. Rainfall data are provided in Figure 1.4. Rainfall recorded in Kiritimati is very low since it is very far from the ITCZ and SPCZ.

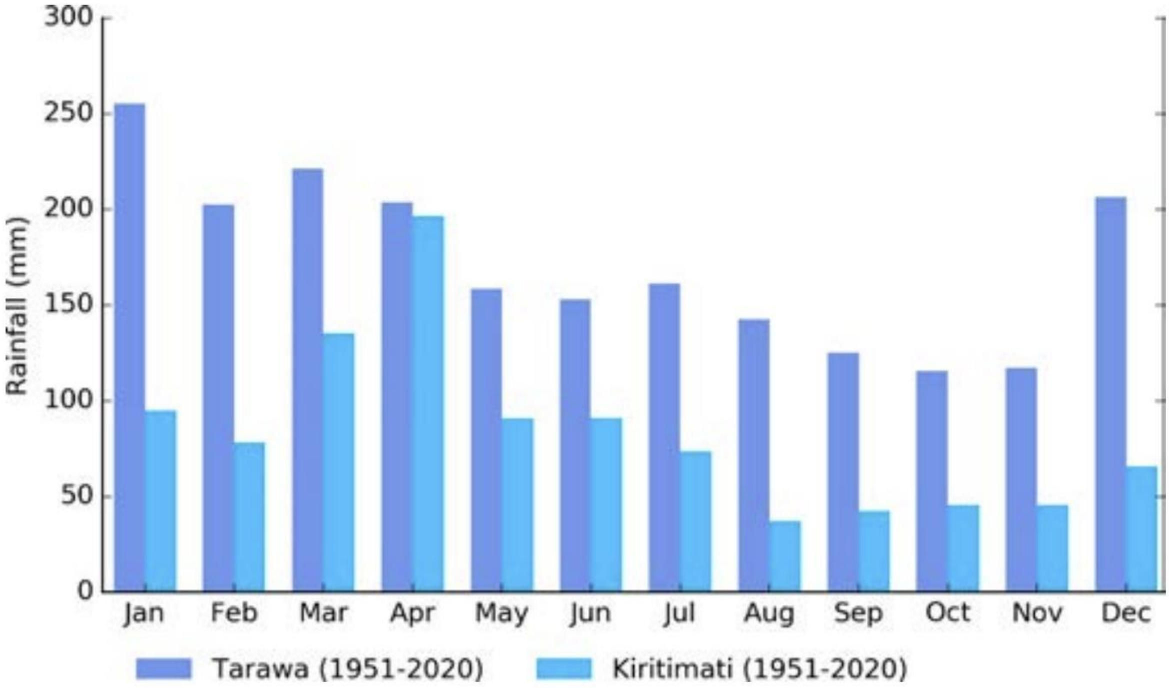



**Figure 1.4: Average monthly rainfall for the Tarawa and Kiritimati islands**

El Nino Southern Oscillation is the couple of ocean temperature and atmospheric conditions that are used to predict the phase and strength of El Nino and La Nina events in the Pacific islands. During the El Nino phase the ITCZ moves closer and persists much longer at the equator, which then increases the intensity of Wet and Dry seasons. On the other hand, the La Nina phase reverses the El Nino situation. Both El Nino and La Nina have a great impact on the weather patterns as in or during the tropical cyclone season. The SPCZ moves northeast during El Nino and move southwest during La Nina based on SPI (Salinger J, NIWA. 2007). The Madden-Julian Oscillation (MJO) is one of the major fluctuations in the tropical weather on a shorter weekly to monthly time scale (Source: Bureau of Meteorology, Australia). The influence of MJO causes changes in weather patterns such as higher precipitation and more intense tropical cyclone activity. Kiribati Meteorological Service (KMS) continually monitors the MJO forecast on a weekly basis during its strengthening phase in the West Pacific region.

The annual rainfall (bar graph) and number of wet days (where rainfall is at least 1 mm; line graph) at Tarawa and Kiritimati are given in Figure 1.5. Straight lines indicate linear trends for annual rainfall (black) and number of wet days (blue). Criteria for statistical robustness were not met for determining a linear trend for number of wet days at Kiritimati. No of we days is on the increasing trend which is also reflected similarly by annual rainfall.

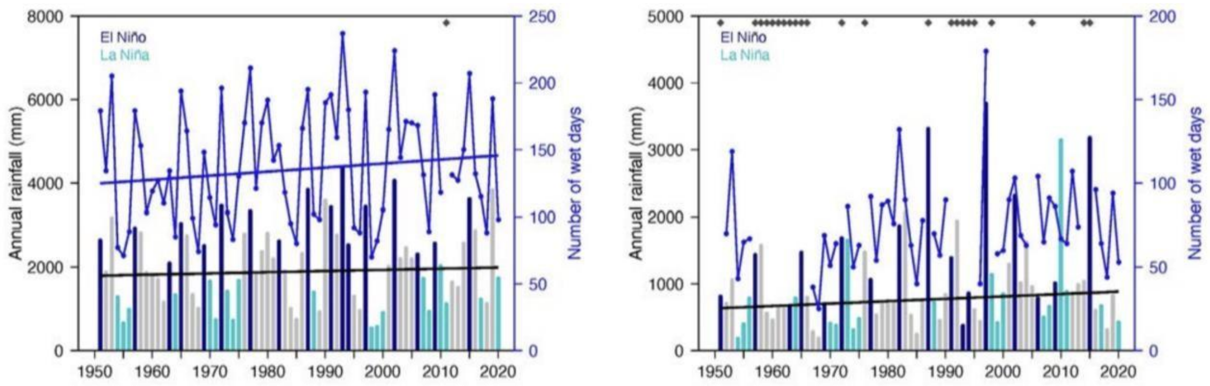



**Figure 1.5: Annual Rainfall and wet days for Tarawa (left) and Kiritimati (right)**

Annual longest run of consecutive dry days (bar graph) and maximum daily rainfall (line graph) at Tarawa and Kiritimati are illustrated in Figure 1.6). Straight lines indicate linear trends for dry days (black) and maximum daily rainfall (blue). Criteria for statistical robustness were not met for determining linear trends at Kiritimati. Diamonds indicate years with insufficient data for one or both variables. Maximum daily rainfall is increasing very slightly over time while the number of dry days is slowly regressing.

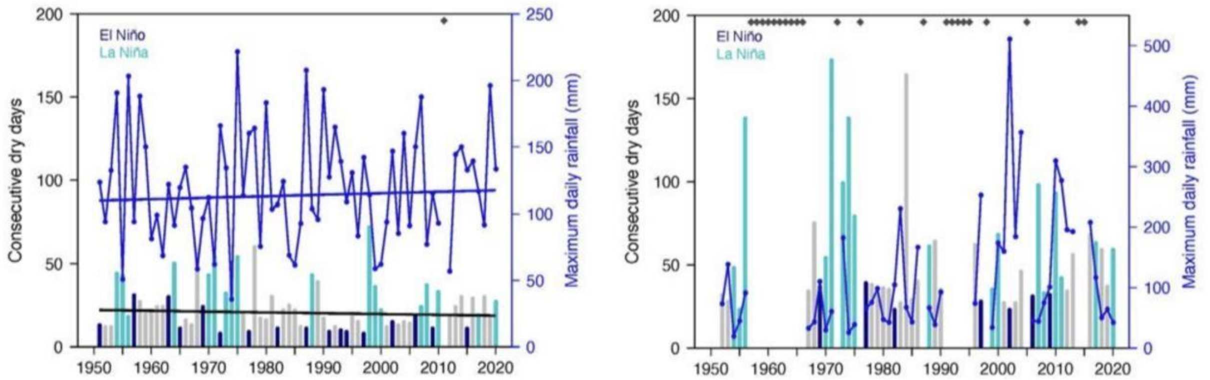



**Figure 1.6: Annual Rainfall and dry days for Tarawa (left) and Kiritimati (right)**

Throughout the year, Kiribati mean temperature is around 28-29ºC. The maximum temperature based on data for the past 3 decades is around 31.2-32.8ºC, except for Kiritimati where it is slightly lower (29.6-30.9ºC). The minimum temperature is around 25.5-26.0ºC in Tarawa and between 24.5-25.0º C in Kirimati which is slightly cooler due to its position relative to the ITCZ (Figure 1.7). When comparing the average temperature for periods 1961 to 1990 with those for 1991 to 2020 for Tarawa, it is clearly observed that both maximum and minimum temperatures have increased in the recent decades.

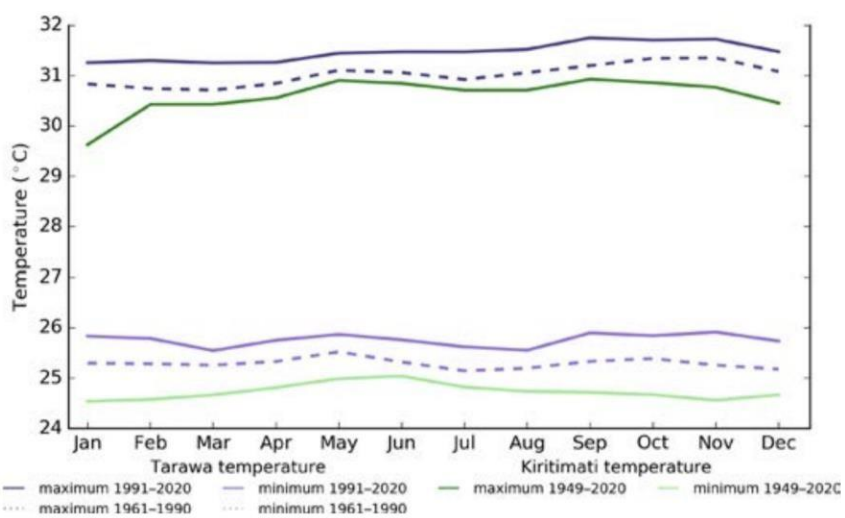



**Figure 1.7: Average monthly minimum and maximum temperatures for Tarawa and Kiritimati islands**

In Kiribati extreme events are associated with ENSO phenomena. The following are some of the extreme events that have occurred in Kiribati. Tropical cyclone may not materialise in the Kiribati region due to a weak Coriolis force at the equator. The increase in impact associated with tropical cyclones during the El Nino phase is severely affecting parts of Kiribati in terms of heavy rain, strong wind, and coastal wave inundation (KMS report, 2015). In 2015/16 during the strongest El Nino, Tropical Storm Bavi and tropical cyclone Pam was the first twin cyclones ever documented by KMS bringing the most devastating impacts to some parts of Kiribati including Arorae, Tamana and Tarawa as well.

Droughts are usually associated with La Nina events and are occasionally severe. For example, only 20 mm of rainfall were received over the 18 months period July 1988 to December 1989 (IPCC REPORT, 2011).

## 1.5. Population profile

The population of Kiribati is characterized by a very young and youthful cluster compared to its neighbouring Pacific Islands. South Tarawa is the most densely populated island due to its status of capital of Kiribati. The two islands South Tarawa and Kiritimati are considered as urban areas, where most of the people from the rural Outer Islands has emigrated. Of the three island groups, the Gilbert group has the highest population.

In the 2010 census, South Tarawa had the largest fraction of the population with 49%, making up for nearly half of the people. The 2020 census recorded a total population of 119,438, of which 70,441 (59%) were urban dwellers and 48,997 (41%) rural. In 2020, 58,904 (49%) were males and 60,534 (51%) females. The increase in demographic rate recorded during the decade 2010 to 2020 is 16%, representing an average annual increase of 1.6%.

There were slightly more women in urban areas in 2020 when they represented 52% of the population compared to 49% in rural areas. The urban population in Kiribati increased by 49% from 2010 to 2020 when the country reached a 59% urbanization rate compared to 49% in 2010. This shows that over and above the population increase, there has also been significant migration from rural to urban areas. The average household size was 5.9 persons/household in 2020 compared to 6.4 in 2010.

Regarding education, 93% of the urban population aged 15 years and above had attended school up to class 3 in 2020 compared to 87% in rural areas. In that same year, 87% of the urban population aged 12 years and above could read and write without difficulty compared to 76% in the rural areas.

The unemployment rate did not change from 2010 to 2020 with 11% of the active workforce not having an economic activity. The active workforce involved in different sectors in 2020 is illustrated in Figure 1.8. The Wholesale and retail trade, including repair of motor vehicles and Agriculture, Forestry and Fishing accounted for 52% of the occupation of the workforce. Women were more employed in the Education and Wholesale and retail trade sectors including repair of motor vehicles where they represented 75% and 54% respectively in these sectors (2020 Population and Housing/General Report and Results).

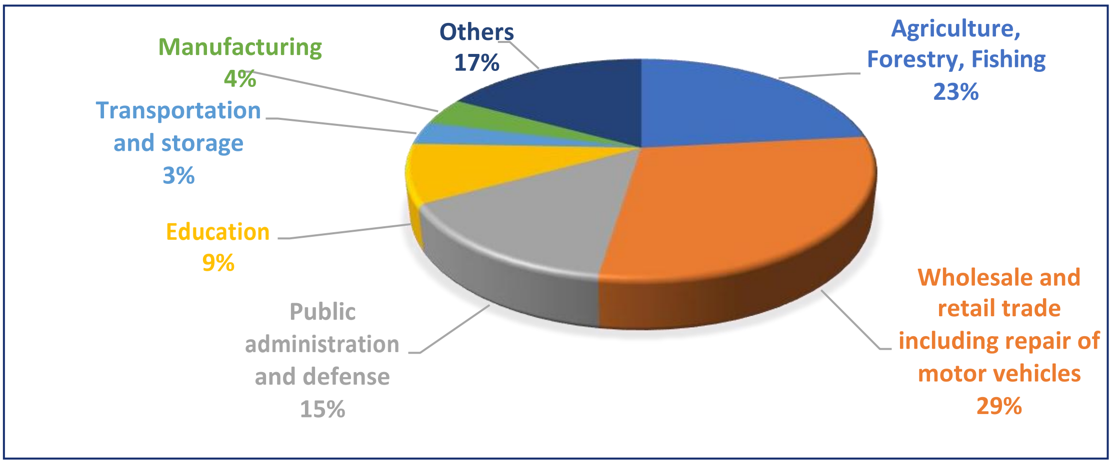
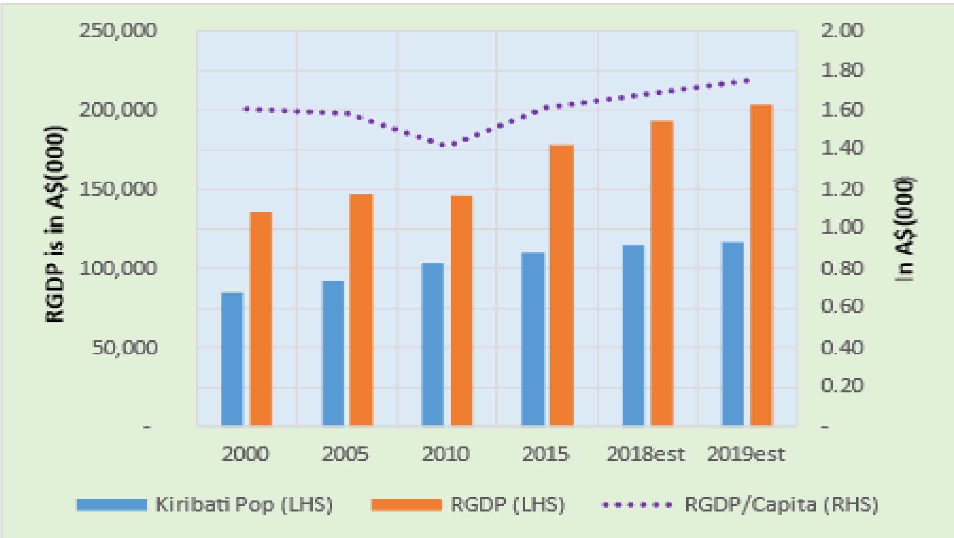



Figure 1.8: Distribution of Kiribati workforce across activities in 2020

## 1.6. Economic profile

Kiribati has a vulnerable economy and is struggling to establish its place in an increasingly globalizing economy. Like many other small island developing states, the country faces many economic challenges given its remoteness, limited resource base, small market size, and limited institutional capacity. International development assistance contributes significantly to government revenues and is an important source of foreign exchange.

Prior to the COVID-19 outbreak, Kiribati's economy performed well with an average annual real GDP growth rate of 4.75% during the period 2015 to 2019. However, in 2020 a decline of 0.5% in economic growth was recorded. Strict border and containment restrictions and a sharp drop of 16% in fishing revenues were contributors to this decline (IMF, 2021). Real GDP per capita increased from AUD 1,612 in 2015 to AUD 1,749 in 2019 as reflected in Figure 1.9.




**Source: NSO, 2020**

Figure 1.9: Per capita real GDP growth (2000 – 2019)

## 1.7. Impact of COVID-19 on the economy

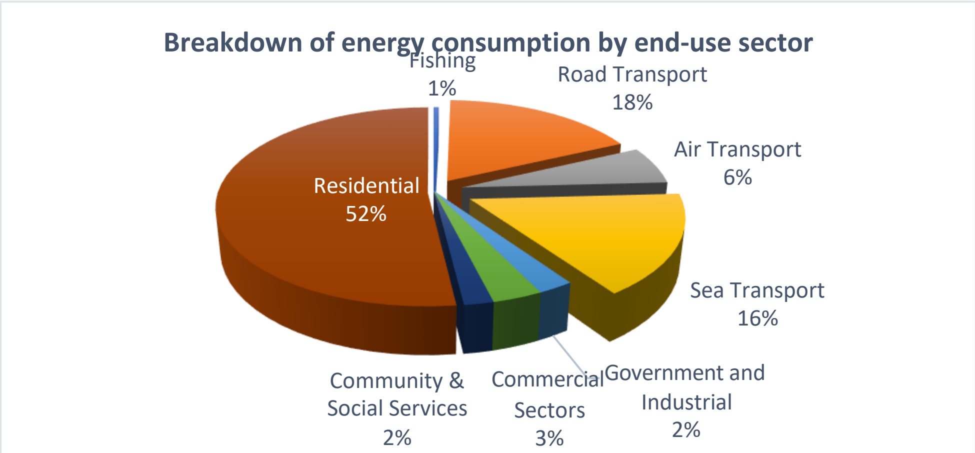
According to the Kiribati Vision (KV20), the nation draws its focus and attention to two key productive sectors which are fisheries and tourism with an expectation that other developments will follow through sectoral linkages. However, in 2020, in the wake of the COVID-19 pandemic, although not greatly affected compared to other neighbouring countries, Kiribati has commenced shifting its focus and resources towards preparedness plans and prevention measures.

The pandemic and strict containment measures strained the economic activities resulting in many development projects being delayed because of the restrictions on the movement of personnel and materials such as prolonged delays in cargo shipments affecting local business' operations, shortage of imported goods. The pandemic also contributed in the reduction of employment opportunities which translated into reduced income and persistence of inequality.

## 1.8. Energy

South Tarawa accounts for the highest electricity demand in Kiribati at 29.6 GWh of generation in 2018. Hence, South Tarawa has the largest and most complex electricity generation system in Kiribati with an installed capacity of 6.6 MW of diesel generation and 1.6 MWp of PV (PED report, 2019). Kiritimati island has the second largest electricity demand with an estimated total demand of 2.2 GWh in 2017. The remainder of Kiribati's power generation systems consists of small diesel generators, PV-diesel macro grids and solar home systems distributed across the outer islands.

In 2019, the Kiribati (Gilbert Island Group) total final energy consumption was 1523 TJ of which 54% was generated using petroleum products and 46% from renewable sources (1% from solar and 45% from biomass). The residential sector is the largest consumer of energy with a share of 52.0% (Figure 1.10) followed by the road transport sector that used 17.6%. Marine navigation consumed 16% of the national energy demand. In 2019, electricity represented only 3.9% of households' energy consumption. More than 80% of household's energy consumption comes from biomass in the form of coconut residue and firewood (87.0%) with petroleum products in the form of kerosene (6.2%) and gasoline (2.9%) accounting for the remaining. Liquefied petroleum gas use is limited due to high costs, especially in comparison to subsidized kerosene prices. Gasoline was the major fossil fuel used with a 42% share of consumption while diesel followed with 35% on the national basis (Personal communication-MISE; 2019 Energy Balance).




**Source: MISE Energy Balance Table 2019**

**Figure 1.10: Breakdown of energy consumption by end-user**

Even though Kiribati is blessed with abundant indigenous energy resources from solar, wind, ocean, coconut copra and biomass, it is highly dependent on petroleum imports for electricity generation, transportation, and domestic uses. Imported petroleum products are diesel, gasoline, kerosene, and lubricants. Energy products made up 14% of the total value of imports in 2018 (NSO, 2018). The Government of Kiribati (GOK) uses price controls and tax exemptions for fossil fuels to keep their prices more affordable for low-income households. However, the Government subsidy is only applied to household kerosene and diesel used for electricity generation (SPC, Fuel subsidy report). The high dependency on imported fuel makes oil prices volatile and results in high energy costs, which place a burden on local development.

The Energy Policy of 2009 is the document guiding the development of the sector. In its Integrated Energy Roadmap (KIER 2017-2025), GOK has targeted a reduction of 45% in fossil fuel consumption in South Tarawa and 60% in Kiritimati, by scaling-up renewable energy and adopting energy efficiency measures. GOK's short-term and long-term policy strategies, Kiribati Development Plan (2016-2019) and Kiribati 20 years (2016 – 2036) Vision, iterate Government's goal to increase its citizen's access to high quality and climate resilient infrastructure by increasing the use of renewable energy in all sectors of the economy.

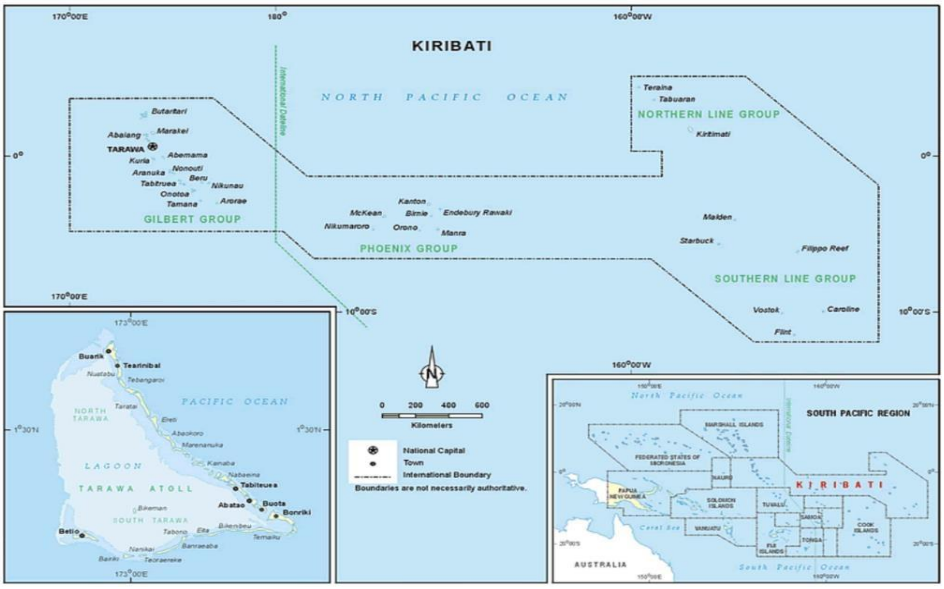
## 1.9. Transportation

### 1.9.1. Air transport

Two main international airports in Kiribati provide regular international and domestic services. Bonriki International Airport (BIA) is located on the island of Tarawa, which is part of the Gilbert group of islands, and Cassidy International Airport (CXI) is located on the island of Kiritimati which is part of the Phoenix group of islands. BIA and CXI, considered as hubs, are supported by 17 others on outer islands.

### 1.9.2. Maritime Transport

Kiribati is an oceanic nation, and a large proportion of its population is engaged in marine activities. Shipping is critical to the economic and social welfare of the people of Kiribati. Safe navigation is vital to secure social welfare and protect the environment. Kiribati has a total Exclusive Economic Zone (EEZ) of 3,5 million km$^2$. Since the Kiribati islands are scattered over the four hemispheres, Kiribati faces an enormous geographical challenge of isolation and distance as shown by the fact that the distance from the capital, Tarawa, to the Phoenix Islands is 1,500 km and 3,300 km to the Line Islands (Figure 1.11). The islands are connected via sea transportation in addition to aviation.




**Source: Kiribati Maritime Transport Policy (2016 – 2020)**

**Figure 1.11: Distribution of Kiribati islands over the ocean**

### 1.9.3. Road transport

Due to its topography, size and restricted resources, the road infrastructure of Kiribati is limited. It consists of about 700 km of roadways of which the only tarred one of some 50 km is found on the South Tarawa Island. Current records show 9,394 registered vehicles on South Tarawa, comprising of private, commercial and government vehicles, such as trucks, buses, sedans as well as motorbikes and tricycles. Since Kiribati Land Transport Authority (KLTA) is not yet established in the Line and Phoenix groups of islands, consequently the data for vehicles in those two groups are not available. It is estimated that 89% of the vehicles are in the Gilbert group, with 11% of non-registered vehicles found on the Line (7%) and Phoenix (4%) groups. Most of the vehicles are second-hand imported ones.

## 1.10. Manufacturing

Kiribati is not an industrialized country due to its remoteness and restricted connectivity, small size, lack of indigenous resources, very small economy and lack of specialized skills. Major industries include clothing, fish processing, food processing, handicrafts, and tourism. The main industrial products exported are copra, fish and processed fish. The five sectors of the tourism segment are transportation, accommodation, food and beverage, recreation and entertainment, and travel services. In 2019, manufacturing contributed a nominal 3.9% to national GDP with AUD 9.7 million.

## 1.11. Waste

The type of wastes found in Kiribati is typical to those commonly found in small island developing states. The characteristics and generation of waste over the years reflect the population increase and change in lifestyle. Kiribati imports a significant quantity of products including foods from abroad to meet the local population needs. Consequently, most of the waste problems arrive from overseas as packaging for these essential goods. The materials produced locally are organic and can be managed at the household level, with little concern for their impact. According to statistics from the Kiribati Waste Management Resource Recovery Strategy (2020), the average waste composition was 59% organic waste, 10% miscellaneous, 9% metal, 7% glass/ceramic, 7% plastic, 5% paper, and 3% textile/rubber.

Only South Tarawa and Kiritimati Islands possess proper waste disposal infrastructures. There are three approved landfills on South Tarawa - Betio, Nanikaai and Bikenibeu landfills. Kiritimati Island has one approved dumpsite and one hazardous cell. The dumpsites on Kiritimati Island, both approved and illegal, are not regulated and managed to required standards. On outer islands, there are no proper waste collection systems in place. So, waste is simply buried indiscriminately, burned at dumpsites or disposed of at sea, threatening the marine environment.

In Kiribati, waste incineration is resorted to mainly to treat medical and quarantine wastes. The hospital incinerators are operated only on South Tarawa, Tabiteuea North and Kiritimati Islands. The Tabitebuea North and Kiritimati incinerators break down frequently.

Kiribati operates a recycling plant through a private business supported under the Special Fund (Waste Material Recovery) Act 2004 and Special Fund (Waste Material Recovery) Regulation 2005. Currently, only specific waste materials including lead-acid batteries, aluminium cans, and PET bottles are accepted under the Act. The government, through the Kiribati Waste Management and Resource Recovery Strategy 2020-2030 (KWMRRS), aims to expand the scope of these recycling activities to include other waste materials which have value such as e-waste, scrap metal and used oil. Export of these recyclables from 2005 to 2022 totalled some 376 tons.

Wastewater, including sanitation and industrial wastewater, are addressed by different government ministries. For instance, the Ministry of Infrastructure and Sustainable Energy (MISE) is responsible for sanitation. There is no treatment system for sewage from the households that are collected by the sewerage system operated by the Public Utilities Board (PUB) on South Tarawa and Betio. The sewerage system only collects sewage and discharges it into the ocean at three main sea outfalls. There are other sewerage systems such as the hospital system in Nawerewere and Moroni High School that are not connected to the PUB network. They have their own outfalls. These systems do not have treatment plants as well. Those households that are not connected to the PUB network have their own on-site septic system. They are serviced by the PUB vacuum truck to de-sludge their septic tanks when they are full for discharge into the PUB system and disposal into the ocean through the outfalls. Sanitation is a major problem in South Tarawa. During floods, the poor sanitation contaminates freshwater resources which results in vector-borne diseases. In other words, poor sanitation is contributing to the vulnerability of water resources and human health sectors with second order effects on the development of the economy.

Based on 2018 data, Kiribati imported about 150,000 litres which resulted in about 75,000 litres of used oil being generated. In 2019, about 50,000 litres of used oil were exported in International Organization for Standardization (ISO) tanks by Kiribati Oil Company limited (KOIL) and PUB for recycling in Fiji.

Another important feature of waste treatment in Kiribati is composting. The main composting facility operates on approximately one hectare of land by MELAD. Very little soil is available on the islands of Kiribati, and, therefore, composting for use as fertilizers is a very useful activity to promote. Approximately 60 tonnes of compost are produced annually.

## 1.12. Agriculture, Forestry and Fisheries

There are many limitations affecting agriculture, forestry, and livestock activities. Undertaking agriculture, forestry, and livestock rearing in Kiribati is either very challenging or very expensive because of the infertile, very alkaline and coarse-textured soil, the limited land area, and limited water. The most common agricultural livestock are pigs and chickens, mostly raised under a subsistence production system. In 2018, agricultural land accounted for 42% of the total land area. The main crops cultivated in Kiribati are coconut, breadfruit, bananas and vegetables including cassava, sweet potato and cabbage.

Agriculture and Fisheries are key activities for th e country both for subsistence and commercial purposes. Kiribati's main exports are coconut products and fish, and these products were valued at AUD 11.3 million in 2020, representing 83% of the country's total export value of AUD 13.5 million. Additionally, they are critical because food and nutrition security rank high on the Government agenda at the national level. Copra from coconuts continues to be Kiribati's main agricultural export with 623 tonnes exported in 2020 valued at AUD 353,000 (KNSO, 2020 preliminary estimate) which is well below the 7,260 tonnes (valued at AUD 6.3 million) exported in 2017. In 2020, agriculture, forestry and fishing, contributed AUD 68.8 million (or 26.2%) to the GDP of Kiribati (KNSO,2021 preliminary)

Of the 76,521 (64% of the total population) surveyed as persons of working age of 15 years old and over in 2020, 7,029 workers (23%) reported their main industry as Agriculture, forestry and fishing. This placed the industry next to the Wholesale and retail trade industry with 8,816 workers (29%). Of the 20,354 households of the country, 15,467 (76%) reported having some type of agricultural activity. 68% of the total households are involved with livestock raising, 44% in crop growing, 47% in fishing activity and 22% practicing handicrafts. Many households undertake a combination of these activities, including mixed farming (both cropping and raising livestock) as well as fishing.

## 1.13. Water resources

The geography of Kiribati creates significant human development and growth challenges, including access to safe and reliable water, and sanitation. Freshwater resources of Kiribati consist of rainwater, shallow unconfined groundwater generally within less than 2 m of the surface, imported water or desalination (Falkland, 2002). The raised island of Banaba uniquely has freshwater pools in subterranean caves that could serve as an emergency source of water in times of severe drought. The World Bank quoted 39.14% people in rural (% of rural population) areas and 91.53% urban (% of urban population) using at least basic sanitation services in 2020.

Numerous reports and policy documents have highlighted the major issues and concerns on water and sanitation in the country. Some of the main concerns are:

- Provision of adequate water for human health and community development.
- Provision of equitable access to safe water.
- Protection of water sources.
- Provision of appropriate sanitation.
- Impact of droughts on water supplies.
- Impact of sea level rise on water resources.
- Provision of sustainable water supply and sanitation systems.
- Ensuring groundwater supply systems do not compromise rights or livelihoods.
- Improvement in water governance, capacity building and maintenance of skills.
- Improvement in knowledge and monitoring; and
- Land and water ownership in water source areas and common perceptions.

## 1.14. Health

In Kiribati, high density housing facilitates transmission of infectious and other diseases outbreaks. Being an atoll, there is an acute water security problem, which is exacerbated by increasing waste generation and pollution as well as fluctuating weather patterns. All these have significant health consequences for the people of Kiribati, especially those living on South Tarawa.

The National Climate Change and Health Action Plan (NCCHAP) developed for Kiribati by the World Health Organization (WHO) identified five key health domains having the potential to be impacted by climate change. These include water safety and water-borne diseases, food safety and food-borne diseases, vector-borne diseases, disease surveillance, and ciguatera fish poisoning (GOK, 2011).

Urbanization and lifestyle changes have contributed to erosion of the Kiribati culture with negative effects on health. Almost 80 to 90% of the total population rely on imported food grains such as rice, flour, and sugar, as their staple food sources. Diabetes prevalence (% of population ages 20 to 79) in Kiribati was reported at 22.1 % in 2021 (https://data.worldbank.org/). The same source reported the cause of death (% of total) in 2019, by communicable diseases and maternal, prenatal and nutrition conditions at 21.62 % and by non-communicable diseases (% of total) at 72.81 %. This abnormally high death rate from non-communicable diseases is attributed to an increased dependence on imported food that are of poor nutritional quality, the inactive lifestyles of the people and a shift towards a more Westernized diet. The number of people reported as being undernourished was at 100,000 in 2020 (https://data.worldbank.org/).

In Kiribati, there is one main headquarter hospital located on South Tarawa, the capital island, which is the referral hospital and a secondary one located in Betio. The other two hospitals are located on Tabiteuea North in the southern part of the Gilberts, and Kiritimati Island in the Line Group. These four hospitals are supported by a network of 22 Health Centres and 82 village clinics. Medical supplies, medical equipment, and qualified medical doctors to adequately service the main and sub-hospitals for the public, including the outer islands medical health centres are limited. Health infrastructures and facilities are also inadequate, resulting in overseas medical referrals to either Fiji, New Zealand, India and Taiwan for major and complex cases.

## 1.15. Biodiversity

Climate changes are threatening individual species as well as entire ecosystems, with adverse consequences for human well-being and the society. On the other hand, biodiversity, through the ecosystem services it supports, makes an important contribution to both climate change mitigation and adaptation (Diversity, 2009). Biodiversity conservation, management and sustainable utilisation, are critical to addressing climate change. Ecosystems like mangroves, seagrass and coral reefs, have important roles in the carbon cycle through atmospheric carbon dioxide ($CO_2$) sequestration and storage (Kapos, Scharlemann, Campbell, Chenery, & Dickson, 2008). These three ecosystems are protected in Kiribati under the Environment Amendment Act 2007.

Under the MELAD environment portfolio, GOK has invested in the establishment of marine protected areas (MPA) at the national and island levels under the Environment Amendment Act 2007, through the PIPA in the Phoenix Islands Group in 2006, the Southern Line Islands Marine Protected Area (SLIMPA) in the Line Islands Group in 2020, and through the community based protected areas in several islands of the Gilbert Group.

Areas occupied by mangroves have been mapped and changes in the coastal areas due to mangroves are currently taken into consideration by the Lands Management Division (LMD) of MELAD with the support of ECD. In some islands, mangrove replanting and monitoring is ongoing with the full support of the villages and islands concerned. Similar work for seagrass and coral reefs ecosystems is under way under the responsibility of MELAD ECD. Nineteen species of birds (avifauna), which include the only endemic vertebrate terrestrial bird 'te bokikokiko' (Kiritimati Islands warbler, *Acrocephalus aequinoctialis*), and the bonefish are protected under the Wildlife Conservation Amendment Ordinance 2007 and the Kiritimati Island Bonefish Regulations under the Fisheries Act. The bonefish on South Tarawa is also protected under the Bonefish Regulation under the Fisheries Act.

## 1.16. Development priorities and objectives

The Government of Kiribati has two national plans that expresses the development priorities of the country. These plans are the Kiribati Vision for 20 years (KV20) covering the period 2016 to 2036 and the Kiribati Development Plan (KDP) that covers successive four years periods. The KV20 is the long-term development blueprint for the country and the KDP guides the formulation of policies and programs to advance the socio-economic development of Kiribati. The KV20 comprises 4 pillars – Wealth, Peace and Security, Infrastructure for Development, and Governance. In addition to the 4 core pillars the Vision has included the Environment, Climate Change and Sustainable Development under cross-cutting issues. It recognizes Kiribati's vulnerability to climate change as a key constraint to achieving the desired outcomes. The Vision underscores the need to mainstream climate change adaptation and mitigation into various programmes. Mainstreaming climate change into development programmes will ensure that the working environment is sensitive to environment conservation, climate change and sustainable development. The environment conservation adaptation and mitigation measures will reduce risks and ensure that the development programmes implemented create sustainable development for all.

Strategic plans are also developed across all government ministries, aligned to the two national documents which identify specific priority areas and sectoral approaches. To help achieve these priorities, ministries recognize and adopt other strategies which include the Kiribati Joint Implementation Plan (KJIP 2019 – 2028) and the Kiribati Waste Management and Resource Recovery Strategy (KWMRRS 2020 – 2030) among others.

# 2. National greenhouse gas inventory

## 2.1. Introduction

### 2.1.1. Commitments under the Convention

The Republic of Kiribati ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 06 January 1997 as a non-Annex 1 Party. Under Article 4.1 (a) of the Convention, each Party must develop, periodically update, publish, and make available to the Conference of the Parties (COP), in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the COP. Kiribati has to-date submitted two national greenhouse gas (GHG) inventories as components of first and second national communications. The present GHG inventory is being compiled within the framework of the preparation of the Third National Communication in accordance with the Modalities, Procedures and Guidelines contained in the latest COP decision (CMA/18.1) as far as possible.

### 2.1.2. The inventory process

#### 2.1.2.1. Background

The preparation of the present inventory started in 2013 and has been updated during the year 2022. Kiribati did not have an operational GHG inventory management system (GHGIMS) for sustainably preparing GHG inventories in line with decision 18/CMA.1 and the existing ad hoc system was once more adopted. Kiribati is working on institutionalization of the process to address the higher frequency of reporting, the higher standard and quality, and the enhanced transparency requirement of the PA during the preparation of its first Biennial Update Report. Furthermore, Kiribati resorted to international consultants to update the GHG inventory prepared by national consultants to improve its quality of GHG.

This present inventory provides information on GHG emissions by sources and removals by sinks for all years for the period 2010 – 2019. Improvements over the previous inventory consisted in the review of activity areas for maximum completeness and recalculations with the availability of better national activity data (AD) for all years to enhance consistency and accuracy.

#### 2.1.2.2. Institutional arrangements for inventory preparation

Kiribati has always prepared its GHG inventories using national experts, the objective being to build and strengthen existing capacities. The national experts estimated emissions for a restricted number of sectors and categories using spreadsheets. These estimates were summed up to arrive at national emissions. The international consultants, after collating additional data over more categories, worked for improving the GHG inventory. The existing GHGIMS, inclusive of the institutional arrangements for compiling the inventory, and further development is be presented in the BUR1 (In press) alongside the Measurements Reporting and Verification system for emissions.

## 2.2. Overview of the inventory

### 2.2.1. Coverage

This GHG inventory covers the whole territory of the Republic of Kiribati with estimates made at the national scale.

The national GHG inventory includes estimates for the four IPCC sectors, namely, Energy, IPPU, AFOLU and Waste. However, the categories and subcategories have not been fully exhausted because of their limited contribution to the economy and lack of AD for this period. The coverage of activity areas is provided under the completeness section of this chapter.

The GHG inventory includes emissions of the direct GHGs $CO_2$, $CH_4$ and $N_2O$ only.

In line with the requirement to provide a trend of estimates, the period 2010 to 2019 has been adopted. To ensure consistency, estimates for all years have been calculated, using the same methodology and data sources.

### 2.2.2. Method

Estimates of GHG emissions provided in this report have been compiled using the 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2007). The purpose of adopting these guidelines is to ensure that the GHG emission estimates are Transparent, Accurate, Complete, Consistent and Comparable (TACCC) as far as possible and in line with decision 18/CMA.1.

Results from the GHG inventory of the NC2, availability of resources, existing capacity and availability of AD dictated the choice of source categories to be included for compilation. Selection of the Tier level was guided by the general decision-tree reproduced in Figure 2.1 and category specific decision trees provided in the Guidelines.

The selection of the Tier level for all sectors was constrained by the limited availability of disaggregated AD (e.g., facility level data) and national EFs. This led to the adoption of the Tier 1 level for all categories. National AD was complemented with those available in international databases and IPCC default EFs were used. Detailed descriptions of the methods adopted for generating missing data and equations used in each sector, including AD and EFs used, are provided under each IPCC sector in this report.

The different steps guiding the preparation of the present inventory were:

- Review of previous inventory to prioritise use of resources.
- Collect, quality control and validate AD.
- Selection of Method – Tier level within each category and sub-category.
- Selection and validation of emission factors (EFs).
- Computation of GHG emissions by the international firm supported by experts from key institutions and ECD.
- Key Category Analysis (KCA).
- Uncertainty Analysis.
- QA / QC of emissions computations and outputs.
- Assessment of completeness.
- Trend analysis.
- Identification of gaps, constraints and needs.
- National Inventory Improvement Plan.

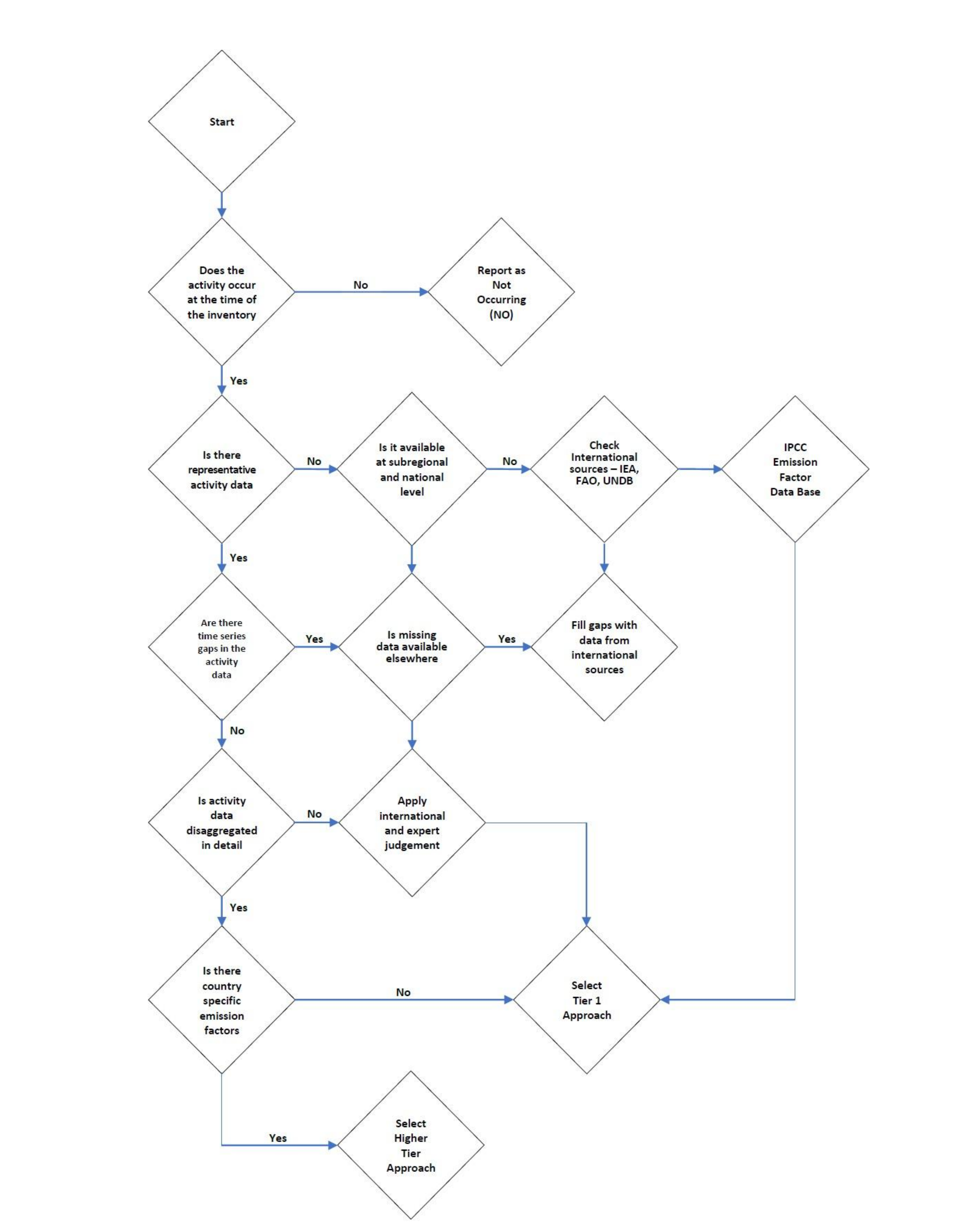



**Figure 2.1: Decision tree used to determine Tier Level method**

### 2.2.3. Global Warming Potential

Global Warming Potentials (GWP) of the IPCC Fifth Assessment Report (AR5) have been used to convert GHGs other than $CO_2$ to the latter equivalent as prescribed in Decision 18/CMA.1. These GWPs provide a consistent basis for comparing the relative effect of the emissions of all GHGs uniformized over a period of 100 years by converting the emissions of the other GHGs to that of $CO_2$. The values adopted for the three direct GHGs $CO_2$, $CH_4$ and $N_2O$ are provided in Table 2.1

**Table 2.1: Global Warming Potential**

| Gas | Symbol | GWP |
|---|---|---|
| Carbon Dioxide | $CO_2$ | 1 |
| Methane | $CH_4$ | 28 |
| Nitrous Oxide | $N_2O$ | 265 |

The size of the country and its population results in low emission values. For ease of understanding and to conform with recent COP decisions, emissions in this report have been expressed in tonnes where 1 Gigagram = 1,000 tonne = 1,000,000 kilograms = 1,000,000,000 grams.

### 2.2.4. Key Category Analysis

KCA gives the characteristics of the emission sources and sinks. According to the 2006 IPCC Guidelines (Vol. 1_4, Ch. 4 – Method Choice), key categories are those which contribute 95% of the total annual emissions, when ranked from the largest to the smallest emitter. A key category is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHGs in terms of the absolute level of emissions, the trend in emissions, or both (IPCC, 1997). Thus, it is a good practice to identify key categories, as it helps prioritize efforts and improve the overall quality of the national inventory, while also guiding mitigation policies, strategies, and actions.

The KCA was performed using the tool available within the IPCC inventory software (Version 2.69) for both the level and trend assessments. The results for the level assessment for the year 2019 are presented in Table 2.2 and the trend assessment in Table 2.3. Eleven key categories were identified in the quantitative level assessment for the year 2 019. The main category, Forest Land remaining Forestland, is responsible for 17.9% of emissions/removals in absolute terms. All sectors, except IPPU, are represented among the categories that contributed to 95% of emissions/removals in the year 2019.

**Table 2.2: Key Category Analysis for the year 2019: Approach 1 – level assessment**

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| **IPCC Category code** | **IPCC Category** | **GHG** | **2019 Ex,t (t $CO_2$ e)** | **\|Ex,t\| (t $CO_2$ e)** | **Lx,t** | **Cumulative Total of Column F** |
| 3.B.1.a | Forest land Remaining Forest land | $CO_2$ | -27,741 | 27,741 | 0.179 | 0.179 |
| 1.A.3.b | Road Transportation | $CO_2$ | 23,421 | 23,421 | 0.151 | 0.330 |
| 1.A.4 | Other Sectors – Liquid Fuels | $CO_2$ | 21,867 | 21,867 | 0.141 | 0.471 |
| 4.D | Wastewater Treatment and Discharge | $CH_4$ | 20,503 | 20,503 | 0.132 | 0.603 |
| 1.A.1 | Energy Industries – Liquid Fuels | $CO_2$ | 19,067 | 19,067 | 0.123 | 0.726 |
| 3.A.2 | Manure Management | $CH_4$ | 15,858 | 15,858 | 0.102 | 0.828 |
| 1.A.4 | Other Sectors – Biomass | $CH_4$ | 5,337 | 5,337 | 0.034 | 0.863 |
| 1.A.3.a | Civil Aviation | $CO_2$ | 4,122 | 4,122 | 0.027 | 0.889 |
| 3.A.2 | Manure Management | $N_2O$ | 3,631 | 3,631 | 0.023 | 0.913 |
| 1.A.3.d | Water-borne Navigation – Liquid Fuels | $CO_2$ | 3,600 | 3,600 | 0.023 | 0.936 |
| 4.A | Solid Waste Disposal | $CH_4$ | 3,048 | 3,048 | 0.020 | 0.956 |

This situation does not change when considering the trend assessment for the period 2010 to 2019 (Table 2.3). The major contributor in the trend assessment did not change with Forestland remaining Forestland ($CO_2$) topping the list with 26.8% of emissions. Other main ones are Manure management

($CH_4$), Energy Industries-Liquid fuels ($CO_2$), Wastewater treatment and discharge ($CH_4$), with 44.4% of the 95% contributions of the assessment.

**Table 2.3: Key Category Analysis (2010 – 2019): Approach 1 – Trend Assessment**

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| IPCC Category code | IPCC Category | GHG | 2010 Year Estimate Ex0 (t $CO_2$ e) | 2019 Year Estimate Ext (t $CO_2$ e) | Trend Assessment (Txt) | % Contribution to Trend | Cumulative Total of Column G |
| 3.B.1.a | Forest land Remaining Forest land | $CO_2$ | -28,187 | -27,741 | 0.110 | 0.268 | 0.268 |
| 3.A.2 | Manure Management | $CH_4$ | 17,124 | 15,858 | 0.079 | 0.194 | 0.462 |
| 1.A.1 | Energy Industries - Liquid Fuels | $CO_2$ | 17,234 | 19,067 | 0.054 | 0.133 | 0.595 |
| 4.D | Wastewater Treatment and Discharge | $CH_4$ | 9,776 | 20,503 | 0.048 | 0.117 | 0.712 |
| 1.A.3.b | Road Transportation | $CO_2$ | 13,792 | 23,421 | 0.023 | 0.056 | 0.768 |
| 3.A.2 | Manure Management | $N_2O$ | 3,921 | 3,631 | 0.018 | 0.044 | 0.813 |
| 1.A.4 | Other Sectors - Liquid Fuels | $CO_2$ | 15,926 | 21,867 | 0.016 | 0.038 | 0.851 |
| 1.A.3.a | Civil Aviation | $CO_2$ | 1,664 | 4,122 | 0.013 | 0.033 | 0.884 |
| 1.A.4 | Other Sectors - Biomass | $CH_4$ | 4,534 | 5,337 | 0.012 | 0.029 | 0.912 |
| 3.C.4 | Direct $N_2O$ Emissions from managed soils | $N_2O$ | 1,984 | 1,834 | 0.009 | 0.023 | 0.935 |
| 1.A.3.d | Water-borne Navigation - Liquid Fuels | $CO_2$ | 3,159 | 3,600 | 0.009 | 0.022 | 0.957 |

The summary of Key Categories based on the quanti tative evaluation for the 2019 level assessment and trend for the period 2010 to 2019, is presented in Table 2.4. Ten categories are common to both the level and trend assessments.

**Table 2.4: Summary of Key Categories for Level (2019) and Trend (2010 – 2019) Assessments**

| Number | IPCC category code | IPCC category | GHG | Approach used | Comment |
|---|---|---|---|---|---|
| 1 | 1.A.1 | Energy Industries - Liquid Fuels | $CO_2$ | L1 T1 | Quantitative |
| 2 | 1.A.3.a | Civil Aviation | $CO_2$ | L1 T1 | Quantitative |
| 3 | 1.A.3.b | Road Transportation | $CO_2$ | L1 T1 | Quantitative |
| 4 | 1.A.3.d | Water-borne Navigation - Liquid Fuels | $CO_2$ | L1 T1 | Quantitative |
| 5 | 1.A.4 | Other Sectors - Liquid Fuels | $CO_2$ | L1 T1 | Quantitative |
| 6 | 1.A.4 | Other Sectors - Biomass | $CH_4$ | L1 T1 | Quantitative |
| 7 | 3.A.2 | Manure Management | $CH_4$ | L1 T1 | Quantitative |
| 8 | 3.A.2 | Manure Management | $N_2O$ | L1 T1 | Quantitative |
| 9 | 3.B.1.a | Forest land Remaining Forest land | $CO_2$ | L1 T1 | Quantitative |
| 10 | 3.C.4 | Direct $N_2O$ Emissions from managed soils | $N_2O$ | T1 | Quantitative |
| 11 | 4.A | Solid Waste Disposal | $CH_4$ | L1 | Quantitative |
| 12 | 4.D | Wastewater Treatment and Discharge | $CH_4$ | L1 T1 | Quantitative |

**Notation keys: L = key category according to level assessment; T = key category according to trend assessment; and Q = key category according to qualitative criteria. The Approach used to identify the key category is included as L1, L2, T1 or T2.**

### 2.2.5. Methodological issues

This section provides an overview of the methodological approach adopted for computing emissions for this inventory. More specific details are provided under the respective IPCC sectors and sub-sectors.

The method adopted to compute emissions involved multiplying AD by the relevant appropriate EF, as shown below:

**Emissions (E) = Activity Data (AD) x Emission Factor (EF)**

As per Good Practices all methods and tools recommended by IPCC for estimating emissions have been used and followed when compiling this inventory.

Default EFs were assessed for their appropriateness prior to their adoption, namely the situations under which they have been developed and the extent to which they were representative of national circumstances.

There exists no dedicated national framework for data collection and archiving for preparing GHG inventories in the country. Hence, the collection of AD for all sectors was done directly with the stakeholders supported by the project coordinator. Most missing AD were generated using the splicing techniques recommended in the IPCC 2006 Guidelines, based on existing AD and related socio-economic indicators.

### 2.2.6. Quality Assurance and Quality Control (QA / QC)

QA and QC procedures, as defined in the 2006 IPCC Guidelines (IPCC, 2007) were not implemented by Kiribati during the preparation of this inventory. QA and QC was performed by the consultants through analysis of the time series consistency, by cross verifying with national data from official reports of the statistics agency and through comparison of national data sets with those from international databases. QA was done by an independent expert of the international consultancy firm who was not involved in the compilation exercise. The QA exercise comprised the following steps:

- Confirmation of data quality and reliability used for computing emissions based on available information,
- Comparison of AD with those available from national and international websites,
- Review of the AD and EFs adopted within each source category as a first step,
- Verification of the calculation steps in the software to ensure accuracy, and
- Ensuring the report reflects the estimates and results generated by the software.

### 2.2.7. Uncertainty assessment

Uncertainty estimation is an essential element of a GHG Inventory in addition to the KCA to provide information on the source categories to be prioritized for allocation of resources to improve the quality of the inventory. Inventories prepared in accordance with the 2006 IPCC Guidelines (IPCC, 2007) will typically contain a wide range of uncertainties in the emission estimates associated with AD and EF used. Estimates may be of good quality with low uncertainties when carefully measured and demonstrably complete data sets are used or of lower quality with higher uncertainty estimates such as with $N_2O$ fluxes from soils and waterways. For this inventory, median values from the IPCC recommended range were adopted for both AD and EFs. The annual and trend uncertainties for the timeseries for the full inventory are presented in Table 2.5.

**Table 2.5: Results of the annual and trend uncertainty (%) analyses for the timeseries 2010 to 2019**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Annual** | 23.15 | 23.12 | 22.71 | 22.36 | 22.06 | 21.90 | 21.69 | 21.20 | 20.67 | 20.02 |
| **Trend (base year 2010)** | - | 29.51 | 29.92 | 30.97 | 30.72 | 32.20 | 33.70 | 35.29 | 36.92 | 34.97 |

Annual uncertainty of the inventory varied between 20.06% and 23.15% while the trend uncertainty increased from 29.51% for the year 2010 to 34.97% for the year 2019, with a dip in the year 2014.

### 2.2.8. Assessment of completeness

An assessment of completeness provides valuable information on the level of coverage of the inventory and provides for areas of work in the NIIP. An assessment was made for individual activity areas within each source category. Detailed information on the completeness is available in the national and sectoral tables from the software under each IPCC sector, provided later in this chapter. The methodology adopted was according to the 2006 IPCC Guidelines (IPCC 2007) with the following notation keys used:

| Notation key | Meaning |
|---|---|
| NA | Not Applicable |
| NO | Not Occurring |
| NE | Not Estimated |
| IE | Included Elsewhere |

### 2.2.9. Recalculations

The GHG inventories of the First and Second National Communications (NC1 & NC2 respectively) for the year 1994 and period 2004 to 2008 were compiled at Tier 1 level using the IPCC 1996 Guidelines and IPCC 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2007). Both these inventories were incomplete, the coverage being Energy, Livestock and Landfills for the NC1 and Energy and Livestock for the NC2.

The present inventory covers the period 2010 to 2019 and thus no recalculations have been performed for the previous years. An extended time series is expected to be covered in the inventory of the first Biennial Update Report and recalculations will then be considered.

### 2.2.10. Time series consistency

This inventory now covers the period 2010 to 2019 and AD within category were captured from the same sources for all years. Outliers were corrected using the recommended IPCC splicing techniques of the IPCC 2006 Guidelines. The same EFs have been used throughout the time series. This enabled a consistent time series to be built with a good level of confidence and comparability between years in the trend of the emissions.

### 2.2.11. Gaps, constraints and needs

The main challenges encountered during the compilation of the present inventory and listed below consist essentially of gaps in AD, especially at the plant level, and lack of national EFs for moving to Tier 2 level for key categories.

***Main challenges encountered during the compilation of the present inventory***

- *Information required for the inventory were obtained from various sources upon request of the MELAD-ECD because of the lack of formal arrangements (MOUs) and channels for an automatic flow and data sharing between MELAD and stakeholders.*
- *Kiribati still does not have appropriate templates for data collection to feed into the software.*
- *Most of the AD were not in the required format for feeding in the software to make the emission estimates.*
- *Reliable national biomass (bm) data are not available and had to be derived using statistical modelling or adopted from the FAO database.*
- *Inconsistencies cropped up when data came from different sources.*
- *Emissions for a substantial number of categories have not been estimated due to lack of AD, and*
- *Capacity of stakeholders for data collection and computation of emissions are severely lacking. It is recommendable that they strengthen their capacity on these items.*

### 2.2.12. National Inventory Improvement Plan (NIIP)

The most urgent improvements were identified based on the constraints, gaps and other challenges encountered during the preparation of the present inventory. Key items needing improvement and retained for action during the next inventory cycle are listed below.

- Development and implementation of a national framework for adequate and proper data capture, QC, validation, storage and retrieval to facilitate the compilation of future inventories, typically on an annual basis.
- Capacity building of stakeholders and strengthening of the existing institutional framework within a robust GHG Management Information System (GHGIMS) to provide improved coordinated action for a smooth implementation of the GHG inventory cycle.
- Invest in the collection of the required AD for categories not covered in this exercise to improve completeness of future inventories.
- Extend the coverage to include indirect GHGs, HFCs and PFCs.
- Computation of emissions of the missing years 1990 to 2009 to have the complete time series.

## 2.3. National GHG emissions

### 2.3.1. Emissions trends for the period 2010 to 2019

The Republic of Kiribati remained a net emitter throughout the timeseries 2010 to 2019. Gross national emissions increased from 94,797 t $CO_2$ e in 2010 to reach 127,283 t $CO_2$ e in 2019. Removals from the AFOLU sector decreased slightly, by 439 t $CO_2$, from 28,206 in the year 2010 to 27,767 t $CO_2$ in 2019. Net emissions were estimated at 99,516 t $CO_2$ e in the year 2019, representing an increase of 49% over the year 2010 (Table 2.6). The impact of the COVID-19 pandemic on the emissions of 2019 is clearly visible. The increase was slower because of the economic downturn.

**Table 2.6: GHG emissions (t $CO_2$ e) trends (2010 – 2019)**

| Year | Gross emissions | AFOLU removals | Net emissions | Per capita emission (t) |
|---|---|---|---|---|
| 2010 | 94,797 | -28,206 | 66,591 | 0.65 |
| 2011 | 95,643 | -28,158 | 67,485 | 0.65 |

| Year | Gross emissions | AFOLU removals | Net emissions | Per capita emission (t) |
|---|---|---|---|---|
| 2012 | 98,658 | -28,109 | 70,549 | 0.67 |
| 2013 | 102,384 | -28,058 | 74,326 | 0.69 |
| 2014 | 104,345 | -28,006 | 76,339 | 0.70 |
| 2015 | 107,834 | -27,954 | 79,880 | 0.73 |
| 2016 | 112,400 | -27,909 | 84,491 | 0.75 |
| 2017 | 119,076 | -27,862 | 91,214 | 0.80 |
| 2018 | 126,300 | -27,815 | 98,485 | 0.85 |
| 2019 | 127,283 | -27,767 | 99,516 | 0.84 |

Consequently, the per capita net emissions increased from 0.65 in the year 2010 to 0.84 t $CO_2$ e in 2019 representing an increase of 29%.

### 2.3.2. Emissions trend by IPCC sector

Total gross emissions increased by 34% over the 10-years timeseries, mainly driven by significant increases in the Energy and Waste sectors. The AFOLU sector emissions decreased gradually from 2010 to 2019 (7%). In 2019, the Energy sector was the main emitter followed by the Waste sector, while the IPPU sector remained the least emitting sector throughout the whole timeseries.

During the period 2010 to 2019, the emissions from the Energy sector increased by 37%. The sector emitted 78,783 t $CO_2$ e in 2019 which represented 62% of national emissions as depicted in Table 2.7.

AFOLU emissions decreased from 24,651 t $CO_2$ e in 2010 to reach 22,824 t $CO_2$ e in 2019 (Table 2.7). This sector was the second highest contributor in 2010 when its emissions amounted to 26% of national emissions. This share gradually decreased to 18% in 2019 when it became the third highest emitter.

The IPPU sector contributed marginally to total national emissions with its share decreasing from 0.09% in 2010 to 0.06% in 2019. Emissions from the IPPU sector fell by 14% from the year 2010 when it emitted 87 t $CO_2$ e to 75 t $CO_2$ e in 2019 (Table 2.7).

Emissions from the Waste sector increased slowly from 13% of national emissions in 2010 to 20% in 2019. Emissions from this sector increased by nearly 100% from the 2010 level of 12,747 t $CO_2$ e to 25,602 t $CO_2$ e in 2019.

**Table 2.7: National GHG emissions (t $CO_2$ e) by sector (2010 – 2019)**

| Year | Gross emissions | Energy | IPPU | AFOLU | Waste |
|---|---|---|---|---|---|
| 2010 | 94,797 | 57,312 | 87 | 24,651 | 12,747 |
| 2011 | 95,643 | 57,314 | 80 | 24,455 | 13,794 |
| 2012 | 98,658 | 59,421 | 79 | 24,255 | 14,903 |
| 2013 | 102,384 | 62,175 | 70 | 24,055 | 16,085 |
| 2014 | 104,345 | 63,085 | 60 | 23,854 | 17,346 |
| 2015 | 107,834 | 65,434 | 61 | 23,638 | 18,702 |
| 2016 | 112,400 | 68,667 | 62 | 23,436 | 20,234 |
| 2017 | 119,076 | 73,894 | 62 | 23,233 | 21,888 |
| 2018 | 126,300 | 79,529 | 71 | 23,028 | 23,672 |
| 2019 | 127,283 | 78,783 | 75 | 22,824 | 25,602 |

### 2.3.3. Trend in emissions by direct GHGs

$CO_2$ remained the main contributor to national GHG emissions, followed by $CH_4$ and $N_2O$ over the full time series. In 2019, the share of GHG emissions was as follows: 57% $CO_2$, 37% $CH_4$ and 6% $N_2O$. The trends of the $CO_2$ equivalent emissions and removals by gas is given in Table 2.8 while the annual share of each gas is depicted in Figure 2.2.

**Table 2.8: $CO_2$ equivalent emissions and removals by gas (2010 – 2019)**

| Year | Gross emissions (t $CO_2$ e) | Removals ($CO_2$) (t $CO_2$ e) | Net emissions (t $CO_2$ e) | $CO_2$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) |
|---|---|---|---|---|---|---|
| 2010 | 94,797 | -28,206 | 66,590 | 51,956 | 34,862 | 7,978 |
| 2011 | 95,643 | -28,158 | 67,485 | 51,888 | 35,766 | 7,990 |
| 2012 | 98,658 | -28,109 | 70,549 | 53,913 | 36,728 | 8,017 |
| 2013 | 102,385 | -28,058 | 74,326 | 56,454 | 37,863 | 8,067 |
| 2014 | 104,345 | -28,006 | 76,339 | 57,380 | 38,866 | 8,098 |
| 2015 | 107,834 | -27,954 | 79,880 | 59,423 | 40,236 | 8,175 |
| 2016 | 112,400 | -27,909 | 84,491 | 62,362 | 41,770 | 8,268 |
| 2017 | 119,076 | -27,862 | 91,214 | 67,284 | 43,427 | 8,365 |
| 2018 | 126,300 | -27,815 | 98,485 | 72,623 | 45,201 | 8,476 |
| 2019 | 127,283 | -27,767 | 99,516 | 72,264 | 46,514 | 8,505 |

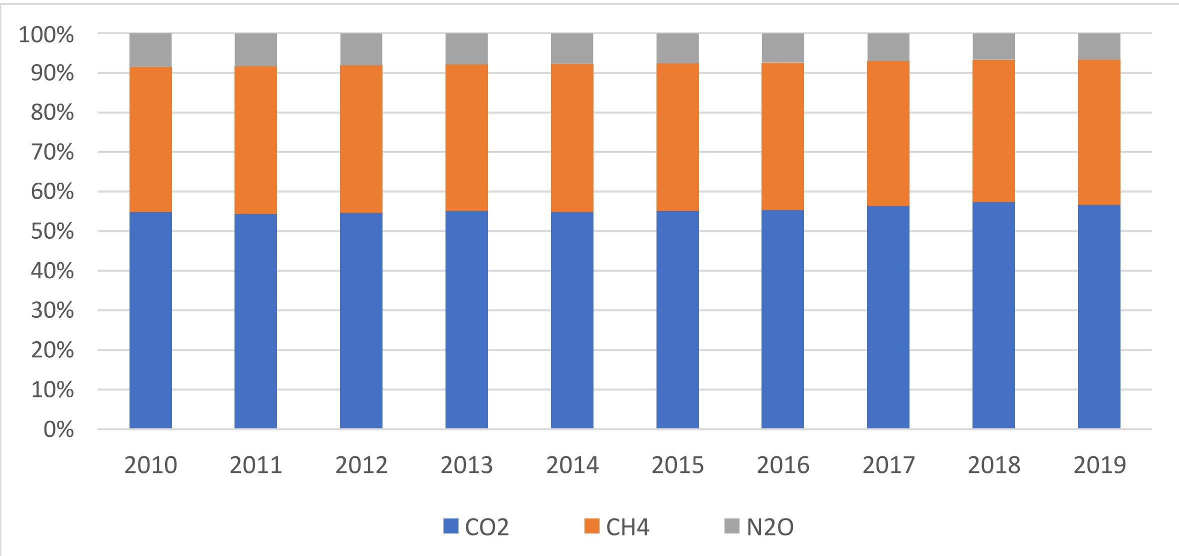



**Figure 2.2: Share (%) of aggregated emissions by gas (2010 – 2019)**

The software results for the short and long summaries are presented in Tables 2.10 and 2.11.

**Table 2.9: Short summary – Inventory year 2019**

| | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | | Emissions (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Categories | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| Total National Emissions and Removals | 44,496.871 | 1,661.212 | 32.095 | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 1 - Energy | 72,075.762 | 199.082 | 4.276 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A - Fuel Combustion Activities | 72,075.762 | 199.082 | 4.276 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.B - Fugitive emissions from fuels | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 1.C - Carbon dioxide Transport and Storage | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2 - Industrial Processes and Product Use | 74.785 | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 2.A - Mineral Industry | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B - Chemical Industry | NO | NO | NE | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.C - Metal Industry | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.D - Non-Energy Products from Fuels and Solvent Use | 74.785 | NO | NO | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 2.E - Electronics Industry | NO | NO | NO | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.F - Product Uses as Substitutes for Ozone Depleting Substances | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.G - Other Product Manufacture and Use | NO | NO | NE | NO | NE | NE | NO | NE | NA | NA | NA | NA |
| 2.H - Other | NE | NE | NO | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 3 - Agriculture, Forestry, and Other Land Use | -27,767.228 | 606.499 | 22.044 | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 3.A - Livestock | NA | 606.499 | 13.703 | NA | NA | NA | NA | NA | NA | NA | NE | NA |
| 3.B - Land | -27,740.841 | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.C - Aggregate sources and non-CO2 emissions sources on land | NO | NE | 8.341 | NA | NA | NA | NA | NA | NO | NO | NA | NA |
| 3.D - Other | -26.387 | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 4 - Waste | 113.551 | 855.631 | 5.775 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 4.A - Solid Waste Disposal | NA | 108.8507 | NO | NA | NA | NA | NA | NA | NO | NO | NE | NE |
| 4.B - Biological Treatment of Solid Waste | NA | NE | NE | NA | NA | NA | NA | NA | NO | NO | NE | NA |
| 4.C - Incineration and Open Burning of Waste | 113.551 | 14.526 | 0.164 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 4.D - Wastewater Treatment and Discharge | NA | 732.254 | 5.611 | NA | NA | NA | NA | NA | NO | NO | NE | NO |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | Emissions (t) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 4.E - Other (please specify) | NO | N0 | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 5 - Other | NO | NO | NE | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOX and NH3 | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 5.B - Other (please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| | | | | | | | | | | | | |
| Memo Items (5) | | | | | | | | | | | | |
| International Bunkers | 3,195.087 | 0.022 | 0.089 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.3.a.i - International Aviation (International Bunkers) | 3,195.087 | 0.022 | 0.089 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.3.d.i - International water-borne navigation (International bunkers) | NE | NE | NE | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.5.c - Multilateral Operations | NE | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

**Note: The original values in gigagrams in the above table from the software output have been converted to tonnes**

### Table 2.10 : Long summary – Inventory year 2019

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | Emissions (t) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| Total National Emissions and Removals | 44,496.871 | 1,661.212 | 32.095 | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 1 - Energy | 72,075.762 | 199.082 | 4.276 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A - Fuel Combustion Activities | 72,075.764 | 199.082 | 4.276 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.1 - Energy Industries | 19,066.501 | 0.772 | 0.154 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.2 - Manufacturing Industries and Construction | IE | IE | IE | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.3 - Transport | 31,142.385 | 4.625 | 1.397 | NA | NA | NA | NA | NA | NE | NE | NE | NE |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | | Emissions (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 1.A.4 - Other Sectors | 21,866.877 | 193.685 | 2.725 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.5 - Non-Specified | IE | IE | IE | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.B - Fugitive emissions from fuels | NO | NO | NO | NA | NA | NA | NA | NA | | | | |
| 1.B.1 - Solid Fuels | NO | NO | NO | NA | NA | NA | NA | NA | NA | NA | NO | NA |
| 1.B.2 - Oil and Natural Gas | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 1.B.3 - Other emissions from Energy Production | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 1.C - Carbon dioxide Transport and Storage | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1.C.1 - Transport of CO2 | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1.C.2 - Injection and Storage | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 1.C.3 - Other | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2 - Industrial Processes and Product Use | 74.785 | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 2.A - Mineral Industry | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.A.1 - Cement production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.2 - Lime production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.3 - Glass Production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.4 - Other Process Uses of Carbonates | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.A.5 - Other (please specify) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B - Chemical Industry | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.B.1 - Ammonia Production | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.2 - Nitric Acid Production | NA | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.3 - Adipic Acid Production | NA | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production | NA | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.5 - Carbide Production | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.6 - Titanium Dioxide Production | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.7 - Soda Ash Production | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.8 - Petrochemical and Carbon Black Production | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B.9 - Fluorochemical Production | NA | NA | NA | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.B.10 - Other (Please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.C - Metal Industry | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | Emissions (t) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 2.C.1 - Iron and Steel Production | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.C.2 - Ferroalloys Production | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.C.3 - Aluminium production | NO | NA | NA | NA | NO | NA | NA | NO | NO | NO | NO | NO |
| 2.C.4 - Magnesium production | NO | NA | NA | NA | NA | NO | NA | NO | NO | NO | NO | NO |
| 2.C.5 - Lead Production | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.C.6 - Zinc Production | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.C.7 - Other (please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.D - Non-Energy Products from Fuels and Solvent Use | 74.785 | NO | NO | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 2.D.1 - Lubricant Use | 74.785 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.D.2 - Paraffin Wax Use | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.D.3 - Solvent Use | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NE | NA |
| 2.D.4 - Other (please specify) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.E - Electronics Industry | NO | NO | NO | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.E.1 - Integrated Circuit or Semiconductor | NA | NA | NA | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.E.2 - TFT Flat Panel Display | NA | NA | NA | NA | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.E.3 - Photovoltaics | NA | NA | NA | NA | NO | NA | NA | NO | NA | NA | NA | NA |
| 2.E.4 - Heat Transfer Fluid | NA | NA | NA | NA | NO | NA | NA | NO | NA | NA | NA | NA |
| 2.E.5 - Other (please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.F - Product Uses as Substitutes for Ozone Depleting Substances | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.1 - Refrigeration and Air Conditioning | NA | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.F.2 - Foam Blowing Agents | NA | NA | NA | NO | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.F.3 - Fire Protection | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.4 - Aerosols | NA | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.F.5 - Solvents | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.6 - Other Applications (please specify) | NA | NA | NA | NO | NO | NA | NA | NA | NA | NA | NA | NA |
| 2.G - Other Product Manufacture and Use | NO | NO | NE | NO | NE | NE | NO | NE | NA | NA | NA | NA |
| 2.G.1 - Electrical Equipment | NA | NA | NA | NA | NE | NE | NA | NE | NA | NA | NA | NA |
| 2.G.2 - SF6 and PFCs from Other Product Uses | NA | NA | NA | NA | NE | NE | NA | NE | NA | NA | NA | NA |
| 2.G.3 - N2O from Product Uses | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | | Emissions (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 2.G.4 - Other (Please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.H - Other | NE | NE | NO | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 2.H.1 - Pulp and Paper Industry | NE | NE | NA | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 2.H.2 - Food and Beverages Industry | NE | NE | NA | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 2.H.3 - Other (please specify) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3 - Agriculture, Forestry, and Other Land Use | -27,767.228 | 606.499 | 22.044 | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 3.A - Livestock | NA | 606.499 | 13.703 | NA | NA | NA | NA | NA | NA | NA | NE | NA |
| 3.A.1 - Enteric Fermentation | NA | 40.130 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.A.2 - Manure Management | NA | 566.369 | 13.703 | NA | NA | NA | NA | NA | NA | NA | NE | NA |
| 3.B - Land | -27,740.841 | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.1 - Forest land | -27,740.841 | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.2 - Cropland | NE | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.3 - Grassland | NO | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.4 - Wetlands | NE | NA | NE | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.5 - Settlements | NE | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.B.6 - Other Land | NE | NA | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.C - Aggregate sources and non-CO2 emissions sources on land | NO | NO | 8.341 | NA | NA | NA | NA | NA | NE | NE | NA | NA |
| 3.C.1 - Emissions from biomass burning | NA | NO | NO | NA | NA | NA | NA | NA | NO | NO | NA | NA |
| 3.C.2 - Liming | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.3 - Urea application | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.4 - Direct N2O Emissions from managed soils | NA | NA | 6.920 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.5 - Indirect N2O Emissions from managed soils | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.6 - Indirect N2O Emissions from manure management | NA | NA | 1.421 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.7 - Rice cultivation | NA | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.C.8 - Other (please specify) | NA | NO | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.D - Other | -26.387 | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 3.D.1 - Harvested Wood Products | -26.387 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 3.D.2 - Other (please specify) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 4 - Waste | 113.551 | 855.631 | 5.775 | NA | NA | NA | NA | NA | NE | NE | NE | NE |

| | Emissions (t) | | | Emissions $CO_2$ Equivalents (t) | | | | | Emissions (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Categories | Net $CO_2$ (1)(2) | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (3) | Other halogenated gases without $CO_2$ equivalent conversion factors (4) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 4.A - Solid Waste Disposal | NA | 108.851 | NO | NA | NA | NA | NA | NA | NO | NO | NE | NA |
| 4.B - Biological Treatment of Solid Waste | NA | NE | NE | NA | NA | NA | NA | NA | NE | NE | NE | NA |
| 4.C - Incineration and Open Burning of Waste | 113.551 | 14.526 | 0.164 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 4.D - Wastewater Treatment and Discharge | NA | 732.254 | 5.611 | NA | NA | NA | NA | NA | NO | NO | NE | NA |
| 4.E - Other (please specify) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 5 - Other | NO | NO | NE | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOX and NH3 | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 5.B - Other (please specify) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Memo Items (5) | | | | | | | | | | | | |
| International Bunkers | 3,195.087 | 0.022 | 0.089 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.3.a.i - International Aviation (International Bunkers) | 3,195.087 | 0.022 | 0.089 | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.3.d.i - International water-borne navigation (International bunkers) | NE | NE | NE | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 1.A.5.c - Multilateral Operations | NE | NO | NO | NO | NO | NO | NO | NO | NE | NE | NE | NE |

**Note: The original values in gigagrams in the above table from the software output have been converted to tonnes**

## 2.4. Energy

### 2.4.1. Description of the sector

Fuel combustion is the process to generate heat used directly or to produce energy to drive mechanical and electrical systems. During this process the direct GHGs $CO_2$, $CH_4$ and $N_2O$, the GHG precursors CO, $NO_X$ and NMVOCs, water and $SO_2$ are released. Furthermore, the extraction of hydrocarbons, such as oil and gas, as well as coal also releases the same direct GHGs, their precursors, water and $SO_2$.

Different activity areas in the Energy sector account for these emissions. The latter are associated with energy production, processing to convert primary fuels to secondary fuels, transportation and storage, and end-product use. Fuel combustion activities are included in these end-product uses and involve both primary and secondary fuels. Upstream of these activities are the extraction, refining, transport, and storage of primary and secondary hydrocarbons. The activities responsible for emissions in Kiribati are:

- Transformation of primary energy into more usable energy forms in power plants for production of heat and electricity generation.
- Use of fuels in stationary and mobile applications, such as
    - Fuel combustion in the transport sector,
    - On-site power generation plants,
    - Industrial use for heat and electricity production to power equipment.

There is no production of fossil fuels in Kiribati. The country is a thus an importer of this commodity for domestic use. The main imported fossil fuels are diesel, motor gasoline, aviation gasoline and dual-purpose kerosene. These fossil fuels are supplemented by renewable energy in the form of fuelwood, crop residues and small amounts of solar. Diesel is utilized for public electricity generation and own-use power generation. Transport fuels include motor gasoline and diesel for road transportation and water-borne navigation and aviation gasoline and jet kerosene for aviation. Fuels consumed in the Commercial / Institutional and Residential sectors include dual purpose kerosene and LPG for cooking and lighting, gasoline, diesel, and biomass fuels (fuelwood and crop residues) for auto-generation of heat and electricity.

Two approaches are recommended for estimating emissions of the Energy sector, and both have been adopted. The Reference Approach (RA) is a Top-Down method which estimates net GHG emissions from combustion of primary and secondary fuels supplied to the economy while the Sectoral Approach (SA) is a Bottom-up method for a more accurate estimation of GHG emissions occurring in each source category from fuel combustion.

### 2.4.2. Methodology

The 2006 IPCC Guidelines for National GHG Inventories (IPCC, 2007) were used to compute emissions for fossil fuel combustion activities. The IPCC Tier 1 Reference and Sectoral approaches were adopted as per the decision tree provided in Figure 1.2 of the Guidelines (Vol. 2 Energy, Ch. 1, page 1.9).

#### 2.4.2.1. The Reference Approach (RA)

The RA, which is a component in the recommended QA / QC procedures, was used to validate the Sectoral approach for the energy sector and involved the following steps:

- Estimation of apparent consumption of fuels by type in the country for the inventory years (2010 – 2019)
- Conversion of fuel amounts to energy units (TJ)

- Computation of total carbon by multiplying apparent consumption by the respective carbon content of each fuel type
- Subtraction of stored carbon (excluded carbon) from fuel carbon
- Conversion of carbon burned to $CO_2$ emissions

The RA for estimating $CO_2$ emissions for combustion processes is expressed as follows:

where:

| | |
|---|---|
| Apparent Consumption = | production + imports - exports - international bunkers - stock change |
| Conversion Factor = | factor to convert fuel to energy units (TJ) on net calorific value basis |
| CC = | carbon content of fuel (tonne C / TJ) |
| Excluded Carbon = | carbon in feed stocks and non-energy use excluded from fuel combustion emissions (Gg C) |
| Carbon oxidation factor (COF) = | fraction of carbon oxidized. For this inventory, the factor is 1, assuming complete oxidation |
| 44 / 12 = | molecular weight ratio of CO2 to C |

### 2.4.2.2. The Sectoral Approach (SA)

The equations used for the estimation of GHGs under the Tier 1 level, assuming 100% combustion of carbon, for all categories are:

**Stationary combustion**

**Emissions GHG, fuel = Fuel Combustion fuel * Emission Factor GHG, fuel**

where:

| | |
|---|---|
| Emissions GHG, fuel = | emissions of a given GHG by type of fuel (kg GHG) |
| Fuel Combustion fuel = | amount of fuel combusted (TJ) |
| Emission Factor GHG, fuel = | emission factor of a given GHG by type of fuel (kg gas / TJ). |

**Mobile combustion**

$$\textbf{Emission} = \sum [\ \textbf{Fuel}_a * \textbf{EF}_a]$$

where:

| | |
|---|---|
| Emissions = | emission in kg |
| EFa = | emission factor kg / TJ |
| Fuela = | fuel consumed, (TJ) (as represented by fuel sold) |
| a = | fuel type (e.g., diesel, Jet Kerosene, Gasoline, Diesel etc.) |

### 2.4.3. Activity data, Emission factors and emissions estimates

#### 2.4.3.1. Reference Approach

**Activity data and emission factors**

Estimation of apparent consumption of fuels for the RA requires a supply balance of primary and secondary fuels, that is, primary and secondary fuels production, imports, exports, international bunkers, changes in stocks as well as fuels used for non-energy purposes. Only fuels recognised as being used in Kiribati have been adopted for calculating apparent consumption for the RA. Imports data from the energy balances from Kiribati Integrated Energy Roadmap (KIER) report (2017) and the Ministry of Industry and Sustainable Energy (MISE) were used for computing apparent consumption of primary and secondary fuels (Table 2.11).

**Table 2.11: Flow of liquid and solid fuels into the economy (2010 – 2019)**

| Fuel (Tons) / Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Diesel** | | | | | | | | | | |
| Imports | 10,057.2 | 10,185.9 | 11,040.9 | 10,867.4 | 11,424.4 | 11,818.3 | 10,689.4 | 13,292.4 | 12,207.0 | 12,100.8 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 10,253.6 | 10,094.3 | 10,410.1 | 10,763.7 | 10,634.2 | 10,841.9 | 11,353.2 | 11,871.6 | 12,837.3 | 12,407.6 |
| **Gasoline** | | | | | | | | | | |
| Imports | 3,771.0 | 4,731.2 | 5,145.4 | 5,340.0 | 5,021.7 | 5,238.0 | 5,361.1 | 7,284.3 | 5,656.9 | 6,136.5 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 3,980.2 | 4,065.0 | 4,351.1 | 4,666.4 | 5,178.1 | 5,448.0 | 5,779.0 | 6,633.8 | 7,149.0 | 7,286.5 |
| **Jet Kerosene** | | | | | | | | | | |
| Imports | 1,168.1 | 1,121.9 | 1,215.0 | 1,171.3 | 1,061.2 | 1,381.3 | 1,306.4 | 1,769.2 | 1,592.6 | 1,941.3 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| International Bunkers | 517.6 | 515.6 | 538.1 | 586.5 | 451.0 | 566.0 | 526.6 | 611.0 | 812.2 | 1013.3 |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 515.9 | 522.9 | 553.7 | 592.6 | 600.6 | 642.6 | 868.9 | 934.4 | 1,120.9 | 1,307.3 |
| **Other Kerosene** | | | | | | | | | | |
| Imports | 1,707.3 | 1,642.2 | 1,659.7 | 1,519.4 | 1,580.7 | 1,930.6 | 1,462.9 | 1,955.3 | 1,407.4 | 1,425.8 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 1,510.5 | 1,519.9 | 1,491.4 | 1,529.4 | 1,566.4 | 1,689.3 | 1,562.6 | 1,708.0 | 1,708.2 | 1,704.3 |
| LPG | | | | | | | | | | |
| Imports | 113.4 | 156.8 | 198.0 | 257.2 | 154.3 | 155.1 | 140.6 | 126.1 | 255.8 | 128.1 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 113.4 | 156.8 | 198.0 | 257.2 | 154.3 | 155.1 | 140.6 | 126.1 | 166.7 | 166.7 |
| **Aviation gasoline** | | | | | | | | | | |
| Imports | 26.9 | 12.0 | 12.0 | 0.0 | 0.0 | 8.2 | 7.8 | 7.4 | 0.0 | 0.0 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 8.2 | 7.8 | 7.4 | 0.0 | 0.0 |
| **Lubricants** | | | | | | | | | | |
| Imports | 106.2 | 105.7 | 180.4 | 93.6 | 156.0 | 154.6 | 163.4 | 172.1 | 114.4 | 102.9 |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 42.6 | 43.4 | 46.7 | 58.3 | 49.9 | 51.9 | 58.8 | 66.9 | 60.8 | 62.8 |
| Non-energy use | 63.6 | 62.3 | 133.7 | 35.2 | 106.1 | 102.7 | 104.6 | 105.2 | 53.6 | 40.1 |
| **Biomass** | | | | | | | | | | |
| Production | 46,535.0 | 47,156.9 | 47,751.8 | 49,385.4 | 48,869.3 | 51,249.0 | 53,628.6 | 56,008.3 | 58,387.9 | 54,770.0 |

| Fuel (Tons) / Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Imports | - | - | - | - | - | - | - | - | - | - |
| Exports | - | - | - | - | - | - | - | - | - | - |
| Stock change | - | - | - | - | - | - | - | - | - | - |
| Consumption | 46,535.0 | 47,156.9 | 47,751.8 | 49,385.4 | 48,869.3 | 51,249.0 | 53,628.6 | 56,008.3 | 58,387.9 | 54,770.0 |

Except for biomass, AD was available from MISE for the years 2010 to 2019. The data were analysed for outliers and gaps were filled using the splicing techniques recommended in the IPCC 2006 Guidelines.

#### Emissions estimates

Emissions based on apparent consumption for the RA approach are provided in Table 2.24 where they are compared with those of the SA.

### 2.4.3.2. Sectoral Approach

#### Activity data and emission factors

The AD for the energy sector inventory includes data on energy consumption. During the inventory, special attention was paid to data used, from both national and international sources, data preparation for use in the software and documentation. Priority was given to using data sourced directly or estimated from available national sources for the timeseries. Existing gaps were filled either by sourcing for additional data from other official sources or generated by the appropriate splicing techniques recommended in the 2006 IPCC Guidelines. For this inventory, fuel consumption data for all categories and sub-categories were sourced from the energy balances from the KIER report (2017) and from consumption data obtained from MISE.

***Energy Industries (1.A.1)***

***Electricity Generation (1.A.1.a.i)***

Emissions in the energy industries category result from fuel combustion in the following:

- Public electricity generation plants,
- Fuel consumption in other energy industries

Emissions from public electricity generating stations in the country result from the combustion of gasoil / diesel in electrical power plants. The AD for activities in this category is provided in Table 2.12.

***Transport (1.A.3)***

In Kiribati, the transport category comprises civil aviation (domestic and international), road transportation and water-borne navigation (domestic). There are no formal national statistics on the fuel consumption pattern for international navigation sub-category. The AD used in the computation of emissions for the transport sector by subcategory and fuel type are provided in Table 2.12.

***Other Sectors (1.A.4) – Commercial / Institutional, Residential and Agriculture / Forestry / Fisheries***

Data for fuel consumption in the Commercial, Residential and Agriculture / Forestry / Fisheries sectors, are presented in Table 2.12. Data gaps were filled by using extrapolation methods. In the commercial sector, diesel is consumed for auto-generation of electricity while, in the residential sector, kerosene, LPG and biomass are used for cooking and lighting and gasoline used for auto-generation of electricity.

In the Agriculture / Forestry / Fisheries sectors, ULP (gasoline) is utilized for mobile combustion for the fishing sub-category.

**Table 2.12: Activity data (Ton) used for Sectoral Approach of Energy Sector (2010 – 2019)**

| Categories | Fuel | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy generation | Diesel | 5408.8 | 5293.6 | 5503.6 | 5713.7 | 5483.0 | 5233.4 | 5585.3 | 5791.4 | 6455.8 | 5983.9 |
| International aviation | Jet kerosene | 517.6 | 515.6 | 538.1 | 586.5 | 451.0 | 566.0 | 526.6 | 611.0 | 812.2 | 1013.3 |
| Domestic aviation | Jet kerosene | 515.9 | 522.9 | 553.7 | 592.6 | 600.6 | 642.6 | 868.9 | 934.4 | 1120.9 | 1307.3 |
| | Aviation gasoline | 12.0 | 12.0 | 12.0 | 12.0 | 12.0 | 8.2 | 7.8 | 7.4 | 0.0 | 0.0 |
| Road transportation | Gasoline | 643.8 | 622.7 | 690.6 | 846.2 | 1172.2 | 1498.3 | 1729.7 | 1966.5 | 2155.8 | 2326.0 |
| | Diesel | 3701.7 | 3630.7 | 3762.1 | 3893.5 | 4024.9 | 4463.3 | 4721.1 | 4756.0 | 4916.3 | 5094.2 |
| | Lubricant | 7.1 | 6.9 | 7.6 | 9.3 | 7.9 | 16.5 | 19.1 | 21.7 | 15.6 | 16.4 |
| Domestic waterborne navigation | Gasoline | 64.4 | 62.0 | 59.7 | 65.2 | 68.6 | 68.8 | 83.7 | 88.5 | 82.0 | 84.7 |
| | Diesel | 928.8 | 955.7 | 939.5 | 939.5 | 923.3 | 929.7 | 819.2 | 996.8 | 1218.6 | 1047.2 |
| | Lubricant | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 0.9 | 0.9 |
| Commercial | Diesel | 214.3 | 214.3 | 204.8 | 217.0 | 203.0 | 215.4 | 227.5 | 327.4 | 246.6 | 282.3 |
| | Other kerosene | 550.0 | 550.8 | 536.0 | 548.5 | 551.9 | 571.5 | 551.3 | 573.3 | 438.8 | 493.5 |
| Residential | Gasoline | 111.2 | 117.0 | 101.7 | 129.4 | 185.3 | 241.2 | 438.2 | 552.6 | 521.4 | 666.6 |
| | Other kerosene | 960.4 | 969.1 | 955.4 | 980.9 | 1014.5 | 1117.8 | 1011.4 | 1134.7 | 1269.4 | 1210.8 |
| | LPG | 113.4 | 156.8 | 198.0 | 257.2 | 154.3 | 155.1 | 140.6 | 126.1 | 6.3 | 74.4 |
| | Other solid primary biomass | 46535.0 | 47156.9 | 47751.8 | 49385.4 | 48869.3 | 51249.0 | 53628.6 | 56008.3 | 58387.9 | 54770.0 |
| Fishing | Gasoline | 3160.7 | 3263.2 | 3499.1 | 3625.5 | 3752.0 | 3639.8 | 3527.5 | 4026.3 | 4389.8 | 4209.2 |
| | Lubricant | 34.8 | 35.9 | 38.5 | 48.3 | 41.3 | 34.6 | 38.8 | 44.3 | 44.3 | 45.5 |

Default EFs for Tier 1 level from the 2006 IPCC Guidelines were used in the estimation of GHGs for the energy sector for the direct gases $CO_2$, $CH_4$ and $N_2O$ and are given in Table 2.13.

**Table 2.13: List of emission factors (kg/TJ) used in the Energy sector by fuel type and category**

| Fuel | Category | Emission factor | | | Source of information | | |
|---|---|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ | $CH_4$ | $N_2O$ |
| Diesel | Electricity generation | 74100 | 3 | 0.6 | Vol. 2, table 2.2 | Vol. 2, table 2.2 | Vol. 2, table 2.2 |
| | Road transportation | 74100 | 3.9 | 3.9 | Vol. 2, table 3.2.1 | Vol. 2, table 3.2.2 | Vol. 2, table 3.2.2 |
| | Domestic waterborne navigation | 74100 | 7 | 2 | Vol. 2, table 3.5.2 | Vol. 2, table 3.5.3 | Vol. 2, table 3.5.3 |
| | Commercial | 74100 | 10 | 0.6 | Vol. 2, table 2.4 | Vol. 2, table 2.4 | Vol. 2, table 2.4 |
| Gasoline | Road transportation | 69300 | 33 | 3.2 | Vol. 2, table 3.2.1 | Vol. 2, table 3.2.2 | Vol. 2, table 3.2.2 |
| | Domestic waterborne navigation | 69300 | 7 | 2 | Vol. 2, table 3.5.2 | Vol. 2, table 3.5.3 | Vol. 2, table 3.5.3 |
| | Residential | 69300 | 10 | 0.6 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |
| | Fishing | 69300 | 10 | 0.6 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |
| Kerosene | International aviation | 71500 | 0.5 | 2 | Vol. 2, table 3.6.4 | Vol. 2, table 3.6.5 | Vol. 2, table 3.6.5 |
| | Civil aviation | 71500 | 0.5 | 2 | Vol. 2, table 3.6.4 | Vol. 2, table 3.6.5 | Vol. 2, table 3.6.5 |
| | Commercial | 71900 | 10 | 0.6 | Vol. 2, table 2.4 | Vol. 2, table 2.4 | Vol. 2, table 2.4 |
| | Residential | 71900 | 10 | 0.6 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |

| Fuel | Category | Emission factor | | | Source of information | | |
|---|---|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ | $CH_4$ | $N_2O$ |
| Aviation gasoline | Civil aviation | 70000 | 0.5 | 2 | Vol. 2, table 3.6.4 | Vol. 2, table 3.6.5 | Vol. 2, table 3.6.5 |
| LPG | Residential | 63100 | 5 | 0.1 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |
| Lubricants | Road transportation | 73300 | n.a | n.a | Vol. 2, table 2.3 | n.a | n.a |
| | Domestic waterborne navigation | 73300 | n.a | n.a | Vol. 2, table 3.5.2 | n.a | n.a |
| | Fishing | 73300 | 10 | 0.6 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |
| Other primary solid biomass | Residential | 100000 | 300 | 400 | Vol. 2, table 2.5 | Vol. 2, table 2.5 | Vol. 2, table 2.5 |

**Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2**

## Emissions estimates by category

Total aggregated emissions from the Energy sector reached 78,783 t $CO_2$ e in the year 2019 compared to 57,312 t $CO_2$ e in 2010, representing an increase of 37% (Figure 2.3 and Table 2.14). Fuel Combustion Activities was the only activity contributing to emissions in the Energy sector.

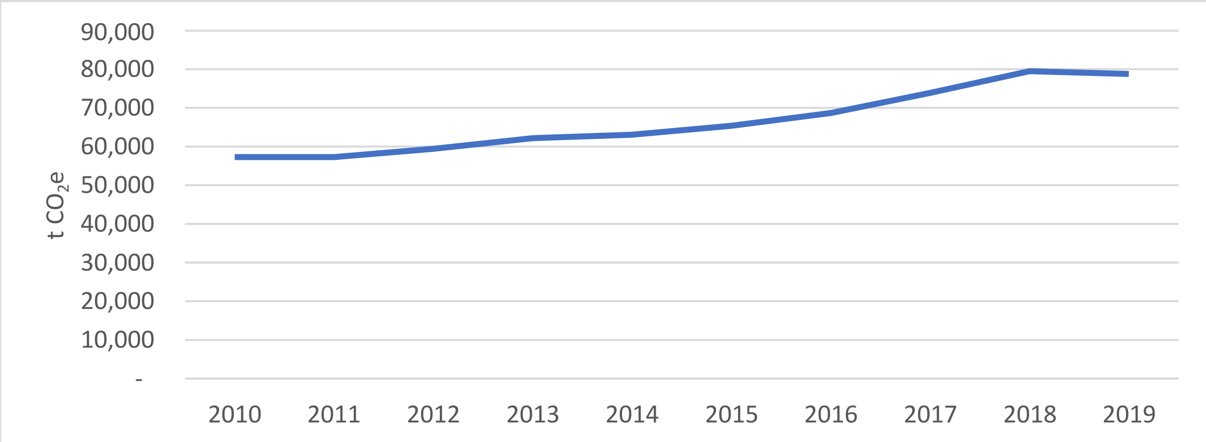



**Figure 2.3: Aggregated GHG emissions (t $CO_2$ e) of the Energy sector (2010 – 2019)**

The Transport category was the highest contributor in total emissions out of the three emitting categories with an average of 36% over the whole timeseries. In 2019, it emitted 31,642 t $CO_2$ e followed by the Other Sectors category with 28,012 t $CO_2$ e and Energy industries with 19,129 t $CO_2$ e. The emissions estimates are provided in Table 2.14.

**Table 2.14: Aggregated emissions (t $CO_2$ e) by category in the Energy sector (2010 – 2019)**

| Year | Total Energy sector | Energy Industries (1.A.1) | Transport (1.A.3) | Other sectors (1.A.4) |
|---|---|---|---|---|
| 2010 | 57,312 | 17,291 | 18,891 | 21,130 |
| 2011 | 57,314 | 16,922 | 18,696 | 21,696 |
| 2012 | 59,421 | 17,594 | 19,375 | 22,452 |
| 2013 | 62,175 | 18,265 | 20,436 | 23,473 |
| 2014 | 63,085 | 17,528 | 21,834 | 23,724 |
| 2015 | 65,434 | 16,730 | 24,481 | 24,223 |
| 2016 | 68,667 | 17,855 | 26,460 | 24,352 |
| 2017 | 73,894 | 18,514 | 28,120 | 27,261 |

| Year | Total Energy sector | Energy Industries (1.A.1) | Transport (1.A.3) | Other sectors (1.A.4) |
|---|---|---|---|---|
| 2018 | 79,529 | 20,638 | 30,479 | 28,412 |
| 2019 | 78,783 | 19,129 | 31,642 | 28,012 |

## Emissions by gas

Table 2.15 provides the emissions for the direct gases for the period 2010 to 2019. $CO_2$ was the main gas in t $CO_2$ e for all years of the time series. In 2019, $CO_2$, with 72,076 t, represented 92% of total emissions followed by $CH_4$ with 7% for a contribution of 5,574 t $CO_2$ e and $N_2O$ at 1% with 1,133 t $CO_2$ e. These emissions exclude $CO_2$ from Biomass burning for energy production which is accounted for as fuelwood removals in the AFOLU sector and reported under Memo Items for informative purposes.

Except for slight dips in emissions from 2010 to 2011, and 2018 to 2019, there was a steady increase in $CO_2$ emissions from 51,775 t in the year 2010 to 72,076 t in 2019 (Table 2.15). This increase from the year 2010 to 2019 amounted to 39 %.

An increasing pattern is observed for $CH_4$ emissions which evolved from 166.7 t in 2010 to 211.5 in 2018 to decrease to 199.1 t in 2019 (Table 2.15) representing a 19% overall increase in emissions.

$N_2O$ emissions also increased by 31%, from 868 t $CO_2$ e in 2010 to 1,133 t $CO_2$ e in 2019 (Table 2.15).

**Table 2.15: Absolute (t) and $CO_2$ equivalent (t $CO_2$ e) emissions by gas for the Energy sector (2010 – 2019)**

| Year | $CO_2$ | $CH_4$ | | $N_2O$ | | Total |
|---|---|---|---|---|---|---|
| | (t) | (t) | (t $CO_2$ e) | (t) | (t $CO_2$ e) | (t $CO_2$ e) |
| 2010 | 51,775 | 166.7 | 4,669 | 3.3 | 868 | 57,312 |
| 2011 | 51,711 | 168.9 | 4,730 | 3.3 | 873 | 57,314 |
| 2012 | 53,736 | 171.2 | 4,794 | 3.4 | 891 | 59,421 |
| 2013 | 56,284 | 177.3 | 4,964 | 3.5 | 927 | 62,175 |
| 2014 | 57,218 | 176.0 | 4,929 | 3.5 | 938 | 63,085 |
| 2015 | 59,258 | 184.9 | 5,176 | 3.8 | 999 | 65,434 |
| 2016 | 62,194 | 193.5 | 5,419 | 4.0 | 1,054 | 68,667 |
| 2017 | 67,114 | 202.6 | 5,673 | 4.2 | 1,107 | 73,894 |
| 2018 | 72,441 | 211.5 | 5,922 | 4.4 | 1,166 | 79,529 |
| 2019 | 72,076 | 199.1 | 5,574 | 4.3 | 1,133 | 78,783 |

## Emissions by gas by sub-category

### *Electricity generation*

The estimates of emissions from electricity generation are given in Table 2.16. Emissions followed a varying trend with peaks and troughs which is characteristic of energy use in the country. There is an 11% increase from the year 2010 to 2019 when aggregated emissions from this sub-category reached 19,129 t $CO_2$ e.

$CO_2$ remained the main GHG emitted for the Energy Industries category with 99.7% with the other two direct gases responsible for the remaining 0.3% of total aggregated emissions. In absolute terms, $CO_2$ emissions reached 19,067 t while $CH_4$ accounted for 0.772 t and $N_2O$ for 0.154 t only in 2019.

Table 2.16: Absolute (t) and aggregated emissions (t $CO_2$ e) from Electricity Generation (2010 – 2019)

| Year | Absolute (t) | | | Aggregated (t $CO_2$ e) | | |
|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | $CH_4$ | $N_2O$ | Total |
| 2010 | 17,234 | 0.698 | 0.140 | 20 | 37 | 17,291 |
| 2011 | 16,867 | 0.683 | 0.137 | 19 | 36 | 16,922 |
| 2012 | 17,536 | 0.710 | 0.142 | 20 | 38 | 17,594 |
| 2013 | 18,206 | 0.737 | 0.147 | 21 | 39 | 18,265 |
| 2014 | 17,470 | 0.707 | 0.141 | 20 | 37 | 17,528 |
| 2015 | 16,675 | 0.675 | 0.135 | 19 | 36 | 16,730 |
| 2016 | 17,796 | 0.721 | 0.144 | 20 | 38 | 17,855 |
| 2017 | 18,453 | 0.747 | 0.149 | 21 | 40 | 18,514 |
| 2018 | 20,570 | 0.833 | 0.167 | 23 | 44 | 20,638 |
| 2019 | 19,067 | 0.772 | 0.154 | 22 | 41 | 19,129 |

***Transport (1.A.3)***

The aggregated emissions for the sub-categories of the Transport category for the period 2010 to 2019 are provided in Table 2.17. Emissions in the transport sub-categories varied between years over the time series due to variations in the intensity of activities. Emissions from the Transport category increased by 67% from 2010 to 2019. Civil Aviation emissions increased by 148%, followed by Road Transportation and Water-borne Navigation with an increase of 70% and 14% respectively.

Table 2.17: Aggregated emissions (t $CO_2$ e) of direct GHGs from the Transport sub-sector (2010 – 2019)

| Year | 1.A.3 Transport | 1.A.3.a Civil Aviation | 1.A.3.b Road Transport | 1.A.3.d Navigation |
|---|---|---|---|---|
| 2010 | 18,891 | 1,677 | 14,024 | 3,190 |
| 2011 | 18,696 | 1,699 | 13,728 | 3,270 |
| 2012 | 19,375 | 1,797 | 14,369 | 3,210 |
| 2013 | 20,436 | 1,920 | 15,289 | 3,227 |
| 2014 | 21,834 | 1,912 | 16,736 | 3,185 |
| 2015 | 24,481 | 2,067 | 19,207 | 3,207 |
| 2016 | 26,460 | 2,785 | 20,777 | 2,898 |
| 2017 | 28,120 | 2,992 | 21,643 | 3,485 |
| 2018 | 30,479 | 3,561 | 22,740 | 4,178 |
| 2019 | 31,642 | 4,153 | 23,854 | 3,635 |

Table 2.18 provides absolute and aggregated emissions of the direct gases by category within the transport sub-sector for the year 2019. In absolute terms the transport sub-sector emitted 31,142 t of $CO_2$, 4.625 t of $CH_4$ and 1.397 t of $N_2O$.

When considering their respective GWPs, $CO_2$ with 31,142 t $CO_2$ e made up for 98% of the total emissions of the direct GHGs. $CH_4$ and $N_2O$ represented 2% with emissions of 129.5 and 370.2 t $CO_2$ e respectively. Road transportation contributed the major share of emissions in this sub-sector with 23,854 t $CO_2$ e (75.4%), followed by Domestic Aviation with 4,153 t $CO_2$ e (13.1%) and Water-borne Navigation with 3,635 t $CO_2$ e (11.5%).

Table 2.18: Absolute and $CO_2$ equivalent emissions (t $CO_2$ e) for the Transport categories for 2019

| Category | $CO_2$ (t) | $CH_4$ (t) | $N_2O$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) | Total (t $CO_2$ e) |
|---|---|---|---|---|---|---|
| 1.A.3 Transport | 31,142 | 4.625 | 1.397 | 129.5 | 370.2 | 31,642 |
| 1.A.3.a - Civil Aviation | 4,122 | 0.029 | 0.115 | 0.8 | 30.6 | 4,153 |
| 1.A.3.a.ii - Domestic Aviation | 4,122 | 0.029 | 0.115 | 0.8 | 30.6 | 4,153 |
| 1.A.3.b - Road Transportation | 23,421 | 4.255 | 1.184 | 119.1 | 313.8 | 23,854 |
| 1.A.3.d - Water-borne Navigation | 3,600 | 0.341 | 0.098 | 9.6 | 25.9 | 3,635 |
| 1.A.3.d.ii - Domestic Water-borne Navigation | 3,600 | 0.341 | 0.098 | 9.6 | 25.9 | 3,635 |

### *Other Sectors (1.A.4)*

Aggregated emissions for the Other Sectors sub-categories are provided in Table 2.19. An increase in emissions from the year 2010 to 2019 is observed for all sub-categories but not uniformly over the years of the time series. As such, emissions witnessed an increase or a decrease from one year to the next because of varying intensity in activity. Total aggregated emissions for Other Sectors increased by 33% from 21,130 t $CO_2$ e in 2010 to 28,012 t $CO_2$ e in 2019. In 2019, the highest contribution came from activities in the Agriculture / Forestry / Fishing sector with 47% of emissions. The Residential sub-category activities contributed 44% and Commercial / Institutional activities the remaining 9%. Increases in the sub-categories were 33% for Agriculture / Forestry / Fishing, 40% for Residential and 2% for Commercial / Institutional over the timeseries. The sub-category, Fishing (mobile combustion) was the only emitting activity of the Agriculture / Forestry / Fishing sub-category.

Table 2.19: GHG emissions (t $CO_2$ e) for direct gases in Other Sectors (2010 – 2019)

| Year | 1.A.4 – Other Sectors | 1.A.4.a – Commercial / Institutional | 1.A.4.b – Residential | 1.A.4.c – Agriculture / Forestry / Fishing / Fish Farms | 1.A.4.c.iii – Fishing (mobile combustion) |
|---|---|---|---|---|---|
| 2010 | 21,130 | 2,430 | 8,833 | 9,867 | 9,867 |
| 2011 | 21,696 | 2,432 | 9,076 | 10,187 | 10,187 |
| 2012 | 22,452 | 2,355 | 9,174 | 10,924 | 10,924 |
| 2013 | 23,473 | 2,434 | 9,697 | 11,343 | 11,343 |
| 2014 | 23,724 | 2,400 | 9,611 | 11,713 | 11,713 |
| 2015 | 24,223 | 2,501 | 10,375 | 11,347 | 11,347 |
| 2016 | 24,352 | 2,476 | 10,864 | 11,012 | 11,012 |
| 2017 | 27,261 | 2,866 | 11,826 | 12,569 | 12,569 |
| 2018 | 28,412 | 2,181 | 12,539 | 13,693 | 13,693 |
| 2019 | 28,012 | 2,468 | 12,405 | 13,139 | 13,139 |

The aggregated and absolute emissions by gas is given in Table 2.20. In 2019, $CO_2$ contributed most emissions from this activity area, with 21,867 t (78%), $CH_4$ coming next with 5,423 t $CO_2$ e (19%) and $N_2O$ with 722 t $CO_2$ e (3%). In absolute terms also, the highest contribution came from $CO_2$ with 21,867 t. Agriculture/Forestry/Fishing/Fish Farms contributed 60% of $CO_2$ while the Residential activities emitted 99% of the $CH_4$ and 95% of the $N_2O$ in this category.

Table 2.20: Absolute (t), aggregated and $CO_2$ e emissions (t $CO_2$ e) for direct gases – Other Sectors (2019)

| Category | $CO_2$ (t) | $CH_4$ (t) | $N_2O$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) | Total (t $CO_2$ e) |
|---|---|---|---|---|---|---|
| 1.A.4 - Other Sectors | 21,867 | 193.69 | 2.72 | 5,423.2 | 722.1 | 28,012 |

| Category | $CO_2$ (t) | $CH_4$ (t) | $N_2O$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) | Total (t $CO_2$ e) |
|---|---|---|---|---|---|---|
| 1.A.4.a - Commercial / Institutional | 2,454 | 0.34 | 0.02 | 9.5 | 5.4 | 2,468 |
| 1.A.4.b - Residential | 6,357 | 191.46 | 2.59 | 5,361.0 | 686.8 | 12,405 |
| 1.A.4.c - Agriculture / Forestry / Fishing / Fish Farms | 13,056 | 1.88 | 0.11 | 52.7 | 29.9 | 13,139 |
| 1.A.4.c.iii - Fishing (mobile combustion) | 13,056 | 1.88 | 0.11 | 52.7 | 29.9 | 13,139 |

### *Memo items*

Emissions from fuels used for international aviation and international marine bunkers (IMB) are excluded from the national total and reported as memo items for information purposes. For this inventory, AD for international Aviation was available and emissions have been estimated and reported. Aggregated emissions from International Aviation increased by 96% from 1,644 t $CO_2$ e in 2010 to 3,219 t $CO_2$ e in 2019 (Table 2.21) with variation between the years.

To avoid double counting, $CO_2$ emissions from biomass combustion for energy production are also reported under Memo Items and not included in the Energy sector emissions. Only $CH_4$ and $N_2O$ emissions resulting from combustion of the biomass is reported under Energy. This activity emitted 53,981 t $CO_2$ in 2010, increasing to 63,533 t $CO_2$ in 2019 which represents an increase of 18%.

**Table 2.21: Total emissions (t $CO_2$ e) and emissions by activity area for international bunkering and burning of biomass (2010 – 2019)**

| Year | Total emissions | International aviation | $CO_2$ from biomass burning for energy production |
|---|---|---|---|
| 2010 | 55,625 | 1,644 | 53,981 |
| 2011 | 56,340 | 1,638 | 54,702 |
| 2012 | 57,102 | 1,710 | 55,392 |
| 2013 | 59,150 | 1,863 | 57,287 |
| 2014 | 58,121 | 1,433 | 56,688 |
| 2015 | 61,247 | 1,798 | 59,449 |
| 2016 | 63,882 | 1,673 | 62,209 |
| 2017 | 66,911 | 1,941 | 64,970 |
| 2018 | 70,310 | 2,580 | 67,730 |
| 2019 | 66,753 | 3,219 | 63,533 |

The absolute and aggregated direct GHGs emitted in 2019 are presented in Table 2.22. Total aggregated emissions were 3,219 t $CO_2$ e with $CO_2$ contributing 99.2%, $CH_4$, 0.1% and $N_2O$, 0.7% in the year 2019.

**Table 2.22: Absolute (t) and $CO_2$ equivalent (t $CO_2$ e) emissions from International Aviation Bunkers in 2019**

| Category | $CO_2$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) | Total (t $CO_2$ e) | $CH_4$ (t) | $N_2O$ (t) |
|---|---|---|---|---|---|---|
| International Bunkers – 1.A.3.a.i - Aviation | 3,195 | 0.6 | 23.7 | 3,219 | 0.022 | 0.089 |

### *Comparison of the IPCC Tier 1 Reference and Sectoral Approaches*

It is good practice to compare emissions from these two approaches as significant differences may indicate possible inconsistencies with AD, large statistical differences between energy supply and energy consumption, significant mass imbalances and the approximate net calorific value and carbon content values adopted, unrecorded consumption of fuels, high distribution losses and missing information on stock changes. A relatively small gap (5% or less) is typically expected between the two approaches.

Table 2.23 provides a comparison of the data adopted for computing emissions by the reference and sectoral approaches. When the mass of all fuels is considered, there is an annual variation in total energy consumption between the RA and SA approaches which ranged from -11.6% to 12.0%. This indicates that the data collection system needs to be improved for reducing the large differences observed in some years. These differences are reflected in the emissions also which varied between -11.5% to 11.9% for the timeseries.

**Table 2.23: Fuel consumption and emissions under the Reference and Sectoral Approaches (2010 – 2019)**

| Year | Reference Approach (RA) | Sectoral Approach (SA) | RA/SA difference | Reference Approach (RA) | Sectoral Approach (SA) | RA/SA difference |
|---|---|---|---|---|---|---|
| | (TJ) | | (%) | Emissions (t) | | (%) |
| 2010 | 687.8 | 713.7 | -3.6% | 49,870 | 51,770 | -3.7% |
| 2011 | 756.4 | 713.5 | 6.0% | 54,690 | 51,710 | 5.8% |
| 2012 | 817.5 | 741.9 | 10.2% | 59,090 | 53,740 | 10.0% |
| 2013 | 811.2 | 777.7 | 4.3% | 58,570 | 56,280 | 4.1% |
| 2014 | 819.6 | 791.1 | 3.6% | 59,310 | 57,210 | 3.7% |
| 2015 | 871.1 | 819.7 | 6.3% | 63,020 | 59,260 | 6.3% |
| 2016 | 805.4 | 860.3 | -6.4% | 58,190 | 62,190 | -6.4% |
| 2017 | 1040.6 | 929.4 | 12.0% | 75,110 | 67,110 | 11.9% |
| 2018 | 886.5 | 1003.3 | -11.6% | 64,090 | 72,442 | -11.5% |
| 2019 | 904.6 | 999.0 | -9.5% | 65,370 | 72,070 | -9.3% |

Emissions estimates for the Energy sector from the IPCC inventory software for the inventory year 2019 are presented in Table 2.24.

**Table 2.24: Energy Sectoral Table - Inventory Year 2019**

| | Emissions (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| Categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 1 - Energy | 72,075.762 | 199.082 | 4.276 | NE | NE | NE | NE |
| 1.A - Fuel Combustion Activities | 72,075.762 | 199.082 | 4.276 | NE | NE | NE | NE |
| 1.A.1 - Energy Industries | 19,066.501 | 0.772 | 0.154 | NE | NE | NE | NE |
| 1.A.1.a - Main Activity Electricity and Heat Production | 19,066.501 | 0.772 | 0.154 | NE | NE | NE | NE |
| 1.A.1.a.i - Electricity Generation | 19,066.501 | 0.772 | 0.154 | NE | NE | NE | NE |
| 1.A.1.a.ii - Combined Heat and Power Generation (CHP) | NO | NO | NO | NO | NO | NO | NO |
| 1.A.1.a.iii - Heat Plants | NO | NO | NO | NO | NO | NO | NO |
| 1.A.1.b - Petroleum Refining | NO | NO | NO | NO | NO | NO | NO |
| 1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries | NO | NO | NO | NO | NO | NO | NO |
| 1.A.1.c.i - Manufacture of Solid Fuels | NO | NO | NO | NO | NO | NO | NO |
| 1.A.1.c.ii - Other Energy Industries | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2 - Manufacturing Industries and Construction | IE | IE | IE | NE | NE | NE | NE |
| 1.A.2.a - Iron and Steel | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.b - Non-Ferrous Metals | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.c - Chemicals | NO | NO | NO | NO | NO | NO | NO |

| | Emissions (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| Categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 1.A.2.d - Pulp, Paper and Print | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.e - Food Processing, Beverages and Tobacco | IE | IE | IE | NE | NE | NE | NE |
| 1.A.2.f - Non-Metallic Minerals | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.g - Transport Equipment | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.h - Machinery | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.i - Mining (excluding fuels) and Quarrying | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.j - Wood and wood products | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.k - Construction | IE | IE | IE | NE | NE | NE | NE |
| 1.A.2.l - Textile and Leather | NO | NO | NO | NO | NO | NO | NO |
| 1.A.2.m - Non-specified Industry | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3 - Transport | 31,142.385 | 4.625 | 1.397 | NE | NE | NE | NE |
| 1.A.3.a - Civil Aviation | 4,122.113 | 0.029 | 0.115 | NE | NE | NE | NE |
| 1.A.3.a.i - International Aviation (International Bunkers) (1) | | | | | | | |
| 1.A.3.a.ii - Domestic Aviation | 4,122.113 | 0.029 | 0.115 | NE | NE | NE | NE |
| 1.A.3.b - Road Transportation | 23,420.771 | 4.255 | 1.184 | NE | NE | NE | NE |
| 1.A.3.b.i - Cars | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.i.1 - Passenger cars with 3-way catalysts | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.i.2 - Passenger cars without 3-way catalysts | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.ii - Light-duty trucks | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.iii - Heavy-duty trucks and buses | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.iv - Motorcycles | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.v - Evaporative emissions from vehicles | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.b.vi - Urea-based catalysts | IE | IE | IE | NE | NE | NE | NE |
| 1.A.3.c - Railways | NO | NO | NO | NO | NO | NO | NO |
| 1.A.3.d - Water-borne Navigation | 3,599.500 | 0.341 | 0.098 | NE | NE | NE | NE |
| 1.A.3.d.i - International water-borne navigation (International bunkers) (1) | | | | | | | |
| 1.A.3.d.ii - Domestic Water-borne Navigation | 3,599.500 | 0.341 | 0.098 | NE | NE | NE | NE |
| 1.A.3.e - Other Transportation | NO | NO | NO | NO | NO | NO | NO |
| 1.A.3.e.i - Pipeline Transport | NO | NO | NO | NO | NO | NO | NO |
| 1.A.3.e.ii - Off-road | NO | NO | NO | NO | NO | NO | NO |
| 1.A.4 - Other Sectors | 21,866.877 | 193.685 | 2.725 | NE | NE | NE | NE |
| 1.A.4.a - Commercial/Institutional | 2,453.633 | 0.338 | 0.020 | NE | NE | NE | NE |
| 1.A.4.b - Residential | 6,357.069 | 191.465 | 2.592 | NE | NE | NE | NE |
| 1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms | 13,056.176 | 1.883 | 0.113 | NE | NE | NE | NE |
| 1.A.4.c.i - Stationary | NE | NE | NE | NE | NE | NE | NE |
| 1.A.4.c.ii - Off-road Vehicles and Other Machinery | NE | NE | NE | NE | NE | NE | NE |
| 1.A.4.c.iii - Fishing (mobile combustion) | 13,056.176 | 1.883 | 0.113 | NE | NE | NE | NE |
| 1.A.5 - Non-Specified | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.a - Stationary | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.b - Mobile | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.b.i - Mobile (aviation component) | IE | IE | IE | NE | NE | NE | NE |

| | Emissions (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| Categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 1.A.5.b.ii - Mobile (water-borne component) | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.b.iii - Mobile (Other) | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.c - Multilateral Operations (1)(2) | | | | | | | |
| 1.B - Fugitive emissions from fuels | NO | NO | NO | NO | NO | NO | NO |
| 1.B.1 - Solid Fuels | NO | NO | NA | NA | NA | NO | NA |
| 1.B.1.a - Coal mining and handling | NO | NO | NA | NA | NA | NO | NA |
| 1.B.1.a.i - Underground mines | NO | NO | NA | NA | NA | NO | NA |
| 1.B.1.a.i.1 - Mining | NO | NO | NA | NA | NA | NO | NA |
| 1.B.1.a.i.2 - Post-mining seam gas emissions | NO | NO | NA | NA | NA | NO | NA |
| 1.B.1.a.i.3 - Abandoned underground mines | NO | NO | NA | NA | NA | NA | NA |
| 1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO2 | NO | NO | NA | NA | NA | NA | NA |
| 1.B.1.a.ii - Surface mines | NO | NO | NA | NA | NA | NA | NA |
| 1.B.1.a.ii.1 - Mining | NO | NO | NA | NA | NA | NA | NA |
| 1.B.1.a.ii.2 - Post-mining seam gas emissions | NO | NO | NA | NA | NA | NA | NA |
| 1.B.1.b - Uncontrolled combustion and burning coal dumps | NO | NA | NA | NO | NO | NO | NO |
| 1.B.1.c - Solid fuel transformation | NO | NO | NO | NE | NE | NE | NE |
| 1.B.2 - Oil and Natural Gas | NO | NO | NO | NO | NO | NO | NO |
| 1.B.2.a - Oil | NO | NO | NO | NO | NO | NO | NO |
| 1.B.2.b - Natural Gas | NO | NO | NO | NO | NO | NO | NO |
| 1.B.3 - Other emissions from Energy Production | NO | NO | NO | NO | NO | NO | NO |
| 1.C - Carbon dioxide Transport and Storage | NO | NA | NA | NA | NA | NA | NA |

| | Emissions (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| Categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | SO2 |
| Memo Items (3) | | | | | | | |
| International Bunkers | 3,195.087 | 0.022 | 0.089 | NE | NE | NE | NE |
| 1.A.3.a.i - International Aviation (International Bunkers) (1) | 3,195.087 | 0.022 | 0.089 | NE | NE | NE | NE |
| 1.A.3.d.i - International water-borne navigation (International bunkers) (1) | IE | IE | IE | NE | NE | NE | NE |
| 1.A.5.c - Multilateral Operations (1)(2) | NO | NO | NO | NO | NO | NO | NO |
| Information Items | | | | | | | |
| CO2 from Biomass Combustion for Energy Production | 63,533.200 | | | | | | |

**Note: The original values in gigagrams in the above table from the software output have been converted to tonnes**

## 2.5. Industrial Processes and Product Use (IPPU)

### 2.5.1. Description of sector

Kiribati is not an industrialized country and emissions occur from a very restricted number of categories. GHGs are also emitted during non-energy use of hydrocarbons such as lubricants and solvents while HFCs and PFCs are lost from installed equipment. Other gases also emitted in different IPPU sub-categories, include sulphur hexafluoride ($SF_6$) and NMVOCs.

Because of unavailability of appropriate datasets, the only category and activity area covered in this inventory is:

- Non-Energy Products from Fuels and Solvent Use – Use of Lubricants

### 2.5.2. Methods

The method provided in the 2006 IPCC Guidelines for National GHG Inventories, Vol. 3 (IPCC, 2007) was used for computing emissions.

The formula used for computing emissions is

$$\textbf{Emissions} = \sum A_j * EF_i$$

where:

| | |
|---|---|
| A = | Activity is Production Process Input or output (tonnes / year) |
| j = | Industrial Activity |
| EF = | Emission factor (t / kt) and |
| i = | GHG or precursor |

### 2.5.3. Activity Data, Emission factors and Emissions Estimates

#### 2.5.3.1. Lubricant Use

**Activity data**

The total amount of lubricants estimated in the Energy sector was discounted for the part burned in 2-stroke engines and the remainder used as AD for this activity. Data on lubricants used for estimating emissions are given in Table 2.25.

**Table 2.25: Use of lubricants (TJ) (2010 – 2019)**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Amount of lubricants | 5.9 | 5.4 | 5.4 | 4.8 | 4.1 | 4.1 | 4.2 | 4.2 | 4.8 | 5.1 |

**Emission factors**

All EFs used for computing emissions in the IPPU sector were the IPCC defaults adopted from the 2006 IPCC Guidelines and are given in Table 2.26 for the category estimated.

**Table 2.26: EFs and their sources for the IPPU sector**

| Category | EF adopted | 2006 IPPC Guidelines |
|---|---|---|
| Lubricant Use | Carbon content: 20.0 t C / TJ of lubricant – ODU factor: 0.2 | Vol. 3_3, Ch. 5 Non-Energy from Fuels and Solvent Use Ch. 5.2.2.2, Page 5.9 |

**Trend of emissions - IPPU Sector**

Since only lubricants use is considered in the IPPU sector, $CO_2$ was the only GHG emitted. A 14% decrease in total $CO_2$ emissions (Table 2.27), from 87 t in 2010 to 75 t in 2019 is observed across the timeseries.

Table 2.27: Emissions of $CO_2$ (t) by sub-category for the IPPU sector (2010 – 2019)

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Emissions (t $CO_2$) | 87 | 80 | 79 | 70 | 60 | 61 | 62 | 62 | 71 | 75 |

Results of the estimates from the IPCC inventory software for the inventory year 2019 are presented in Table 2.28.

Table 2.28: Sectoral IPPU table – Inventory Year 2019

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents(t) | | | | | (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (1) | Other halogenated gases without $CO_2$ equivalent conversion factors (2) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 2 - Industrial Processes and Product Use | 74.785 | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| 2.A - Mineral Industry | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.1 - Cement production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.2 - Lime production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.3 - Glass Production | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.4 - Other Process Uses of Carbonates | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.A.4.a - Ceramics | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.4.b - Other Uses of Soda Ash | NO | NA | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.A.4.c - Non Metallurgical Magnesia Production | NO | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.A.4.d - Other (please specify) (3) | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.A.5 - Other (please specify) (3) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.B - Chemical Industry | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.C - Metal Industry | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| 2.D - Non-Energy Products from Fuels and Solvent Use (6) | 74.785 | NO | NO | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 2.D.1 - Lubricant Use | 74.785 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.D.2 - Paraffin Wax Use | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents(t) | | | | | (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (1) | Other halogenated gases without $CO_2$ equivalent conversion factors (2) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 2.D.3 - Solvent Use (7) | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA | NE | NA |
| 2.D.4 - Other (please specify) (3), (8) | NE | NE | NE | NA | NA | NA | NA | NA | NE | NE | NE | NE |
| 2.E - Electronics Industry | NO | NO | NO | NO | NO | NO | NO | NO | NA | NA | NA | NA |
| 2.F - Product Uses as Substitutes for Ozone Depleting Substances | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.1 - Refrigeration and Air Conditioning | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.1.a - Refrigeration and Stationary Air Conditioning | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.1.b - Mobile Air Conditioning | NA | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.F.2 - Foam Blowing Agents | NE | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.F.3 - Fire Protection | NE | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.4 - Aerosols | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.5 - Solvents | NA | NA | NA | NE | NE | NA | NA | NA | NA | NA | NA | NA |
| 2.F.6 - Other Applications (please specify) (3) | NA | NA | NA | NO | NO | NA | NA | NA | NA | NA | NA | NA |
| 2.G - Other Product Manufacture and Use | NO | NO | NE | NO | NE | NE | NO | NE | NA | NA | NA | NA |
| 2.G.1 - Electrical Equipment | NA | NA | NA | NA | NE | NE | NA | NE | NA | NA | NA | NA |
| 2.G.1.a - Manufacture of Electrical Equipment | NA | NA | NA | NA | NO | NO | NA | NO | NA | NA | NA | NA |
| 2.G.1.b - Use of Electrical Equipment | NA | NA | NA | NA | NE | NE | NA | NE | NA | NA | NA | NA |
| 2.G.1.c - Disposal of Electrical Equipment | NA | NA | NA | NA | NE | NE | NA | NE | NA | NA | NA | NA |
| 2.G.2 - SF6 | NA | NA | NA | NA | NO | NO | NA | NO | NA | NA | NA | NA |

| Categories | Emissions (t) | | | Emissions $CO_2$ Equivalents(t) | | | | | (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | HFCs | PFCs | $SF_6$ | Other halogenated gases with $CO_2$ equivalent conversion factors (1) | Other halogenated gases without $CO_2$ equivalent conversion factors (2) | $NO_x$ | CO | NMVOCs | $SO_2$ |
| and PFCs from Other Product Uses | | | | | | | | | | | | |
| 2.G.3 - N2O from Product Uses | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.G.3.a - Medical Applications | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.G.3.b - Propellant for pressure and aerosol products | NA | NA | NE | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.G.3.c - Other (Please specify) (3) | NA | NA | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.G.4 - Other (Please specify) (3) | NA | NA | NO | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2.H - Other | NE | NE | NE | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 2.H.1 - Pulp and Paper Industry | NO | NO | NA | NA | NA | NA | NA | NA | NO | NO | NO | NO |
| 2.H.2 - Food and Beverages Industry | NE | NE | NA | NA | NA | NA | NA | NA | NO | NO | NE | NO |
| 2.H.3 - Other (please specify) (3) | NO | NO | NO | NA | NA | NA | NA | NA | NO | NO | NO | NO |

**Note: The original values in gigagrams in the above table from the software output have been converted to tonnes**

## 2.6. Agriculture, Forestry and Other Land Use (AFOLU)

### 2.6.1. Description

The AFOLU sector comprises four subcategories:

- Livestock (3.A)
- Land (3.B)
- Aggregate sources and non-$CO_2$ emissions from land (3.C)
- Other (3.D)

For this inventory, three subsectors (except 3D) have been covered. Emissions from enteric fermentation and manure management have been estimated for the two livestock populations. For the land (3.B) category, the area of the various land classes has been kept constant over the timeseries due to lack of AD and only the sink capacity of Forestland and fuelwood removal have been considered. This is an improvement on past inventories when only livestock was included. Non-$CO_2$ aggregated sources consisted of direct and indirect $N_2O$ emissions from manure and managed soils. Under Other (3.D), AD for harvested wood products (HWP) were not available but the wood component in waste sent to landfill in the Waste sector module was automatically transferred in the software and this resulted in an emission being estimated for that category.

### 2.6.2. Methods

Tier 1 was adopted for the estimation of emissions and removals in the AFOLU sector as there was no country-specific data to enable computation at the Tier 2 level. AD here refer to the intensity or level of activity that led to emissions / removals of GHGs while EF represents the rate at which a particular GHG is emitted or removed because of use of, change of and level of intensity / frequency of use / number of activities under certain defined conditions. Therefore, the product of AD and EF gives the total GHG emission for a particular activity. The equation is:

$$E = AD * EF$$

where:

| | |
|---|---|
| E = | Emission |
| AD = | Activity Data |
| EF = | Emission factor |

The method used for estimating emissions for the sub-categories of the AFOLU sector were obtained from the IPCC 2006 Guidelines Vol. 4 as follows; Livestock – Ch. 2; Land – Ch. 2, 3 and 4; Aggregate sources and non-$CO_2$ emissions on land – Ch. 2 and 11.

### 2.6.3. Activity Data, Emission factors and emission estimates

#### 2.6.3.1. Activity data and emission factors

The data needed for this inventory were sourced from different relevant national and international institutions (Table 2.29) as appropriate.

**Table 2.29: Activity Data description and sources for the AFOLU sector**

| Category | Sub-category | Data Type | Data Source |
|---|---|---|---|
| Livestock | Enteric Fermentation | Animal population (Swine, and poultry) | MELAD, NSO, BUR 1 draft national circumstances chapter, Expert judgement, IPCC GL |
| | Manure Management | | |
| Land | Forestland | Forest and other land classes area | Wikipedia, World Bank, FAO FRA reports |
| | | Climate zone and soil classification | IPCC GL |
| | | Biomass estimate for 5 IPCC pools (above-ground biomass, below-ground biomass, deadwood, herb, litter and soil | IPCC GL |
| | | Harvested Wood Products | - |
| | | Wood / Fuel wood removal | FAOSTATS |
| Aggregate and non-CO2 emissions on land | Biomass burning | Considered not occurring | - |
| | Direct N2O emission from managed soil | Synthetic fertilizer consumption. Use was banned since 2003. No AD available | - |
| | Indirect N2O | Crop land area | MELAD, BUR 1 draft |

| Category | Sub-category | Data Type | Data Source |
|---|---|---|---|
| | emission from managed soil | | national circumstances chapter, Expert judgement |
| | Indirect emissions from manure management | Animal population (Dairy cow, Cattle, goats, sheep, swine and poultry) | MELAD, BUR 1 draft national circumstances chapter, Expert judgement |

**Source: FAOSTAT – http://faostat.fao.org (Accessed July 2021)**

Outliers and gaps identified in the inventory were filled using the appropriate IPCC splicing technique. The specific technique applied was selected based on the nature and type of the missing or inconsistent data gap. Some of the techniques used were averages, trending, interpolation, and extrapolation.

## Livestock (3A)

Emissions from enteric fermentation and management of manure for the livestock sector are estimated from the domestic population of swine and poultry. The EFs corresponding to the Oceania region for developing countries were adopted. AD used for computing the emissions for both enteric fermentation and manure management are provided in Table 2.30. The total swine population was subdivided in a 90:10 proportion for swine market and swine breeding respectively based on IPCC Guidelines.

Based on expert judgement, the manure management systems assigned to livestock are:

- Swine: 100% dry lot
- Poultry: 90% in Poultry manure with litter and 10% Pasture, Range, Paddock

**Table 2.30: Livestock population (2010 – 2019)**

| Year | Swine market | Swine breeding | Poultry |
|---|---|---|---|
| 2010 | 35,397 | 3,933 | 34,725 |
| 2011 | 36,081 | 4,009 | 37,740 |
| 2012 | 36,774 | 4,086 | 38,460 |
| 2013 | 37,458 | 4,162 | 39,170 |
| 2014 | 38,133 | 4,237 | 39,870 |
| 2015 | 38,412 | 4,268 | 31,280 |
| 2016 | 37,269 | 4,141 | 31,640 |
| 2017 | 36,927 | 4,103 | 30,110 |
| 2018 | 36,540 | 4,060 | 28,500 |
| 2019 | 36,117 | 4,013 | 26,800 |

## Land (3B)

Human activities drive changes in land use from one class to another with possible emissions or sequestration of $CO_2$. The land use change is the result of conversion of land categories amongst the various IPCC land classes, namely (a) Forestland (FL), (b) Cropland, (c) Grassland, (d) Wetlands, (e) Settlements and (f) Other land. This sub-sector was not covered in previous inventories and availability of AD and EFs is still a major challenge for Kiribati. For this inventory, the area determined for the various land classes occurring in Kiribati were kept constant across the timeseries. Thus, emissions stemming from changes in land use have not been computed.

Data for Forestland, Wetland, perennial Cropland were obtained from the different sources listed in Table 2.29. The area of Forestland was divided into two sub-types, namely wooded land and mangroves. The area of mangrove is quite old, dating back to nearly two decades. Cropland was sub-divided in annual cropland and perennial cropland with the latter covering the coconut plantations which are extensive in Kiribati. The remaining three land types were assigned as being 1,000 ha each of annual Cropland, Settlements and the remainder Other Land. Grassland is considered as not occurring in Kiribati. The land cover data are presented in Table 2.31. The IPCC default soil type Sandy mineral and Tropical wet climate were adopted since these were considered as being most appropriate to represent the country. The islands forming the Republic of Kiribati are atolls and most of the soils are of coral sand origin with phosphate deposits originating from birds' droppings on some of the islands. Human intervention and deposits of litter contribute to increase the organic matter content but there is difficulty to classify such soil.

The wooded land part of Kiribati is covered with a mixture of both hard and soft wood species. Some of this vegetation does not qualify for the definition of Forest land but the presence of woody species and their growth must be captured under the specific conditions of Kiribati as an atoll. Stock factors for the specific conditions of Kiribati are not available in the guidelines. Under these circumstances the lowest stock factor available in the Guidelines has been adopted to be conservative and avoid overestimation. The mangroves in Kiribati are of the fringing type in the absence of rivers and estuaries.

The situation of annual Cropland in Kiribati is also very special as the area is intermingled with Settlement due to the lack of well-defined areas on the atolls. The same applies for breadfruit and coconut trees present in backyards. Default stock factors were adopted for perennial coconut crop.

Settlements include houses, buildings, roads and other infrastructure such as the ports and airports.

Other land are the areas covered by rock outcrops and exposed coral sand areas primarily.

Further improvement of data quality is required to improve the estimates of the Land sector by moving to the Tier 2 level through the inclusion of land use changes between the IPCC land classes over the full time series as well as deriving national stock and EFs specific to the country. Land cover by the six IPCC classes and their management practices are given in Table 2.31.

**Table 2.31: Land cover (ha) by the different land classes (2010 – 2019) and their management practices**

| Land cover | Area | Land use (FLU) | Management (FMG) | Input (FI) |
|---|---|---|---|---|
| Forestland – Wooded land | 11,892 | 1.0 | 1.0 | 1.0 |
| Forestland – Mangrove | 258 | 1.0 | 1.0 | 1.0 |
| Cropland Annual | 1,000 | 0.48 | 1.22 | 1.0 |
| Cropland perennial | 64,800 | 1.0 | 1.0 | 1.0 |
| Wetland | 4 | | Not applicable | |
| Settlements | 1,000 | 1.0 | 1.0 | 1.0 |
| Other land | 2,046 | 1.0 | 1.0 | 1.0 |

***Wood removals for the period 2010 to 2019***

National statistics are not available on the amount of fuelwood and merchantable wood removed. Wood, coconut husks and leaves, and copra waste are used for cooking according to census reports while poles are sometimes used for construction purposes. Fuelwood quantities from FAOSTATS were adopted (Table 2.32). These were estimated to be removed as tree parts as per expert judgement.

**Table 2.32: Wood removal ($m^3$) from Forestland (2010 – 2019)**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| Fuel wood removals | 2,937 | 2,986 | 3,036 | 3,087 | 3,140 | 3,193 | 3,239 | 3,286 | 3,334 | 3,383 |

**Source: FAOSTATS**

***Carbon stock factors in different land representations***

Stock factors from IPCC Guidelines assigned to the three sub-classes Wooded land and Mangrove are given in Table 2.33. Default factors for tropical wet region, tropical rainforest and other broadleaf were considered as most appropriate and adopted.

**Table 2.33: Stock factors of Forestland sub-classes**

| | Forestland (Wooded land) | Forestland (Mangrove) |
|---|---|---|
| Age class (years) | Above 20 | Above 20 |
| Growing stock level (m3/ha) | 10-20 | 61-80 |
| Above ground biomass (tdm/ha) | 30.0 | 60.0 |
| Above ground biomass growth (tdm / ha / yr) | 1.0 | 5.0 |
| Ratio above to below ground | 0.37 | 0.37 |

## Aggregate sources and non-$CO_2$ emissions on land (3C)

Three out of the eight IPCC categories in the Aggregate sources and non-$CO_2$ emissions on land sub-sector occur in Kiribati. The categories are:

- 3.C.4 - Direct $N_2O$ emissions from managed soils
- 3.C.5 - Indirect $N_2O$ emissions from managed soils
- 3.C.6 - Indirect $N_2O$ emissions from manure management

Emissions for 3.C.4 and 3.C.6 were estimated while those from 3.C.5 were not computed due to the absence of readily available data. AD used for estimating emissions for these activities were obtained from the same sources as for the livestock sub-sector. Inorganic fertilizers have been banned from use since 2003.

## Other (3D) - Harvested Wood Products (3.D.1)

No estimates were made for HWP due to lack of data even from the FAOSTATS. However, during the processing of Solid Waste Disposal (4A) under the Waste sector, wood sent to landfill is estimated by the software for HWP. Thus, a sink value was estimated by the software for HWP.

### 2.6.3.2. Emissions estimates

Table 2.34 shows the emissions and removals by category of the AFOLU sector. Overall, the sector removed 4,944 t $CO_2$ e in 2019. Total emissions for that year amounted to 22,824 t $CO_2$ e while total removals stood at 27,767 t $CO_2$ e. The Land Sector (3B) accounted for 99.9% of removals across the time series. Total removals decreased by 2% from the year 2010 to 2019. The highest emitter of the AFOLU sector is Livestock (3A) with 90% of total aggregated emissions in the year 2019 and the remainder occurred in the Aggregate sources and non-$CO_2$ emissions on land (3C) subsector.

**Table 2.34: Emissions and removals (t $CO_2$ e) by source category (2010 – 2019)**

| Year | Livestock (3A) | Removals from Land | Aggregate sources and non-CO2 emissions on land (3C) | Other – HWP (3D) | Total emissions | Net removals |
|---|---|---|---|---|---|---|
| 2010 | 22,258 | -28,187 | 2,393 | -20 | 24,651 | -3,555 |
| 2011 | 22,078 | -28,138 | 2,377 | -20 | 24,455 | -3,703 |
| 2012 | 21,896 | -28,088 | 2,358 | -21 | 24,255 | -3,854 |
| 2013 | 21,715 | -28,037 | 2,340 | -22 | 24,055 | -4,004 |
| 2014 | 21,533 | -27,984 | 2,322 | -22 | 23,854 | -4,152 |
| 2015 | 21,345 | -27,931 | 2,293 | -23 | 23,638 | -4,316 |
| 2016 | 21,163 | -27,885 | 2,274 | -24 | 23,436 | -4,472 |
| 2017 | 20,980 | -27,838 | 2,253 | -25 | 23,233 | -4,630 |
| 2018 | 20,796 | -27,790 | 2,231 | -26 | 23,028 | -4,787 |
| 2019 | 20,613 | -27,741 | 2,210 | -26 | 22,824 | -4,944 |

The trend of absolute and $CO_2$ equivalent emissions by gas, and aggregated emissions for the AFOLU sector is presented in Table 2.35. Emissions ranged between 16,982 to 18,337 t $CO_2$ e for $CH_4$ and between 5,842 to 6,314 t $CO_2$ e for $N_2O$. In 2019, $CH_4$ and $N_2O$ contributed 16,982 t $CO_2$ e and 5,842 t $CO_2$ e respectively when taking their GWP into consideration. $CH_4$ remained the main gas emitted over the entire period 2010 to 2019 followed by $N_2O$.

**Table 2.35: Absolute and $CO_2$ equivalent emissions (t) by gas, and total emissions for the AFOLU sector (2010 – 2019)**

| Year | $CH_4$ (t) | $N_2O$ (t) | $CH_4$ (t $CO_2$ e) | $N_2O$ (t $CO_2$ e) | Total (t $CO_2$ e) |
|---|---|---|---|---|---|
| 2010 | 654.9 | 23.8 | 18,337 | 6,314 | 24,651 |
| 2011 | 649.6 | 23.6 | 18,189 | 6,266 | 24,455 |
| 2012 | 644.3 | 23.5 | 18,039 | 6,216 | 24,255 |
| 2013 | 638.9 | 23.3 | 17,889 | 6,165 | 24,055 |
| 2014 | 633.6 | 23.1 | 17,740 | 6,115 | 23,854 |
| 2015 | 628.0 | 22.8 | 17,585 | 6,053 | 23,638 |
| 2016 | 622.7 | 22.6 | 17,435 | 6,002 | 23,436 |
| 2017 | 617.3 | 22.4 | 17,284 | 5,949 | 23,233 |
| 2018 | 611.9 | 22.2 | 17,133 | 5,895 | 23,028 |
| 2019 | 606.5 | 22.0 | 16,982 | 5,842 | 22,824 |

### Livestock

Total aggregated emissions from livestock varied between 20,613 and 22,258 t $CO_2$ e for the period 2010 to 2019 with emissions for 2019 standing at 20,613. Manure management was the major contributor to total emissions throughout the timeseries with 95% of total emissions on average. In absolute terms, emissions were 606 t of $CH_4$ and 14 t of $N_2O$ in 2019 (Table 2.36).

Emissions in the enteric fermentation category originated from swine only. In 2019, total emissions of $CH_4$ from enteric fermentation were 1,124 t $CO_2$ e representing a slight decrease from year 2010 emissions which stood at 1,213 t $CO_2$ e (Table 2.36).

**Table 2.36: Absolute (t) and $CO_2$ equivalent emissions (t $CO_2$ e) from livestock (2010 – 2019)**

| Year | $CO_2$ equivalent emissions (t) | | | Absolute (t) | |
|---|---|---|---|---|---|
| | Enteric fermentation | Manure management | Aggregated total | $CH_4$ | $N_2O$ |
| 2010 | 1,213 | 21,045 | 22,258 | 655 | 15 |
| 2011 | 1,203 | 20,875 | 22,078 | 650 | 15 |
| 2012 | 1,193 | 20,703 | 21,896 | 644 | 15 |
| 2013 | 1,183 | 20,531 | 21,715 | 639 | 14 |
| 2014 | 1,173 | 20,359 | 21,533 | 634 | 14 |
| 2015 | 1,163 | 20,182 | 21,345 | 628 | 14 |
| 2016 | 1,153 | 20,009 | 21,163 | 623 | 14 |
| 2017 | 1,144 | 19,836 | 20,980 | 617 | 14 |
| 2018 | 1,134 | 19,663 | 20,796 | 612 | 14 |
| 2019 | 1,124 | 19,490 | 20,613 | 606 | 14 |

***Manure Management (3.A.2)***

Absolute, $CO_2$ equivalent, and total aggregated emissions are presented in Table 2.37. Total aggregated emissions decreased from 21,045 t $CO_2$ e in 2010 to 19,490 t $CO_2$ e in 2019 (Table 2.37). In 2019, $CH_4$ contributed about 81% of the total aggregated emissions from manure management and $N_2O$ the remaining 19%. $CH_4$ and $N_2O$ emissions decreased over the period 2010 to 2019, reaching 566 t and 14 t respectively in absolute terms in 2019.

**Table 2.37: Trend of absolute, $CO_2$ equivalent and aggregated $CH_4$ and $N_2O$ emissions (2010 – 2019) from manure management**

| Year | Absolute (t) | | $CO_2$ equivalent (t) | | Total (t $CO_2$ e) |
|---|---|---|---|---|---|
| | $CH_4$ | $N_2O$ | $CH_4$ | $N_2O$ | |
| 2010 | 612 | 15 | 17,124 | 3,921 | 21,045 |
| 2011 | 607 | 15 | 16,986 | 3,889 | 20,875 |
| 2012 | 602 | 15 | 16,846 | 3,857 | 20,703 |
| 2013 | 597 | 14 | 16,706 | 3,825 | 20,531 |
| 2014 | 592 | 14 | 16,566 | 3,793 | 20,359 |
| 2015 | 586 | 14 | 16,421 | 3,760 | 20,182 |
| 2016 | 581 | 14 | 16,281 | 3,728 | 20,009 |
| 2017 | 576 | 14 | 16,140 | 3,696 | 19,836 |
| 2018 | 571 | 14 | 15,999 | 3,664 | 19,663 |
| 2019 | 566 | 14 | 15,858 | 3,631 | 19,490 |

## Emissions from Land (3B)

The estimated $CO_2$ removals from land decreased from 28,187 t in 2010 to reach 27,740 t in 2019 (Figure 2.4). This is mainly due to an increase in fuelwood removal. The Land sub-sector remained a net sink throughout the time series.

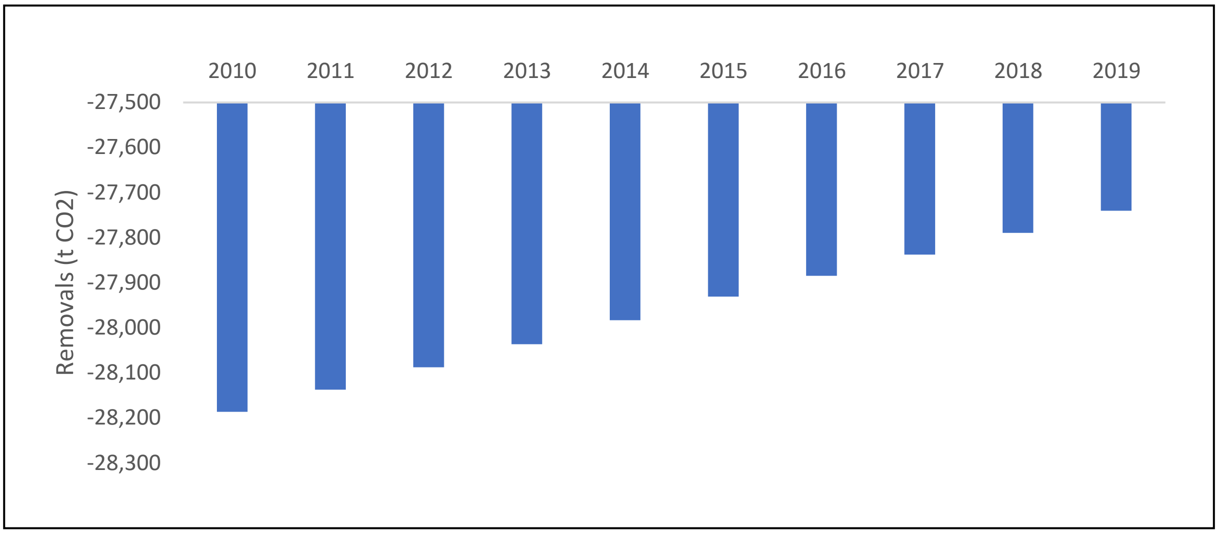



**Figure 2.4: Trend of emissions in Forestland**

***Non-$CO_2$ emissions from Land (3C)***

In 2019, the total aggregated non-$CO_2$ emissions from Land decreased from 2,393 t $CO_2$ e (Table 2.38) in 2010 to 2,210 in 2019.

**Table 2.38: Emissions of $N_2O$ (t $CO_2$ e) from sub-sector 3C (2010 – 2019)**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|
| $N_2O$ emissions (t $CO_2$ e) | 2,393 | 2,377 | 2,358 | 2,340 | 2,322 | 2,293 | 2,274 | 2,253 | 2,231 | 2,210 |

Direct $N_2O$ emissions from managed soils was the major contributor to total emissions with an average share of 83% throughout the timeseries (Figure 2.5). Direct emissions dropped gradually from 1,984 t $CO_2$ e in the year 2010 to 1,834 t $CO_2$ e in 2019, with Indirect emissions regressing from 409 t $CO_2$ e in 2010 to 376 t $CO_2$ e in 2019.

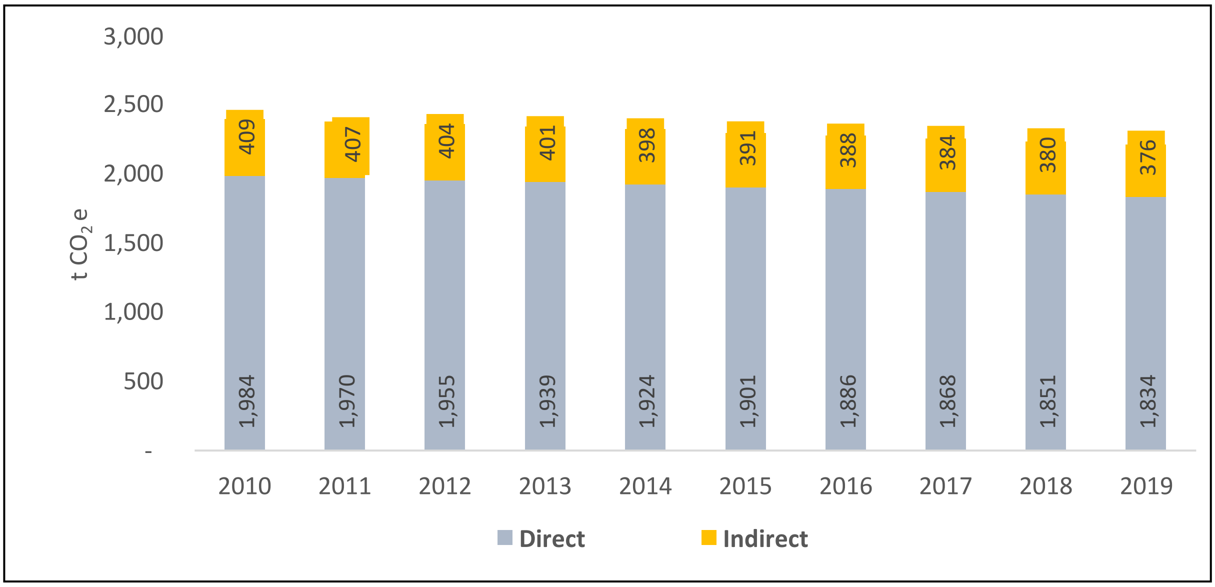



**Figure 2.5: Trends of direct and indirect emissions of $N_2O$ from soil management**

### *Harvested Wood Products*

HWPs represented a sink of $CO_2$ which increased during the period 2010 to 2019. The evolution of removals through HWPs is given in Figure 2.6. There was an overall gain in removals between 2010 and 2019, from 20 t $CO_2$ to 26 t $CO_2$.

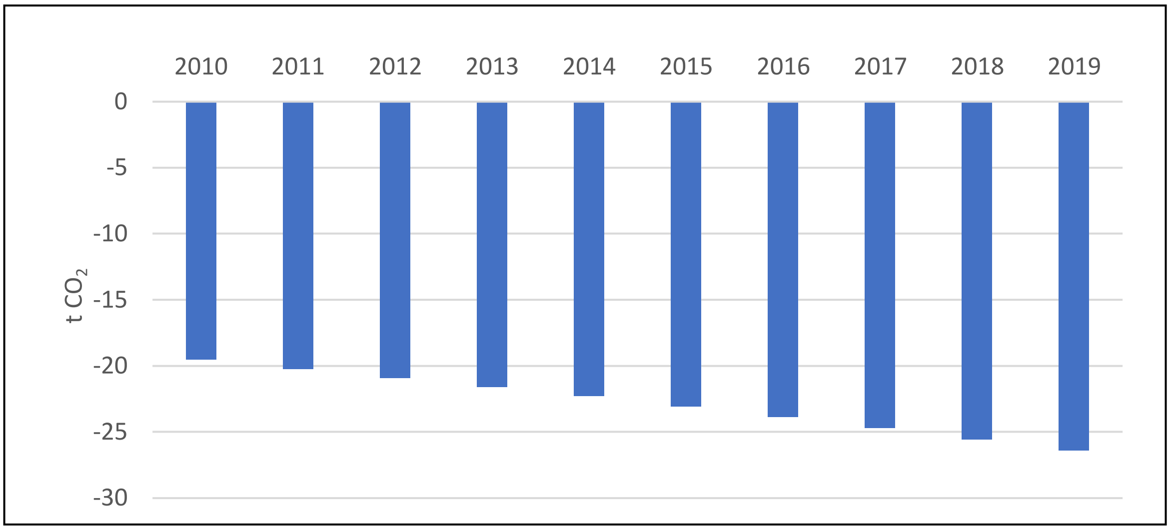



**Figure 2.6 $CO_2$ removed and stored in HWP**

Results of the estimates from the IPCC inventory software for the inventory year 2019 are presented in Table 2.39.

**Table 2.39: AFOLU sector results – Inventory year 2019**

| Categories | Emissions (t) | | | | | |
|---|---|---|---|---|---|---|
| | Net $CO_2$ emissions / removals | Emissions | | | | |
| | | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs |
| 3 - Agriculture, Forestry, and Other Land Use | -27,767.228 | 606.499 | 22.044 | NE | NE | NE |
| 3.A - Livestock | NA | 606.499 | 13.703 | NA | NA | NE |
| 3.A.1 - Enteric Fermentation | NA | 40.130 | NA | NA | NA | NA |
| 3.A.1.a - Cattle | NA | NO | NA | NA | NA | NA |
| 3.A.1.a.i - Dairy Cows | NA | NO | NA | NA | NA | NA |
| 3.A.1.a.ii - Other Cattle | NA | NO | NA | NA | NA | NA |
| 3.A.1.b - Buffalo | NA | NO | NA | NA | NA | NA |
| 3.A.1.c - Sheep | NA | NO | NA | NA | NA | NA |
| 3.A.1.d - Goats | NA | NO | NA | NA | NA | NA |
| 3.A.1.e - Camels | NA | NO | NA | NA | NA | NA |
| 3.A.1.f - Horses | NA | NO | NA | NA | NA | NA |
| 3.A.1.g - Mules and Asses | NA | NO | NA | NA | NA | NA |
| 3.A.1.h - Swine | NA | 40.130 | NA | NA | NA | NA |
| 3.A.1.j - Other (please specify) | NO | NO | NO | NO | NO | NO |
| 3.A.2 - Manure Management (1) | NA | 566.369 | 13.703 | NA | NA | NE |
| 3.A.2.a - Cattle | NA | NO | NO | NA | NA | NE |
| 3.A.2.a.i - Dairy cows | NA | NO | NO | NA | NA | NE |
| 3.A.2.a.ii - Other cattle | NA | NO | NO | NA | NA | NE |
| 3.A.2.b - Buffalo | NA | NO | NO | NA | NA | NO |
| 3.A.2.c - Sheep | NA | NO | NO | NA | NA | NE |
| 3.A.2.d - Goats | NA | NO | NO | NA | NA | NE |
| 3.A.2.e - Camels | NA | NO | NO | NA | NA | NE |
| 3.A.2.f - Horses | NA | NO | NO | NA | NA | NE |
| 3.A.2.g - Mules and Asses | NA | NO | NO | NA | NA | NE |
| 3.A.2.h - Swine | NA | 565.833 | 13.693 | NA | NA | NE |
| 3.A.2.i - Poultry | NA | 0.536 | 0.010 | NA | NA | NE |

| Categories | Emissions (t) | | | | | |
|---|---|---|---|---|---|---|
| | Net $CO_2$ emissions / removals | Emissions | | | | |
| | | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs |
| 3.A.2.j - Other (please specify) | NO | NO | NO | NO | NO | NO |
| 3.B - Land | -27,740.841 | NE | NE | NE | NE | NE |
| 3.B.1 - Forest land | -27,740.841 | NE | NE | NE | NE | NE |
| 3.B.1.a - Forest land Remaining Forest land | -27,740.841 | NE | NE | NE | NE | NE |
| 3.B.1.b - Land Converted to Forest land | NE | NE | NE | NE | NE | NE |
| 3.B.1.b.i - Cropland converted to Forest Land | NE | NE | NE | NE | NE | NE |
| 3.B.1.b.ii - Grassland converted to Forest Land | NO | NO | NO | NO | NO | NO |
| 3.B.1.b.iii - Wetlands converted to Forest Land | NE | NE | NE | NE | NE | NE |
| 3.B.1.b.iv - Settlements converted to Forest Land | NE | NE | NE | NE | NE | NE |
| 3.B.1.b.v - Other Land converted to Forest Land | NE | NE | NE | NE | NE | NE |
| 3.B.2 - Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.a - Cropland Remaining Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.b - Land Converted to Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.b.i - Forest Land converted to Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.b.ii - Grassland converted to Cropland | NO | NO | NO | NO | NO | NO |
| 3.B.2.b.iii - Wetlands converted to Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.b.iv - Settlements converted to Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.2.b.v - Other Land converted to Cropland | NE | NE | NE | NE | NE | NE |
| 3.B.3 - Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.a - Grassland Remaining Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b - Land Converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b.i - Forest Land converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b.ii - Cropland converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b.iii - Wetlands converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b.iv - Settlements converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.3.b.v - Other Land converted to Grassland | NO | NO | NO | NO | NO | NO |
| 3.B.4 - Wetlands | NE | NE | NE | NE | NE | NE |
| 3.B.4.a - Wetlands Remaining Wetlands | NE | NE | NE | NE | NE | NE |
| 3.B.4.a.i - Peatlands remaining peatlands | NA | NA | NA | NA | NA | NA |
| 3.B.4.a.ii - Flooded land remaining flooded land | NE | NE | NE | NE | NE | NE |
| 3.B.4.b - Land Converted to Wetlands | NE | NE | NE | NE | NE | NE |
| 3.B.4.b.i - Land converted for peat extraction | NA | NA | NA | NA | NA | NA |
| 3.B.4.b.ii - Land converted to flooded land | NE | NE | NE | NE | NE | NE |
| 3.B.4.b.iii - Land converted to other wetlands | NA | NA | NA | NA | NA | NA |
| 3.B.5 - Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.a - Settlements Remaining Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.b - Land Converted to Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.b.i - Forest Land converted to Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.b.ii - Cropland converted to Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.b.iii - Grassland converted to Settlements | NO | NA | NA | NA | NA | NA |
| 3.B.5.b.iv - Wetlands converted to Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.5.b.v - Other Land converted to Settlements | NE | NA | NA | NA | NA | NA |
| 3.B.6 - Other Land | NE | NA | NA | NA | NA | NA |
| 3.B.6.a - Other land Remaining Other land | NE | NA | NA | NA | NA | NA |
| 3.B.6.b - Land Converted to Other land | NE | NA | NA | NA | NA | NA |
| 3.B.6.b.i - Forest Land converted to Other Land | NE | NA | NA | NA | NA | NA |
| 3.B.6.b.ii - Cropland converted to Other Land | NE | NA | NA | NA | NA | NA |
| 3.B.6.b.iii - Grassland converted to Other Land | NO | NA | NA | NA | NA | NA |
| 3.B.6.b.iv - Wetlands converted to Other Land | NE | NA | NA | NA | NA | NA |
| 3.B.6.b.v - Settlements converted to Other Land | NE | NA | NA | NA | NA | NA |
| 3.C - Aggregate sources and non-CO2 emissions | NE | NO | 8.341 | NO | NO | NA |

| Categories | Emissions (t) | | | | | |
|---|---|---|---|---|---|---|
| | Net $CO_2$ emissions / removals | Emissions | | | | |
| | | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs |
| sources on land (2) | | | | | | |
| 3.C.1 - Emissions from biomass burning | NA | NO | NO | NO | NO | NA |
| 3.C.1.a - Biomass burning in forest lands | NA | NO | NO | NO | NO | NA |
| 3.C.1.b - Biomass burning in croplands | NA | NO | NO | NO | NO | NA |
| 3.C.1.c - Biomass burning in grasslands | NA | NO | NO | NO | NO | NA |
| 3.C.1.d - Biomass burning in all other land | NA | NO | NO | NO | NO | NA |
| 3.C.2 - Liming | NO | NA | NA | NA | NA | NA |
| 3.C.3 - Urea application | NO | NA | NA | NA | NA | NA |
| 3.C.4 - Direct N2O Emissions from managed soils (3) | NA | NA | 6.920 | NA | NA | NA |
| 3.C.5 - Indirect N2O Emissions from managed soils | NA | NA | NE | NA | NA | NA |
| 3.C.6 - Indirect N2O Emissions from manure management | NA | NA | 1.421 | NA | NA | NA |
| 3.C.7 - Rice cultivation | NA | NO | NA | NA | NA | NA |
| 3.C.8 - Other (please specify) | NE | NO | NO | NA | NA | NA |
| 3.D - Other | -26.387 | NO | NO | NO | NO | NO |
| 3.D.1 - Harvested Wood Products | -26.387 | NA | NA | NA | NA | NA |
| 3.D.2 - Other (please specify) | NO | NO | NO | NO | NO | NO |

## 2.7. Waste sector

### 2.7.1. Description

Anthropogenic activities lead to the generation of both solid and liquid wastes. These wastes consist of different materials, including plastics, wood, paper, food remains and garden waste among others.

Wastes are further sub-divided into domestic and industrial wastes as listed below:

- Solid waste: Municipal (Domestic) and industrial solid wastes
- Wastewater: Domestic and industrial wastewater.

Currently in Kiribati, solid waste is often disposed of in an unsustainable manner. Kiribati currently has very limited landfills that are engineered. Solid waste, collected by the city councils, are mostly disposed of at unmanaged dump sites. Most of the rural population carry out composting of domestic organic waste. Hospitals incinerate hazardous clinical waste. Liquid waste is disposed of into closed systems, septic tanks, and latrines.

GHG emissions from the Waste sector result largely from disposal of solid wastes through landfilling, dumping, incineration, open burning and treatment of domestic and industrial liquid wastes. The emissions, from solid waste are $CH_4$ from disposal sites and predominantly $CO_2$ from open burning of waste. Wastewater can also be a source of $CH_4$, when treated or disposed of anaerobically, as well as of $N_2O$ emissions. Key factors that affect emissions are population growth, rural-urban drift, and improper management of waste, both at its source of generation and its final fate.

The 2006 IPCC Guidelines divide the Waste sector into the following source categories: Solid Waste Disposal (4A), Biological Treatment of solid waste (4B), Incineration and Open Burning (4C) and Wastewater Treatment and Discharge (4D). Each source category is further divided into sub-categories that consider different waste attributes, management practices and approaches.

Analysis of waste disposal practices led to the identification of 5 categories for computing emissions of the Waste sector in Kiribati. These are:

- 4.A. - Waste Disposal Sites
- 4.C.1 - Waste Incineration
- 4.C.2 - Open Burning of Waste
- 4.D.1 - Domestic Wastewater Treatment and Discharge; and
- 4.D.2 - Industrial Wastewater Treatment and Discharge.

### 2.7.2. Methods

#### 2.7.2.1. Solid waste

The decision tree of the 2006 IPCC Guidelines was used to choose the most appropriate method for computing emissions of this sector. There are limited data on specificity and management of waste, such as annual information on the amount and composition of waste generated, the details pertaining to waste management practices in both the rural and urban areas of the country, the waste generation rate in the industry and other relevant data. This resulted in the adoption of Tier 1 methodology.

Under this Tier 1 methodology waste emissions were computed using the formula:

$$E = AD * EF$$

where:

E = emissions (tonnes)

AD is the activity data (population and waste generation rate)

EF is emission factor (tonnes per tonne waste)

The decision tree of the 2006 IPCC Guidelines (Vol. 5, Ch. 5, Page 5.9) guided the choice of method for estimating emissions from Incineration and Open Burning and the Tier 1 approach was adopted. The emissions estimates were done by entering the amount of waste incinerated and open burnt directly in the software.

#### 2.7.2.2. Wastewater

The decision tree of the 2006 IPCC Guidelines (Vol. 5, Ch. 6, Page 6.10) guided the estimation of GHG emissions from this subcategory. Domestic wastewater in the software is allocated based on the fraction of total population using each wastewater management system identified in the country.

### 2.7.3. Activity Data, Emission factors and emissions estimates

#### 2.7.3.1. Activity data and emissions factors

**Solid Waste Disposal (4.A) - Waste Disposal Sites**

The amount of waste generated in Kiribati was derived from the urban and rural population data times per capita waste generation rates as follows:

- Waste generation studies for urban regions in years 2010 and 2017 (KWMRRS 2020 to 2030) were used to generate a consistent timeseries of per capita waste generation rate for urban region.
- The waste generation rate for rural regions was estimated at 50% that of the urban region. (Expert judgement).

- Waste characterization data done at the same time as the generation rate was averaged and a single waste characterization was adopted for the timeseries 2010 to 2019.
- An adjustment was made for food waste fed to swine by allocating 25% of food waste in urban and 50% in rural region of the food waste fraction (Expert judgement). Waste characterization was adjusted accordingly, and the final information used was 18% food waste, 37% garden waste, 5% paper, 1% wood, 2% textile, 3% nappies and the remaining 33% as plastics and other inert materials.
- Census information of 2010 and 2015 were used to estimate the fate of solid municipal waste in the different waste streams. The nomenclature from the census was assigned to match the terminology of the IPCC Guidelines. Information from the census confirms that waste collection occurs only in the urban region.
- The estimated waste generated in the urban and rural regions was added to bring it to the whole country for making the sectoral estimates in the software.

Information provided in Table 2.40 was adopted for generating AD for computing emissions from solid waste.

**Table 2.40: Municipal Solid Waste (MSW) activity data used for estimating emissions (2010 – 2019)**

| Year | Total population | Waste per capita (kg/cap/yr) | Fraction of waste sent to SWDS | % MSW to each SWDS | | | Amount of waste open burnt (t) |
|---|---|---|---|---|---|---|---|
| | | | | Managed – Semi aerobic | Unmanaged shallow SWDS | Unmanaged SWDS | |
| 2010 | 103,058 | 99.006 | 0.499 | 36% | 47% | 17% | 1,707 |
| 2011 | 104,474 | 100.695 | 0.501 | 36% | 47% | 17% | 1,757 |
| 2012 | 105,889 | 102.401 | 0.502 | 36% | 46% | 17% | 1,808 |
| 2013 | 107,305 | 104.126 | 0.503 | 36% | 46% | 17% | 1,861 |
| 2014 | 108,720 | 105.870 | 0.505 | 37% | 46% | 17% | 1,915 |
| 2015 | 110,136 | 107.633 | 0.506 | 37% | 46% | 17% | 1,969 |
| 2016 | 112,097 | 109.343 | 0.507 | 37% | 46% | 17% | 2,034 |
| 2017 | 114,058 | 110.895 | 0.508 | 37% | 46% | 17% | 2,097 |
| 2018 | 116,018 | 112.637 | 0.509 | 37% | 46% | 17% | 2,165 |
| 2019 | 117,979 | 114.398 | 0.510 | 37% | 46% | 17% | 2,234 |

***Estimation of emissions were based on the following:***

- A tropical wet climate in the Oceania – Other Oceania region was chosen for the Republic of Kiribati. Default values for $CH_4$ generation rate for constant (k) and degradable organic content for each waste constituent available in the software were used.
- The Waste by composition approach based on population was chosen with 2010 as starting year.
- The delay time is set at 6 months and oxidation factor (OX) as 0.
- No industrial waste is produced in the country.

### Incineration and Open Burning of Waste (4.C.)

Data from national statistics on clinical waste (150 kg burnt each day) has been used to compute emissions resulting from incineration. AD for Open Burning generated from available information are already given in Table 2.40.

The other elements for calculating emissions for waste incineration were: Dry matter content is constant at 70%, fraction of carbon in dry matter is 60%, fossil carbon in total carbon is 40% and oxidation factor 1.0. The EF for $CH_4$ is 60 kg $CH_4$/Gg wet waste and that of $N_2O$ is 56 kg $N_2O$/Gg wet waste.

The other elements for calculating emissions for Open burning were: Dry matter content is constant at 48%, fraction of carbon in dry matter is 35%, fossil carbon in total carbon is 10% and oxidation factor 0.58. The EF for $CH_4$ is 6,500 kg $CH_4$/Gg wet waste and that of $N_2O$ is 150 kg $N_2O$/Gg dry waste.

### Wastewater Handling (4D) – Domestic Wastewater Treatment and Discharge (4.D.1)

The level of adoption of wastewater management systems by population are applied to generate the organically degradable material in wastewater. Census data from KSO for years 2010 and 2015 were used to estimate the fraction of population using the different systems. The nomenclature used in the census were harmonized with those in the IPCC Guidelines and 3 systems were retained. The AD generated and used in the computation of emissions for domestic wastewater are presented in Table 2.41. The remaining fraction of population have been assigned as using open air defecation which in Kiribati is referred to as beach, bush, or sea. The protein intake from FAOSTATS, available for years 2014 to 2018, were averaged (27.2 kg/person/year) and used for all years across the timeseries.

The reticulate system in South Tarawa discharges in a sea outfall. Due to lack of information on the water table, the highest emitting option for latrines (warm weather and high-water table) was adopted.

**Table 2.41: Activity data used for domestic wastewater (2010 – 2019)**

| | Fraction (%) of population using WW system | | |
|---|---|---|---|
| Year | Sea, river, lake discharge | Septic tank | Latrine |
| 2010 | 0.070 | 0.133 | 0.263 |
| 2011 | 0.068 | 0.144 | 0.281 |
| 2012 | 0.065 | 0.155 | 0.300 |
| 2013 | 0.063 | 0.168 | 0.321 |
| 2014 | 0.060 | 0.182 | 0.342 |
| 2015 | 0.058 | 0.197 | 0.366 |
| 2016 | 0.056 | 0.213 | 0.390 |
| 2017 | 0.054 | 0.230 | 0.417 |
| 2018 | 0.052 | 0.249 | 0.445 |
| 2019 | 0.050 | 0.269 | 0.475 |

The EFs adopted (IPCC 2006 Guidelines Vol. 5, Ch. 6), based on the maximum $CH_4$ production capacity and $CH_4$ correction factor for each treatment type, are presented in Table 2.42.

**Table 2.42: Emission factor for domestic wastewater calculations**

| Type of treatment / discharge | Maximum $CH_4$ producing capacity-BO [kg $CH_4$ / kg BOD] | $CH_4$ correction factor for each treatment system – MCFj | Emission Factor [kg $CH_4$ / kg BOD] |
|---|---|---|---|
| Sea, river, lake discharge | 0.6 | 0.1 | 0.06 |
| Latrine, dry climate | 0.6 | 0.7 | 0.42 |
| Septic tank | 0.6 | 0.5 | 0.30 |

### 2.7.3.2. Emissions estimates

**Aggregated emissions by source category**

The annual emissions by category from the Waste sector for the period 2010 to 2019 are provided in Table 2.43. The Waste sector emitted 25,602 t $CO_2$ e in 2019. This represented a 100% increase on the year 2010 when 12,747 t $CO_2$ e were emitted. Wastewater remained the highest contributor throughout the timeseries. Emissions increased from 1,769 to 3,048 t $CO_2$ e (72%) for solid waste and from 439 to 564 t $CO_2$ e (28%) for Incineration and open burning.

**Table 2.43: Aggregated emissions (t $CO_2$ e) of the Waste sector (2010 – 2019)**

| Year | SWDS | Incineration and open burning | Wastewater | Total |
|---|---|---|---|---|
| 2010 | 1,769 | 439 | 10,539 | 12,747 |
| 2011 | 1,938 | 451 | 11,405 | 13,794 |
| 2012 | 2,095 | 463 | 12,345 | 14,903 |
| 2013 | 2,244 | 475 | 13,365 | 16,085 |
| 2014 | 2,386 | 488 | 14,471 | 17,346 |
| 2015 | 2,522 | 501 | 15,679 | 18,702 |
| 2016 | 2,654 | 516 | 17,064 | 20,234 |
| 2017 | 2,785 | 531 | 18,571 | 21,888 |
| 2018 | 2,916 | 547 | 20,209 | 23,672 |
| 2019 | 3,048 | 564 | 21,990 | 25,602 |

In 2019, Wastewater treatment and discharge was the major contributor with 86% (21,990 t $CO_2$ e) of the Waste sector emissions. Solid Waste Disposal Sites (SWDS) emissions followed with 3,048 t $CO_2$ e (12%) and Incineration and Open Burning contributed the remaining 2% (564 t $CO_2$ e) (Figure 2.7).

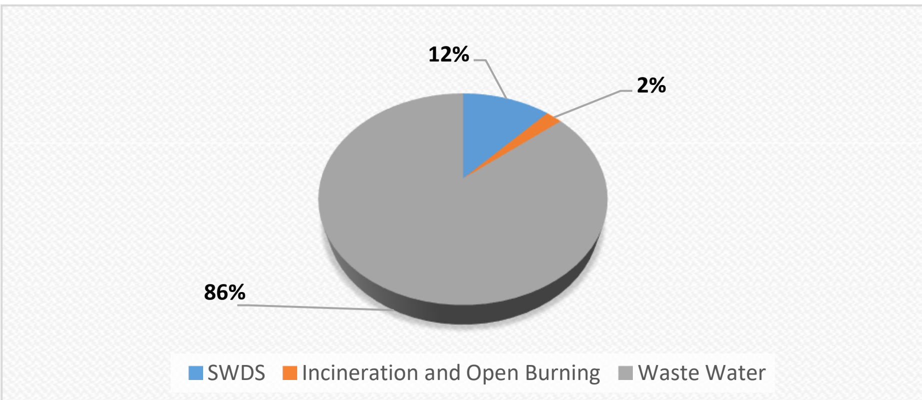



**Figure 2.7: Contribution (%) by source category in emissions of the Waste sector in 2019**

### Emissions by gas

Emissions by gas for the Waste sector are given in Table 2.44. $CH_4$ was the highest contributor of total emissions from the sector when expressed in t $CO_2$ e. Its 93% share of 2010 rose to 94 % in 2019. $N_2O$ was the next contributor with 1,530 t $CO_2$ e in 2019 representing 6% of total emissions while $CO_2$ emissions were marginal with a share of 0.4% (114 t) in the same year. The increase in emissions from the year 2010 to 2019 was 102% for $CH_4$, 92% for $N_2O$ and 20% for $CO_2$.

**Table 2.44: Absolute, $CO_2$ equivalent and total aggregated emissions by gas (2010 – 2019)**

| Year | Absolute (t) | | | $CO_2$ Equivalent (t) | | Total aggregated |
|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | $CH_4$ | $N_2O$ | (t $CO_2$ e) |
| 2010 | 95 | 423.44 | 3.00 | 11,856 | 796 | 12,747 |
| 2011 | 96 | 458.82 | 3.21 | 12,847 | 851 | 13,794 |
| 2012 | 98 | 496.23 | 3.44 | 13,895 | 910 | 14,903 |
| 2013 | 100 | 536.06 | 3.68 | 15,010 | 975 | 16,085 |
| 2014 | 102 | 578.50 | 3.95 | 16,198 | 1,046 | 17,346 |
| 2015 | 104 | 624.12 | 4.24 | 17,475 | 1,123 | 18,702 |
| 2016 | 106 | 675.58 | 4.57 | 18,916 | 1,212 | 20,234 |
| 2017 | 109 | 731.06 | 4.94 | 20,470 | 1,309 | 21,888 |
| 2018 | 111 | 790.94 | 5.34 | 22,146 | 1,415 | 23,672 |
| 2019 | 114 | 855.63 | 5.78 | 23,958 | 1,530 | 25,602 |

### *Emissions from Solid Waste Disposal Systems*

The direct GHG $CH_4$ is emitted from SWDS and the emissions from 2010 to 2019 are presented in absolute and aggregated values in Table 2.45. $CH_4$ emissions increased from 63 t or 1,769 t $CO_2$ e in 2010 to reach 109 t or 3,048 t $CO_2$ e in 2019.

**Table 2.45: Emissions of $CH_4$ from solid waste disposal systems (2010 – 2019)**

| Year | $CH_4$ (t) | $CH_4$ (t $CO_2$ e) |
|---|---|---|
| 2010 | 63 | 1769 |
| 2011 | 69 | 1938 |
| 2012 | 75 | 2095 |
| 2013 | 80 | 2244 |
| 2014 | 85 | 2386 |
| 2015 | 90 | 2522 |
| 2016 | 95 | 2654 |
| 2017 | 99 | 2785 |
| 2018 | 104 | 2916 |
| 2019 | 109 | 3048 |

### *Incineration and Open Burning of waste*

All three direct GHGs are emitted during incineration and open burning of waste. Emissions from Incineration and Open Burning, in absolute and aggregated amounts are given in Table 2.46. Total emissions increased by 28% from 439 t $CO_2$ e in 2010 to 564 t $CO_2$ e in 2019. $CH_4$ remained the major contributor across the time series and its share was 72% (407 t $CO_2$ e) in 2019 while $CO_2$ emissions accounted for 20% and $N_2O$ the remaining 8% in the same year. $CH_4$ and $N_2O$ increased by 31% and 30% respectively from the year 2010 to 2019.

**Table 2.46: Absolute, $CO_2$ equivalent and total aggregated emissions by gas from Incineration and Open Burning (2010 – 2019)**

| Year | Absolute (t) | | | $CO_2$ Equivalent (t) | | Total |
|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | $CH_4$ | $N_2O$ | (t $CO_2$ e) |
| 2010 | 95 | 11 | 0.13 | 311 | 33 | 439 |
| 2011 | 96 | 11 | 0.13 | 320 | 34 | 451 |
| 2012 | 98 | 12 | 0.13 | 329 | 35 | 463 |
| 2013 | 100 | 12 | 0.14 | 339 | 36 | 475 |
| 2014 | 102 | 12 | 0.14 | 349 | 37 | 488 |
| 2015 | 104 | 13 | 0.14 | 359 | 38 | 501 |
| 2016 | 106 | 13 | 0.15 | 370 | 40 | 516 |
| 2017 | 109 | 14 | 0.15 | 382 | 41 | 531 |
| 2018 | 111 | 14 | 0.16 | 394 | 42 | 547 |
| 2019 | 114 | 15 | 0.16 | 407 | 43 | 564 |

***Emissions from Wastewater***

The annual absolute (t) and aggregated (t $CO_2$ e) emissions of direct GHGs from Wastewater increased significantly from 2010 to 2019 as presented in Table 2.47. The total aggregated emissions reached 21,990 t $CO_2$ e in 2019 which represents an increase of 109% from the year 2010. Wastewater in Kiribati generated more emissions as $CH_4$ (93%) than $N_2O$ (7%) when compared in $CO_2$ equivalents in 2019.

**Table 2.47: Absolute, $CO_2$ equivalent and total aggregated emissions for the Wastewater category (2010 – 2019)**

| Year | Absolute (t) | | $CO_2$ Equivalent (t) | | Total aggregated |
|---|---|---|---|---|---|
| | $CH_4$ | $N_2O$ | $CH_4$ | $N_2O$ | (t $CO_2$ e) |
| 2010 | 349 | 3 | 9,776 | 763 | 10,539 |
| 2011 | 378 | 3 | 10,589 | 816 | 11,405 |
| 2012 | 410 | 3 | 11,470 | 875 | 12,345 |
| 2013 | 444 | 4 | 12,426 | 939 | 13,365 |
| 2014 | 481 | 4 | 13,463 | 1,008 | 14,471 |
| 2015 | 521 | 4 | 14,595 | 1,084 | 15,679 |
| 2016 | 568 | 4 | 15,892 | 1,172 | 17,064 |
| 2017 | 618 | 5 | 17,303 | 1,268 | 18,571 |
| 2018 | 673 | 5 | 18,836 | 1,373 | 20,209 |
| 2019 | 732 | 6 | 20,503 | 1,487 | 21,990 |

Results of the estimates from the IPCC inventory software for the inventory year 2019 are presented in Table 2.48.

### Table 2.48: Waste sector sectoral table - Inventory Year 2019

| Categories | Emissions (t) | | | | | | |
|---|---|---|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOCs | $SO_2$ |
| 4 - Waste | 113.551 | 855.631 | 5.775 | NE | NE | NE | NE |
| 4.A - Solid Waste Disposal | NA | 108.851 | NA | NO | NO | NE | NA |
| 4.A.1 - Managed Waste Disposal Sites | NA | IE | NA | NO | NO | NO | NA |
| 4.A.2 - Unmanaged Waste Disposal Sites | NA | IE | NA | NO | NO | NE | NA |
| 4.A.3 - Uncategorised Waste Disposal Sites | NA | IE | NA | NO | NO | NE | NA |
| 4.B - Biological Treatment of Solid Waste | | NE | NE | NE | NE | NE | NA |
| 4.C - Incineration and Open Burning of Waste | 113.551 | 14.526 | 0.164 | NE | NE | NE | NE |
| 4.C.1 - Waste Incineration | 33.726 | 0.003 | 0.003 | NE | NE | NE | NE |
| 4.C.2 - Open Burning of Waste | 79.825 | 14.523 | 0.161 | NE | NE | NE | NE |
| 4.D - Wastewater Treatment and Discharge | NA | 732.254 | 5.661 | NE | NE | NE | NA |
| 4.D.1 - Domestic Wastewater Treatment and Discharge | NA | 732.254 | 5.661 | NE | NE | NE | NA |
| 4.D.2 - Industrial Wastewater Treatment and Discharge | NA | NO | NE | NE | NE | NE | NA |
| 4.E - Other (please specify) | NO | NO | NO | NO | NO | NO | NO |

Note: The original values in gigagrams in the above table from the software output have been converted to tonnes

# 3. Information on mitigation actions and their effects, including associated methodologies and assumptions

## 3.1. Background

Article 4 paragraph 1 (b) of the UNFCCC requires Parties to "*Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol*". Kiribati promoted mitigation towards meeting this requirement and the ultimate objective of the Convention to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

## 3.2. Approach

Kiribati has completed two national mitigation assessments, which were presented in the two submitted national communications, and made a partial one which served to develop its Intended Nationally Determined Contributions (INDC). Since the partial assessment associated with the INDC dates to 6 years, it has been deemed essential to update this exercise within the framework of the preparation of the NC3 to have the most updated information to inform government's decisions and future reporting to the UNFCCC. This exercise also served to build capacity of national experts for eventual transition to the MPGs of the PA in the future. In addition to the updating of the previous assessment, further potential mitigation actions have been identified in the Agriculture, Forestry and Other Land Use (AFOLU) and Waste sectors during the exercise. The latest sectoral policies, plans and roadmaps were analysed and activities presenting a potential for mitigation by addressing anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol were assessed. The measures are at national and sectoral levels and the information include methodologies, assumptions, scenarios and results. As the appropriate institutional arrangements are under development within the framework of the BUR1 (In press), this aspect has been omitted here.

The approach adopted for the mitigation assessment consisted of the following steps:

(i) Analysis of past reports with emphasis on draft NC3 thematic reports, the NC2 and other national development policies, plans and strategies, the INDC, its roadmap and implementation plan, and technical reports.

(ii) Collection of additional data

(iii) Generating a new baseline for each IPCC category responsible for emissions and removals in the country.

(iv) Projecting end-use and other appropriate data to the 2030 time-horizon based on the baseline data.

(v) Generating the Business As Usual (BAU) scenario on the basis of the projected data sets. The time series 2000 to 2013 was used as baseline to develop the BAU scenario. The year 2013 was set as base year as it is the closest one with 2014 that was adopted in the INDC. The year 2013 has been preferred in lieu of 2014 since major mitigation projects were implemented in that year.

(vi) Estimate emissions and removals for the BAU scenario for the 2030 time-horizon using the IPCC 2006 Guidelines and the 2006 IPCC GHG inventory software – version 2.69.

(vii) Screening of the INDC and other plans and reports for identified mitigation measures and actions.

(viii) Identify additional mitigation measures based on the Key Category Analysis of the updated GHG inventory.

(ix) Analyse the mitigation measures or actions relative to activity data used such as end user consumption and penetration of renewable energy for past measures and the new measures adopted.

(x) Estimate emissions with the new sets of activity data inclusive of mitigation potential by IPCC category using the 2006 IPCC GHG inventory software – version 2.69.

(xi) Calculate emissions reduction by category and sum these to obtain the potential by sector and at national level.

(xii) Finally, an assessment has been undertaken to identify data gaps for performing mitigation assessments in view to addressing them to further improve future reporting.

## 3.3. Mitigation assessment

In line with Kiribati's 20-year vision (2016-2036), the country has taken steps to mitigate climate change through the implementation of mitigation actions to reduce emissions and increase removals within its territory. Mitigation measures followed the mainstreaming of climate change in the national policies and strategies, and the eventual inclusion for implementation in the sectoral plans and roadmaps. These measures formed the basis of Kiribati's mitigation agenda and are summarized in the INDC. The national policies and strategies, and the INDC guided this mitigation assessment in addition to the results of the key category analysis obtained during the revision of the GHG inventory for generating the baseline scenario. Some of the policies already developed or on the way to be finalized are:

- The Kiribati National Energy Policy (KNEP), May 2009

The KNEP was built on the theme and vision of the Kiribati Development Plan (KDP 2008 – 2011) "*enhancing economic growth for sustainable development– a vibrant economy for the people of Kiribati*", focused on "*available, accessible, reliable, affordable, clean and sustainable energy options for the enhancement of economic growth and improvement of livelihoods in Kiribati*". In fact, the Policy sets the Government's framework for the planning and management of the energy sector.

- The Kiribati Integrated Energy Roadmap (KIER) 2017 – 2025

The KIER, which is still a basic working document, comprises a policy framework with specific targets and a set of priority actions, with associated cost estimates and specific timelines. The KIER presents a packaged plan of institutional, policy, regulatory, technical, financial, and capacity-building actions that will collectively enable the Government of Kiribati to achieve its energy objectives in line with the Kiribati Development Plan 2012-2015 (Government of Kiribati, 2012).

- The Nationally Determined Contribution (NDC) RoadMap – Transport and Energy Efficiency Sectors in Kiribati (2021)

The objectives of this roadmap are twofold, namely to

(a) Define an implementation plan over time inclusive of investment costs for mitigation actions to reduce GHG emissions and contribute to enable Kiribati to meet its NDC targets, and

(b) Provide sufficient detail on the scope of resources and support needed to implement and track progress of the mitigation actions regarding technology and infrastructure, investment, capacity building and technical assistance, governance and institutional arrangements within a robust Measurement Reporting and Verification system.

The INDC is the official document communicated to the UNFCCC following Decisions 1/CP.19 and 1/CP.20 of the COP. It highlights the climate actions, including climate related targets for GHG emissions reductions, policies, and measures that the government aims to implement in response to climate change. According to the document, Kiribati committed to reduce its emissions by 13.7% by 2025 and 12.8% by 2030 compared to the BAU projection. In addition, and on the understanding that Kiribati obtains international assistance and accesses ample financial and technical resources, it will raise its emissions reduction to 48.8% by 2025 and 49% in 2030 compared to the BAU scenario. The INDC, INDC Roadmap, KIER and various sectoral plans were screened for mitigation measures already implemented, under implementation and planned for inclusion in this report. All identified measures have been assessed for their mitigation potential using the IPCC 2006 software – version 2.69. New measures have been retained and estimates of their emissions reduction, or removal have also been made.

### 3.3.1. National baseline and BAU scenarios

Table 3.1 shows emissions stemming for the base year 2013 and the BAU scenario in 2030. The emissions are projected to increase from 102,384 t $CO_2$ e in 2013 to 135,960 t $CO_2$ e in 2030 which represents an increase of 33%.

For both the base year 2013 and the BAU scenario in 2030, the Energy sector is the main emitter of GHGs followed by AFOLU, Waste and IPPU, the latter emitting marginal amounts. The share of emissions is expected to change in 2030 when the Waste sector will become the second highest emitter behind Energy. However, in terms of % increase under the BAU scenario over the baseline, Waste leads with 106% and Energy with 33% while a decrease of 14% in emissions in the AFOLU and IPPU sectors are anticipated.

**Table 3.1: Emissions (t $CO_2$ e) for the base year and BAU scenarios**

| Parameter | Base year (2013) | BAU (2030) | % Increase |
|---|---|---|---|
| National emissions | 102,384 | 135,960 | 32.8 |
| Energy | 62,175 | 81,500 | 31.1 |
| IPPU | 70 | 60 | -14.2 |
| AFOLU | 24,055 | 21,300 | -11.5 |
| Waste | 16,085 | 33,100 | 105.8 |

### 3.3.2. National mitigation potential by sector

Different mitigation measures have been evaluated for the Energy, AFOLU and Waste sectors. These are further detailed under each sector. Table 3.2 summarizes the mitigation potential (t $CO_2$ e) at the national and sectoral levels relative to the national BAU scenario in 2030. Implementation of all the mitigation measures retained for all the sectors have an emissions reduction potential of 88,085 t $CO_2$ e representing 65% of the BAU scenario. Of these 65%, Energy will contribute 52% (70,135), Waste 8% (11,200) and AFOLU 5% (6,750 ).

**Table 3.2: National mitigation potential (t $CO_2$ e) for year 2030 compared to the BAU scenario**

| Parameter | Year 2030 | % of national BAU emissions |
|---|---|---|
| National mitigation potential | 88,085 | 65% |
| Energy | 70,135 | 52% |
| IPPU | - | - |

| Parameter | Year 2030 | % of national BAU emissions |
|---|---|---|
| AFOLU | 6,750 | 5% |
| Waste | 11,200 | 8% |
| | | |
| ***BAU Scenario Emissions*** | ***135,960*** | |

The list of actions which have been evaluated for the Energy, AFOLU and Waste sectors are provided in **Error! Reference source not found.**. The actions in the Energy Sector regroups those from the INDC, KIER and NDC Roadmap are presented under different themes to enable a better understanding of their focus. Detailed information on these actions are are presented in the BUR1 (In press) individually.

**Table 3.3: Description of actions/group of actions by theme**

| Theme | List of actions |
|---|---|
| **Energy sector** | |
| Renewable Energy (RE) –Photovoltaic (PV) systems and biofuel for electricity generation | 1. 1.3 MW PV in South Tarawa<br>2. Solar PV mini grid system for Southern Kiribati Hospital<br>3. Outer island clinic solar system rehabilitation<br>4. Mereang Taabwai Secondary Schools solar PV mini grid<br>5. Junior Secondary School system with PV in Outer Islands<br>6. Solar Home system for households (3900) in the Outer islands<br>7. Outer islands council solar PV mini grid system in Gilbert and Line Groups<br>8. PV systems in Outer Island Fish Centres<br>9. Desalination plants for vulnerable rural community: 19 systems for 12 community systems in 9 islands<br>10. Outer island police station solar system rehabilitation: 23 solar systems<br>11. Solar PV system for non-government vocational institutions: CCL Manoku and Alfred Sadd Institutions<br>12. Use of coconut fuel as biofuel for electricity generation<br>13. Deployment of additional 1,500 and 1,000 kWp PV in the power system of South Tarawa<br>14. Deployment of 200 kWp PV, 275 kW wind and 264 kW / 560 kWh battery storage in Zone 1<br>15. Deployment of 150 kWp PV, and 165 kW / 350 kWh battery storage in Zone 2<br>16. Solar Home system for additional households (6,000) in the Outer islands<br>17. Ice plants<br>18. School mini-grid small<br>19. Short term deployment of PV reverse osmosis (RO) desalination systems<br>20. Long term deployment of PV RO desalination systems |
| Energy Efficiency – Supply side | 1. Contract for annual maintenance for 3-5 years, competitively bid<br>2. Rehabilitate distribution and transmission lines, including equipment and tools and repair of the electrical workshop at Betio<br>3. Meter audits to identify meter faults and preclude illegal power connections |
| Energy Efficiency (EE) – Demand Side Management (DSM) | 1. CFL promotion – to replace incandescent lights with CFL<br>2. Replacement of 4 feet LTL tube lights with LEDs<br>3. Replacement of 2 feet LTL tube lights with LEDs<br>4. Replacing 4 ft. LTLs with LEDs in 40% of commercial buildings<br>5. Replacing 2 ft LTLs with 2 ft. LED<br>6. Replacing inefficient air conditioners in 40% of commercial buildings<br>7. Replacing inefficient refrigerators in commercial buildings<br>8. Replacement of tube lights to LEDs in government ministry buildings<br>9. Replace an average of 10 inverter type alternating current units per ministry<br>10. Ceiling Fans Regulations Switch and replacement of inefficient ACs to fans |
| EE – Capacity Building and Planning | 1. Utility Led Program to Manage Peak Demand and Savings in South Tarawa<br>2. Capacity Building for Integrated Energy Planning and Energy Statistics in Kiribati<br>3. Promotion of Sustainable Procurement |

| Theme | List of actions |
| --- | --- |
| | 4. Capacity Building in Energy Efficiency in Industry |
| EE – DSM legislation | 1. Adopt and implement the use of energy efficient labels and standards for freezers, refrigerators through an amendment to the Consumer Act<br>2. Strengthening and Expanding the Standards and Labelling Programme for Appliances |
| EE – DSM improved infrastructure | 1. Repairing water pipes leakages and installation of prepayment meters and tariff rates<br>2. Current sanitation project to repair leakages and improve sewerage infrastructure<br>3. Efficient lagoon and sea public transportation developed for nearby islands to South Tarawa |
| EE – DSM building improvement | 1. Building renovations and retrofits and proper insulation in all government buildings<br>2. Supporting the Retrofitting of Major Hotels and Commercial Buildings (Openings) |
| Maritime transport | 1. Outboard motor transition<br>2. Low carbon mini-container ship<br>3. Small Low Carbon Cargo/Passenger Freighter<br>4. Zero Impact Cruise Liner<br>5. Biofuel Blends in Land and Maritime Transport |
| Land transport | 1. Use of coconut oil as biofuel for road transport<br>2. Efficient use of fuel for transport for government sector<br>3. Bicycle/E-Bike Financing Initiative<br>4. Multi-modal Transit Initiative<br>5. Improve energy efficiency of imported used vehicles |
| Air transport | 1. Aviation Operational Training Programme |
| Residential | 1. Pilot study of 100 starter kits to implement in South Tarawa<br>2. Increase access to improved bioenergy cook stoves |
| | |
| **AFOLU** | 1. Planting of Mangroves |
| | |
| **Livestock and Land** | 1. Change in manure management and composting<br>2. Reduce fuelwood removal |
| | |
| **Waste** | 1. 25% reduction in amount of solid waste sent to landfills<br>2. 75% reduction in amount of waste open burned<br>3. Replace 75% of all wet latrines and septic tanks with dry composting latrine system |

## 3.4. Mitigation status for the Energy sector (national level)

Kiribati has been implementing mitigation since the 1990s but did not keep track of them or collected information on them for reporting purposes. As the UNFCCC process evolved, Kiribati also pursued efforts to promote mitigation and more significant actions started in 2014 to continue to-date. Mitigation targeted the Energy sector and a summary of all actions as earmarked in the country's plan/report/roadmap is provided in Table 3.4. Analysis of the INDC actions reveals that 2,412 t $CO_2$ e are presently avoided annually from implemented actions and 237 t $CO_2$ e for those under implementation while the planned reduction potential is 25,856 t $CO_2$ e for a total of 28,505 t $CO_2$ e. Similarly, for the KIER report, emissions avoided through implemented actions amount to 3,711 t $CO_2$ e with another 897 t $CO_2$ e for actions partly implemented and 3,922 t $CO_2$ e for the planned ones. The NDC roadmap projects emissions reduction of 33,100 t $CO_2$ e. Planned measures carries the heaviest weight for mitigation with 89.7% (62,878 t $CO_2$ e) followed by the implemented ones at 8.7% (6,123 t $CO_2$ e) and those under implementation at 1.6% (1,134 t $CO_2$ e). All actions from all reports are expected to result in a national mitigation potential of 70,135 t $CO_2$ e.

Table 3.4: Emissions reduction potential (t $CO_2$ e) of assessed mitigation measures

| Source | Implemented | Ongoing implementation | Planned | Total |
|---|---|---|---|---|
| INDC | 2,412 | 237 | 25,856 | 28,505 |
| KIER | 3,711 | 897 | 3,922 | 8,530 |
| NDC Roadmap | - | - | 33,100 | 33,100 |
| Total | 6,123 | 1,134 | 62,878 | 70,135 |
| Share of national | 8.7% | 1.6% | 89.7% | |

## 3.5. Energy sector

### 3.5.1. Description of sector

Emissions of the Energy sector are restricted to fuel combustion activities only in Kiribati. All fossil fuels are imported, and the source categories concerned are Energy industries, Road Transport, Navigation, Civil Aviation, Commercial, Residential and Fishing. Fuelwood and copra, a crop residue, are also used as fuel in the residential sector.

### 3.5.2. Development of baseline and BAU scenarios

#### 3.5.2.1. Methods and Data

The first step to developing the baseline consisted in collating the necessary activity data (AD), analysing them for their integrity, assuring there has been appropriate quality control and that they are consistent for the time series under consideration before their adoption. Data were sourced from the following institution and reports.

(i) Data from the Ministry of Infrastructure and Sustainable Environment (MISE) - Monthly imports, yearly sales, and consumption by end-users for years 2010 to 2017 – 2018.
(ii) Kiribati Integrated Energy Roadmap: 2017 -2025, Energy Balance, page 128.
(iii) Updated GHG Inventory report of the BUR1 (In press) for emissions and conversion factors used.

**Baseline scenario**

During the preparation of the BUR1 (In press), the GHG inventory time series was extended by 10 years with the addition of the years 2000 to 2009 along with recalculations of the 2 GHG inventories of the NC1 and NC2 using the IPCC 2006 Guidelines for enhanced consistency, estimation of new sources for an enhanced completeness and adoption of the latest recommended GWPs to improve GHG estimates and reporting and meet most recent COP decisions as far as possible. Hence, baseline GHG emissions for the period 2000 to 2013, estimated using the IPCC 2006 software and presented in the BUR1 (In press), were adopted as they provided a longer and more reliable estimates for use when performing the mitigation assessment. The baseline data were restricted to 2013 to match the same base year used for the NDC and enable a better comprehension of the situation. Emissions increased from 49,100 t $CO_2$ e in 2000 to 62,175 t $CO_2$ e in 2013 which represent an increase of 27% at the national level. In terms of categories, Fishing recorded the highest increase with 64% followed by Domestic Aviation with 48%, Residential with 35%, Commercial 35%, Road Transport 19%, Energy Industries (Electricity generation) with 13% and Domestic Navigation 11%. The aggregated emissions for each category are presented in Table 3.5 for the baseline years 2000 and 2013.

**Table 3.5: Baseline GHG emissions (t $CO_2$ e) for the period 2000 and 2013**

| Categories | 2000 | 2013 |
|---|---|---|
| Energy industries | 16,200 | 18,265 |
| Road Transport | 12,900 | 15,289 |
| Navigation | 2,900 | 3,227 |
| Civil Aviation | 1,300 | 1,920 |
| Commercial | 1,800 | 2,434 |
| Residential | 7,200 | 9,697 |
| Fishing | 6,900 | 11,343 |
| **Total** | **49,100** | **62,175** |

## BAU scenario

The BAU scenario is a projection of the present situation into the future, namely the 2030-time horizon. For the Energy sector the BAU scenario is the amount of the different fuels projected for use in 2030 based on the baseline consumption for the period 2000 to 2013. Since the categories will evolve differently as they do not depend on the same drivers, consumption of each fuel by category has been projected to the 2030-time horizon instead of a national projection comprising all categories. Projections to the year 2030 were done by linear extrapolation of the baseline AD for the period 2000 to 2013.

The projected fuel consumption for the year 2030 for the country, the different categories and sub-categories for the Fuel Combustion sub-sector is given in Table 3.6.

**Table 3.6: Baseline AD (TJ) by category for base year 2013 and projected fuel consumption for 2030**

| Categories | 2013 | 2030 |
|---|---|---|
| Electricity generation | 245.7 | 305.5 |
| Road transport | 205.3 | 255.0 |
| Domestic aviation | 26.7 | 36.9 |
| Domestic navigation | 43.3 | 57.1 |
| Commercial | 33.4 | 48.2 |
| Residential | 633.7 | 845.6 |
| Agriculture: Fishing | 162.6 | 241.8 |
| International aviation | 25.9 | 35.2 |
| **Total** | **1376.5** | **1825.3** |

The projected national fuel consumption for the year 2030 will amount to 1825.3 TJ from 1376.5 in 2013 for an increase of 32.6%. This increase stems from those of the categories and sub-categories with 24.3% for electricity generation, 24.2% for Road Transport, 38.2% for Domestic aviation, 31.9% for Domestic navigation, 44.3% for Commercial and 48.7 for Agriculture: Fishing.

For consistency purposes and in line with COP decisions, the 2006 IPCC software was used for estimating emissions for each category or sub-category by fuel for summing up to give the estimates for the Energy sector. The emissions by category, sub-category and national level along with the % increase over the year 2013 are provided in Table 3.7. Emissions increase by 31.1% at the national level. Increases ranged between 24.3% and 49.0% for the categories and sub-categories with Agriculture: Fishing topping the list. The lowest increase is displayed by the Energy industries and Road Transport categories. Energy industries are projected to lead in emissions with 22,700 t $CO_2$ e followed by Road Transport with 19,000 t $CO_2$ e, Agriculture: Fishing with 16,900 t $CO_2$ e, residential with 12,500 t $CO_2$ e, Domestic navigation with 4,200 t $CO_2$ e, Commercial with 3,500 t $CO_2$ e and Domestic Aviation with 2,700 t $CO_2$ e.

**Table 3.7: Projected emissions (t $CO_2$ e) under the BAU scenario for the year 2030**

| Categories | 2013 | 2030 | % Increase 2030 over 2013 |
|---|---|---|---|
| Energy industries | 18,265 | 22,700 | 24.3 |
| Road Transport | 15,289 | 19,000 | 24.3 |
| Domestic Navigation | 3,227 | 4,200 | 30.2 |
| Domestic Aviation | 1,920 | 2,700 | 40.6 |
| Commercial | 2,434 | 3,500 | 43.8 |
| Residential | 9,697 | 12,500 | 28.9 |
| Agriculture: Fishing | 11,343 | 16,900 | 49.0 |
| **Total** | **62,175** | **81,500** | **31.1** |

### 3.5.3. Mitigation analysis

The mitigation assessment privileged the Fuel Combustion categories that are projected to be significant emitters in the future. These are Energy Industries - Electricity generation, Transport – Road Transportation, Domestic Aviation and Domestic Navigation, and Other Sectors – Commercial, Residential and Fishing.

#### 3.5.3.1. Methods and data

The mitigation measures (Table 3.8) considered in this assessment for the Energy sector are from the following reports.

(i) Intended Nationally Determined Contribution (Republic of Kiribati)
(ii) Kiribati Integrated Energy Roadmap: 2017 – 2025
(iii) Nationally Determined Contribution (NDC) Roadmap - Transport and energy efficiency sectors in Kiribati

**Table 3.8: List of mitigation measures**

| Mitigation measure | Source | Description |
|---|---|---|
| ***Energy Industries*** | | |
| Photovoltaic (PV) – Renewable Energy (RE) | KIER and NDC roadmap | Various PV systems for on- and off-grid electricity generation backed with batteries in some cases |
| Coconut oil - RE | INDC | Use of coconut oil as fuel for electricity generation |
| Energy efficiency (EE) | KIER and NDC | Energy efficiency measures in the Energy Industries category |
| ***Transport*** | | |
| Road transportation EE | NDC roadmap | Providing technical assistance, capacity building, and investment in motorized transit services |
| Road transportation Coconut oil - RE | INDC | Use of coconut fuel to replace ADO |
| Road transportation Biofuel - RE | NDC roadmap | Use of imported biofuels to replace gasoline |
| Domestic navigation EE | NDC roadmap | Investment in low carbon mini-container ship |

| Mitigation measure | Source | Description |
|---|---|---|
| Domestic navigation - RE | NDC roadmap | Implementation of zero impact cruise liner |
| Domestic aviation - EE | NDC roadmap | To expect minor emissions reductions through improved on the ground and domestic in-flight systems |
| ***Commercial & Institutional sectors*** | | |
| RE | KIER | Various PV systems implemented for schools, fish centres, health clinics and police stations |
| EE | KIER | Replacement of linear tube lights (LTL) with Light Emitting Diodes (LEDs) and inefficient refrigerators and air conditioners. |
| ***Residential*** | | |
| EE | KIER | Replacement of incandescent bulbs and LTL tubes with compact fluorescent light (CFL) and LED lights. Introduction of more efficient refrigerators and freezers. |
| RE | KIER | Introduction of solar home system |
| ***Fishing*** | | |
| EE | NDC roadmap | To replace 2-stroke outboard motors with either 4-stroke motors or electric outboards |

The emissions reductions provided in the above reports have been adopted to generate emission reduction potentials for each category or sub-category of the Energy sector. In cases where the emissions reductions were not provided for the mitigation measures, these have been worked out based on the power capacity available from the reports and the following assumptions.

(i) Diesel is the sole fuel used for electricity generation in 2030.
(ii) No energy efficiency measures are implemented until 2030.
(iii) The IPCC default emission factors of diesel for $CO_2$, $CH_4$ and $N_2O$ for estimating emissions.
(iv) The Global Warming Potentials (GWPs) from the AR5 to convert $CH_4$ and $N_2O$ emissions into their $CO_2$ equivalent values for aggregation purposes.
(v) Diesel energy content is 0.043 TJ per ton.
(vi) An average daily sunshine of 6 hours for PV systems.
(vii) Thermal efficiency of 35% for diesel combustion.

The capacity of the PV system was equated with the amount of diesel estimated to be combusted for producing the same amount of electricity. These amounts of diesel were then used as AD to feed in the IPCC 2006 software for estimating emissions. It was not possible to calculate the emissions reductions potentials for some measures where relevant information was missing. The emission reduction potential for each measure or action was taken as the amount of GHGs avoided when implementing the measure such as the penetration of renewable energy, introduction of new technologies or adoption of energy efficient measures.

#### 3.5.4. Mitigation potential

The emission reduction or mitigation potential for each measure or group of measures for the Energy sector together with their baseline emissions are shown in Table 3.9 by category and sub-category.

Overall, there exists a potential for mitigation of 70,135 t $CO_2$ e in 2030 from the projected BAU scenario emissions of 81,500 t $CO_2$ e which represents 86.1% of the Energy sector. Energy industries (Electricity generation) will be the major contributor with 36.5% followed by the transport category with 33.2%, Commercial with 10.5%, Fishing with 4.5%, and Residential with 1.3%.

Within the Energy Industries category, use of coconut oil in replacement of diesel will have the greatest share of reduction of emissions with a potential of 12,780 t $CO_2$ e (15.7%), followed by EE measures with 10,866 t $CO_2$ e (13.3%) and PV measures with 6,080 t $CO_2$ e (7.5%).

In the Road Transport category, the use of coconut oil as a replacement for diesel will contribute 12,550 t $CO_2$ e (15.4%), EE measures in land transport 7,000 t $CO_2$ e (8.6%), use of biofuel 3,100 t $CO_2$ e (3.8%), use of other renewables and EE in maritime transport 1,400 t $CO_2$ e each (1.7%), renewables in maritime transport 1,200 t $CO_2$ e (1.5%) and EE in air transport 400 t $CO_2$ e (0.5%). All these percentage reductions are calculated with respect to the total of the Energy sector.

In the Commercial sector, EE measures will be responsible for a reduction of 8,585 t $CO_2$ e (8.8) % of the Energy total compared to renewables accounting for 1,445 t $CO_2$ e (1.8%).

EE measures and use of renewables are projected to contribute to a reduction of 559 and 505 t $CO_2$ e to 0.7% and 0.6% of the Energy total reduction respectively.

EE measures in the Fishing industry is expected to contribute to a reduction of 3,700 t $CO_2$ e (4.5%) of the Energy sector potential.

**Table 3.9: Emissions and mitigation potentials (t CO2 e) by category for the Energy sector for 2030**

| Description | Emissions BAU 2030 | Mitigation potential 2030 | % of BAU |
|---|---|---|---|
| **Energy sector** | **81,500** | **70,135** | **86.1%** |
| PV measures (KIER and NDC Roadmap) | | 6,080 | 7.5% |
| Coconut oil as fuel for energy industries | | 12,780 | 15.7% |
| Energy efficiency measures (KIER and NDC) for energy industries | | 10,866 | 13.3% |
| ***Subtotal energy industries*** | | ***29,726*** | ***36.5%*** |
| Land transport - Energy efficiency measures | | 7,000 | 8.6% |
| Land transport - Use of coconut oil | | 12,550 | 15.4% |
| Land transport - Use of biofuel | | 3,100 | 3.8% |
| Land transport - Use of renewables | | 1,400 | 1.7% |
| Maritime transport - Energy efficiency | | 1,400 | 1.7% |
| Maritime transport - Renewable | | 1,200 | 1.5% |
| Air transport - Energy efficiency | | 400 | 0.5% |
| ***Subtotal transport*** | | ***27,050*** | ***33.2%*** |
| Use of renewable energy in commercial sector | | 1,445 | 1.8% |
| Energy efficiency measures in commercial sector | | 7,140 | 8.8% |
| ***Subtotal Commercial category*** | | ***8,585*** | ***10.5%*** |
| Energy efficiency measures in residential sector | | 559 | 0.7% |
| Use of renewable energy in residential sector | | 505 | 0.6% |
| ***Subtotal residential category*** | | ***1,064*** | ***1.3%*** |
| Fishing | | 3,700 | 4.5% |
| ***Energy efficiency in fishing*** | | ***3,700*** | ***4.5%*** |
| **Total** | | **70,135** | **86.1%** |

## 3.6. Industrial Processes and Product Use (IPPU)

### 3.6.1. Description of sector

For this assessment, the activity areas in the IPPU sector were analysed for inclusion in the BAU scenario. Based on the national circumstances chapter of the NC3 and available documents, the categories where activities are deemed to be occurring are.

- 2D – Non-Energy Products from Fuels and Solvent Use
- 2F – Product Uses as Substitutes for Ozone Depleting Substances
- 2G – Other Product Manufacture and Use
- 2H – Other

All documents availed by Kiribati and others available on the Web were analysed for possible data sources on these occurring activity areas. Due to unavailability of AD, only one category, namely Lubricants Use within 2D was covered.

Activity areas which could be of importance are Refrigeration and Air Cooling and Use of Electrical equipment where gases used have very high GWPs. All these categories have been included as improvement areas to be addressed in the next inventory.

### 3.6.2. Development of baseline and BAU scenarios

#### 3.6.2.1. Methods and Data

Data on lubricants originated from those of the Energy sector after discounting the part burned in this sector. The amount used in the Energy sector for energy purposes, i.e., burned in 2-stroke engines, was deducted and the remaining quantity assigned as AD for Non-energy use in IPPU. The emissions for the baseline were estimated using the IPCC 2006 Inventory Software (Version 2.69).

**Baseline scenario**

Emissions decrease across the timeseries. As from the year 2000, it regressed from 123 t $CO_2$ to 70 t $CO_2$ in 2013.

**BAU scenario**

Future lubricant use was projected through linear extrapolation to obtain the amount for estimating emissions for the BAU scenario for 2030. The decreasing trend of consumption as from the year 2000 to 2013 was retained. The decreasing trend is consistent with the policies in Kiribati to limit the number of vehicles and improve technologies for various engines with longer servicing intervals. This is expected to lead to a reduction in the annual amount of lubricants. Emissions are projected to reach 60 t $CO_2$ in 2030.

### 3.6.3. Mitigation Analysis

Emissions from this sector accounted for less than 0.1% of national emissions in 2013 and will represent 0.04% in 2030. No mitigation measure has been identified in the country's policies to-date. Full coverage of emissions from this sector with the inclusion of the Refrigeration and Air-cooling sub-categories, Other product Manufacture and Use, and fluorinated gases such as HFCs, PFCs and SF6 will definitely change the picture and the relative importance in national emissions. Mitigation of HFCs has been identified in the latest Kiribati First NDC (2022) as one of the measures to be implemented.

## 3.7. Agriculture, Forestry and Other Land Use (AFOLU)

### 3.7.1. Description of sector

Activities linked to agriculture, land use and land use change cause emissions of GHGs and can also act as sinks of $CO_2$. Kiribati regroups numerous islands widely dispersed over a vast expanse of ocean. Most of the islands are under coconut trees that have colonized them. Livestock rearing forms part of the emitting activities while removal of wood for use as fuel for cooking purposes is also responsible for emissions.

Information available from the Food and Agriculture Organisation (FAO – Forest Assessment Reports and FAOSTATS), national census reports, World Bank and other web-based sources were consulted to assess activity areas that could be responsible for emissions or removals of GHGs. The following IPCC categories and subcategories were considered responsible for emissions and removals in Kiribati.

- 3.B.1 to 3.B.6 – Activities on land (except 3.B.3 - Grassland)
- 3.C.3 to 3.C.7 – Fertilizer use, direct and indirect emissions from managed soils and indirect emissions from manure management
- 3.D.1 – Harvested Wood Products

### 3.7.2. Development of baseline and BAU scenarios

#### 3.7.2.1. Methods and Data

The AD used for the GHG inventory were kept for the baseline line period 2000 to 2013 for the livestock sub-sector. For the Land sub-sector, the same areas were kept for the different land classes throughout the baseline period and the projection of the BAU sc enario since there was no information available to provide for changes between them. The most important area is Cropland perennial under coconut plantations. Emissions and removals occurred only in Forestland. Fuelwood removals obtained from FAOSTATS were the only activity responsible for emissions on land. Fuelwood was removed as tree parts from the wooded land as it was estimated that no tree cutting occurred in Kiribati. Data from the census reports indicate that both fuelwood and coconut husks are used for cooking purposes. In fact, the amount of fuelwood used for cooking purposes in the residential subcategory in the Energy sector is much higher than the AD used for fuelwood removal. The difference is estimated to come from coconut husks and leaves obtained from the coconut plantations. These plant parts are produced and removed annually and are assumed to be biogenic. Thus, the only emissions occurring from their use are $CH_4$ and $N_2O$ which have been estimated and accounted for under the Energy sector. The baseline was developed using the IPCC 2006 guidelines and emission estimates made using the IPCC 2006 Inventory Software. Global Warming Potentials of $CH_4$ and $N_2O$ were those of the IPCC AR5.

<u>Baseline scenario</u>

The baseline emissions and removals for the years 2000 and 2013 for the AFOLU sector are given in Table 3.10. The AFOLU sector remained a sink throughout the timeseries. The sink capacity was affected only by fuelwood removal.

**Table 3.10: Emissions and removals of the AFOLU sector (t $CO_2$ e) for baseline period 2000 and 2013**

| Year | Emissions | Removals | Net |
|---|---|---|---|
| 2000 | 22,666 | -28,731 | -6,065 |
| 2013 | 24,055 | -28,059 | -4,004 |

The emissions were mainly due to livestock through enteric fermentation, manure management and direct and indirect emissions from land.

### BAU scenario

Emissions for the year 2030 under the BAU scenario were generated as follows:

(i) For livestock, the decreasing trend for the period 2000 to 2013 was adopted to project the population for the year 2030 using linear extrapolation. This would imply a continuous decrease in animal population on account of regressing available space in urban areas for rearing of animals, coupled with an improved standard of living and more strict environmental regulations. However, to ensure food security a critical animal population has been retained for the country.

(ii) For fuelwood removal, the trend of the FAOSTATS timeseries was projected through linear extrapolation until 2030.

(iii) The sink capacity of the forestland areas has been kept constant until 2030 as no change in land use is forecasted.

The projected emissions and removals for the BAU scenario are presented in Table 3.11. The sector remained a sink of 5,900 t $CO_2$ under the BAU scenario.

**Table 3.11: AFOLU emissions and removals (t $CO_2$ e) under the BAU scenario**

| Year | Emissions | Removals | Net |
|---|---|---|---|
| 2030 | 21,300 | -27,200 | -5,900 |

## 3.7.3. Mitigation analysis

### Methods and data

In addition to the results of the Key Category Analysis obtained from the updated GHG inventory, the identification of mitigation actions and measures was based on the following:

(i) Review of national development plans and policies for identification of measures for mitigating GHG emissions

(ii) Analysis of the emissions from emitting categories and proposal of new mitigation actions/measures.

The documents consulted to take stock of national strategies and initiatives towards mitigating GHG emissions in the AFOLU sector are.

(i) Kiribati 20-year Vision 2016-2036 (2016)
(ii) Kiribati Development Plan 2016-2019 (2016)
(iii) Kiribati INDC (2015)
(iv) Draft Kiribati Integrated Environment Policy 2021-2036 (2021)

The following actions were identified from these documents for the AFOLU sector.

- Use of livestock manure to produce compost.
- Replacing fuelwood with renewable energy and crop residues.
- Planting of mangroves.
- Tree planting schemes.

The key category analysis supported these choices as the three categories Forestland remaining Forestland, Manure management and Direct $N_2O$ emissions from soils were key ones in both the level assessment for 2013 and the trend assessment for the period 2000 to 2013.

Livestock

The current manure management practice in swine husbandry, which contributes to over 99% of emissions in this category, is the use of the dry lot system where animals are kept in a paved open enclosure and manure is mixed with sand. The mixture is removed and spread on land.

The composting of the manure with other organic material, mainly agricultural wastes, has been identified as a potential mitigation option. From information available in various publications, including the IPCC guidelines, when using the composting technology, aeration of the composting pile is of prime importance and determines the mitigation potential that can be achieved through this option. Since the IPCC guidelines have been used to choose the methods to project BAU emissions, default IPCC emission factors for composting with passive aeration have been used for estimating the potential reduction in $CH_4$ and $N_2O$ emissions in manure management of the swine population.

The assumptions used are:

- 75% of manure from swine production is composted.
- Solid organic wastes (coconut husks / leaves / household organic waste) are used to mix with the manure.
- The compost will be used in crop production and accounted for as organic amendment that could result in carbon accumulation in the soil.

Land

The following mitigation actions have been considered for the Land sub-sector:

- Plantation of mangrove
- Reduction in fuelwood removal

Both these actions are mentioned in the national plans and other policy documents. The same methodology used for estimating emissions in the baseline scenario was used to evaluate the mitigation potentials of these actions.

Mangroves

There are naturally existing mangroves in Kiribati and efforts are under way to restore and preserve them. There have been several initiatives led by NGOs in collaboration with MELAD since 2005 to plant mangroves on several shorelines. The mangroves are of the fringing type and the country has produced a guide in 2020 on the best practices to ensure success of this initiative. Additional benefits of planting mangroves are the control of coastal erosion and acting as a replenishment area for preservation of marine life, biodiversity and fish stocks which contributes to food security.

Due to the inherent low fertility of the coastline soil, which is mainly coral sand, insufficient freshwater, attacks by pests, and effects of pollution there have been varying levels of success of the different initiatives. The rate of mangrove plantation is estimated at 0.15 ha annually.

An estimate of the mitigation potential of this measure has been done using the following assumptions:

(i) Biomass growth and accumulation is kept at the same level as in the BAU.

(ii) The annual planting rate of 0.15 ha is increased as from now to reach a total of 4.8 ha replanted in 2030 and all plantations are fully successful.
(iii) No wood removal occurs in these replanted mangroves.

Reduction in fuelwood removal

The various censuses available from the National Statistics Office of Kiribati indicate a significant proportion of households using biomass as a source of fuel for cooking. From 68.3% of households using firewood in 2010, the figure decreased to 44.5% in 2015 with an additional 9.0% using copra husks. However, there was concurrently an increase in those households using either fossil fuel or electricity from 31.3 % in 2010 to 45.0% in 2015.

Using biomass as a renewal energy for residential purposes is a two-pronged mitigation action. The source of the biomass however must be from a renewable source. The main sources identified are the yearly pruning of perennial crop trees and coconut husks, shells, and leaves. The latter source is largely underexploited for its renewable energy potential.

## Mitigation potential

Livestock

The mitigation potential of composting manure from swine production is summarized in Table 3.12. This measure can potentially mitigate 17% of AFOLU emissions in 2030.

**Table 3.12: Mitigation potential of composting of manure from swine production in 2030**

| Gas | Mitigation potential (t $CO_2$ e) |
|---|---|
| Reduction in $CH_4$ emissions | 2,540 |
| Reduction in $N_2O$ emissions | 1,160 |
| **Total** | **3,700** |

Mangroves

Based on the assumptions adopted, the annual biomass accumulation rate of the 4.8 ha of mangroves is estimated at 42.5 t $CO_2$ per year in 2030.

There is evidence that the mangrove ecosystem must be treated differently from other forests. There is a high proportion of carbon which is sequestered around the roots of the mangroves through continuous deposition of leaves and production of new roots to replace damaged ones. However, there are no specific IPCC guidance, on which to base the estimates to refine the amount of biomass accumulated. The more so, that for a fringing type of mangrove ecosystem, available literature consulted was restricted to estuarine types of ecosystems where biomass density is much higher than those of the fringing type mangroves. Spalding et al. (2021), quoted a figure of above 1,000 tons carbon per hectare stored in Indo-Pacific mangrove systems.

Reduction in fuelwood removal

A reduction in wood removal from Forestland has been considered as a mitigation option in the AFOLU sector. Based on wood removal statistics from FAOSTATS, it has been forecasted that in 2030 there will be 4,002 $m^3$ of wood removed from Forestland through cutting of tree parts for use as fuelwood. Reducing this amount by 75% has a mitigation potential of 3,000 t $CO_2$ in that year.

However, a series of concurrent actions will be necessary to achieve this target namely:

- Use of electricity generated from PV or other renewable systems.
- Use of coconut husks, shells, and leaves.

- Use of tree parts obtained from annual pruning of perennial crops only.
- Use of improved cooking stoves – Reducing wood or biomass used by half through a higher conversion efficiency.

There could be additional mitigation potential should these actions also shift the use of fossil fuel, mainly kerosene, for cooking.

The emissions reduction potential of mitigation measures on land are given in Table 3.13.

**Table 3.13: Emissions reduction potential of mitigation measures on land**

| Measure or action | Reduction potential (t $CO_2$) |
|---|---|
| Planting of mangroves to reach 4.8 ha | 42.5 |
| Reduction in wood removal by 75% | 3,000 |
| **Total** | **3,042.5** |

## 3.8. Waste

### 3.8.1. Description of sector

Waste decomposition can be an important source of GHG emissions depending on the management strategy adopted. This involves the disposal of Municipal Solid Waste (MSW), industrial waste, medical waste, domestic and industrial wastewater. Available information indicates that collection of MSW occurs mainly in South Tarawa and Betio. Industrial wastewater production is low, originating particularly from transformation of copra and is disposed in the reticulate system with a sea discharge. Composting of the organic fraction of MSW is a common practice in rural areas and food wastes are mostly used as animal feed. PET bottles, lead batteries and aluminium cans are usually collected and exported for recycling and hazardous wastes such as used oil, batteries, tyres, other electronic equipment, and bulky waste such as (car bodies, shipping containers, white goods, etc.) are stockpiled near the wharf and await shipment for recycling also.

An increase in the standard of living has progressively contributed to increased solid waste generation. Furthermore, improved sanitation and sensitization campaigns has also contributed to reduce defecation in the open air or at sea, thereby increasing the use of latrines.

### 3.8.2. Development of baseline and BAU scenario

#### 3.8.2.1. Methods and Data

A timeseries for waste generation was developed to estimate the amount of MSW produced in the urban and rural areas. Information available from the updated national inventory of the BUR 1 were used to fix generation rates for the years 2000, 2009 and 2018 at 0.225, 0.360 and 0.400 kg per capita per day in the urban areas. Generation rates for all the years were estimated by interpolating between the available data points. The waste generation rate for the rural areas was set at 50% of the urban rate. The same management methods as for the GHG inventory were kept.

The biogenic parts of the waste were discounted during open burning. Medical waste is reported as incinerated at the rate of 150 kg per day. This value was kept constant for all the years.

Data from the census reports of 2005, 2010 and 2015 were used to derive the AD for domestic wastewater. The information was classified under the IPCC domestic wastewater treatment systems and AD for all years between the census were generated using interpolation. No estimate was made for industrial wastewater as the information available suggest that the wastewater is discharged through sea outfalls.

Estimates for the Waste sector were made using the IPCC 2006 guidelines and the 2006 IPCC Inventory software.

**Baseline scenario**

Emissions in the baseline years 2000 and 2013 for the Waste sector are given in Table 3.14.

**Table 3.14: Emissions (t $CO_2$ e) from waste sector categories – Year 2000 and 2013**

| Year | 4A - Solid waste disposal | 4B - Incineration and open burning of waste | 4D - Wastewater treatment and discharge | Total |
|---|---|---|---|---|
| 2000 | 0 | 235 | 4,642 | 4,877 |
| 2013 | 2,244 | 475 | 13,365 | 16,085 |

Emissions rose steadily from 4,877 t $CO_2$ e in the year 2000 to reach 16,085 t $CO_2$ e in 2013. The steady increase in the use of latrines and septic tanks contributed to these increases. The main gas emitted was $CH_4$ with 93% of total emissions in 2013.

**BAU scenario**

The following assumptions have been used for generating emissions under the BAU scenario:

(i) For solid waste disposal systems, and incineration and open burning of waste categories, projected emissions were generated using lin ear extrapolation of the baseline data of the period 2000 to 2013.

(ii) For domestic wastewater:

   a. The population of Kiribati is projected to be 139,195 in 2030. The growth rate has set at 1.5% annually as from the year 2021.

   b. The use of the various wastewater management systems was projected with no open defection / beach / sea as from the year 2024. The use rates of the various systems were 3.3% centralized system, 43.1% septic tanks and 53.6% wet latrines in 2030.

The BAU emissions projections for the waste sector are given in Table 3.15.

**Table 3.15: BAU emissions (t $CO_2$ e) in 2030 for the Waste Sector**

| Year | 4A Solid waste disposal | 4B Incineration and Open Burning of waste | 4D Wastewater treatment and discharge | Waste |
|---|---|---|---|---|
| 2030 | 5,132 | 827 | 27,138 | 33,097 |

Emissions were mainly from wastewater treatment and discharge which accounts for 82% of total emissions from this sector in 2030.

### 3.8.3. Mitigation analysis

The identification of mitigation actions and measures was done on the same principles used for the AFOLU sector. The analysis of the various documents revealed that there is a national strategy, the Kiribati Waste Management and Resource Recovery Strategy 2020-2030 (KWMRRS), for managing solid waste using the reduce, reuse, and recycle approach.

The Wastewater Management and Discharge category was present in both the level and trend key category analysis for the baseline period 2000 to 2013. In view of the importance of the latter, a measure has been identified and is proposed for the management of domestic wastewater, particularly when in 2013 nearly 45% of the population were relieving themselves in nature (non-emitting as per IPCC guidelines) and this practice is expected to be fully replaced using septic tanks and latrines by 2024.

The following measures have thus been identified as mitigation options:

- Consolidate the reduce, reuse and recycle approach.
- Reduce open burning.
- Replace wet latrines with dry composting latrines.
- Use of solid waste for land reclamation.

#### 3.8.3.1. Methods and Data

Solid waste disposal

There are various initiatives and campaigns to address the situation with respect to solid waste management in Kiribati. Strategies include promotion of the 3Rs, and sensitization that will even reach the younger generation through the inclusion of environment issues in their education curriculum.

Incineration and open burning of waste

Another emitting source which will be impacted by the Government's initiatives and strategies to manage solid waste, will be open burning of waste. Legal provisions and sensitization will gradually discourage and reduce the number of people having recourse to open burning. Reducing waste generation, control of import of plastic items, use of recyclable commodities and composting will enable a significant reduction of emissions from this source category.

Wastewater treatment and discharge

This sub-category is the highest emitter in the Waste sector. Adoption of appropriate sanitation practices for hygiene and health has promoted the use of septic tanks and wet latrines during the baseline years and this will continue under the BAU scenario. These wet latrines will contribute to 70 % of the emissions under this sub-category.

Dry composting latrines are designed to transform the waste into compost with the addition of organic material such as coconut leaves. This addition will act as a bulking agent and absorb any liquid such as greywater or urine to keep the heap aerated for optimal bacterial composting activity. These units must be properly designed to include an air vent for proper aeration, a high exhaust for evacuation of any noxious odour and an access trap for removal of the humus. The compost produced is recovered periodically and applied to soil without any risk of contamination as all dangerous bacteria such as e-coli would have disappeared during the composting process.

Studies consulted show that mitigation of GHGs by using this system can be very high, reaching over 80% in some cases. A more conservative figure of 50% has been retained for this assessment. A gradual adoption rate of this technology up to the year 2030 when potentially 75% of all septic tanks and wet latrines are replaced with dry composting latrines.

There are many considerations to be considered for the adoption of this technology, namely lack knowledge and inertia, cost of investment, social and cultural attitude, disgust and reluctance to adopt a technology viewed as less hygienic. Education, sensitization, and transparent explanations are basic tools that can be used to overcome such barriers. Financial support can also be extended for adoption of such composting units.

## Mitigation potential

The mitigation potential of the measures identified for the Waste sector has been estimated based on the following assumptions:

(i) Sending of waste to landfills, reduction of waste generation and enforcement of regulatory measures which started in 2020.
(ii) A 25% reduction of waste generated and sent to landfills as from the year 2020.
(iii) A reduction in waste generated and other regulatory measures will reduce the amount of waste open burned by 75% in 2030.
(iv) Replacing 75% wet latrines and septic tanks with dry composting latrine system in 2030.

Table 3.16 presents the reduction potential of the measures assessed. A reduction of 1,300 t $CO_2$ e in the emissions in the year 2030 is expected from solid waste management and increasing in 2031 onwards. A further 600 t $CO_2$ e in GHG emissions are estimated from the reduction in the amount of waste open burned. The use of dry composting latrines will reduce the emissions from domestic wastewater management by some 9,300 t $CO_2$ e in the year 2030.

Total emissions reduction potential of the Waste sector amount to 11,200 t $CO_2$ e.

**Table 3.16: Emissions reduction potential of mitigation measures in Waste sector**

| Measure or action | Reduction potential (t $CO_2$ e) in 2030 |
|---|---|
| 25% reduction in amount of solid waste sent to landfills | 1,300 |
| 75% reduction in amount of waste open burned | 600 |
| Replace 75% of all wet latrines and septic tanks with dry composting latrine system | 9,300 |
| **Total** | **11,200** |

# 4. Vulnerability and adaptation

## 4.1. Introduction

Signatory Parties to the UNFCCC are expected to communicate to the COP, in accordance with Article 12 paragraph 1 (b), a general description of steps taken or envisaged by the Party to implement the Convention. Kiribati developed its climate change policy and laid more importance to the impacts of climate change because of its very high vulnerability.

Kiribati has further showed its engagement to combat climate change as evidenced by the inclusion under the 4th pillar, Governance, of Kiribati 20-year vision (2016-2036), in the item cross-cutting issues Environment, Climate Change and Sustainable Development. The 20-year vision clearly states *"In order to reduce vulnerability to climate change, Government will continue to implement and build on existing policy measures towards building adaptive and mitigation capacity, particularly of the most vulnerable people. The policy measures will also reduce exposure or sensitivity to climate impacts. In addition, Government will mainstream climate change adaptation and mitigation through development and effective implementation of strategies that fully integrate climate change concerns into various programmes, to ensure that the working environment is sensitive to climate change and sustainable development".*

Vulnerability and adaptation assessments, based on the national circumstances (climatic, environmental, and socio-economic) are key for a country to build its resilience to climate change. The assessments should focus on issues that are relevant to the country and be country-driven for an improved understanding of the impacts of climate change (including risks/threats) and the vulnerability and adaptation status of the country. The information gathered and provided by the vulnerability and adaptation assessments should align to the country's needs and development priorities for adapting to current climate variability and future climate change.

## 4.2. Kiribati's adaptation policy

Kiribati has clearly identified adaptation on an equal footing as mitigation and disaster risk management (DRM) to respond to climate change in its Climate Change policy (CCP). Implementation of the CCP is guided by the principles listed below to:

- Safeguard communities and the country as a whole from the adverse impacts of CC and disasters to ensure a safe and resilient Kiribati.
- Mainstream climate change and disaster risk reduction (DRR) into national and local development plans, policies, and strategies, including budgeting.
- Climate Change Adaptation (CCA), mitigation and Disaster Risk Management (DRM) activities are shared responsibilities that require coordinated, integrated, multi-partner, multi-sectoral and whole-of-government or whole-of island approaches.
- Strengthening key institutions and capacities as a basis for enhanced action and measures to ensure implementation is conducted in an efficient manner.
- Focus on actions that will strengthen the long-term resilience of Kiribati communities through sustainable environmental, social and economic benefits that combine the use of modern technologies with the preservation of traditional knowledge.
- Ensure that the CCA, mitigation and DRM are equitable, inclusive, gender-sensitive, community driven and participatory, and reflect the commitments that Kiribati has agreed to under various multilateral frameworks.
- Strengthen and maintain strategic partnerships both internally and externally.

Kiribati's Vision 2020 (KV20) which covers the period 2016-2036 and charters the long-term development of the country revolves around four pillars: Wealth; Peace and Security; Infrastructure; and Governance.

- The Wealth Pillar targets the development of the natural capital, the human capital, and the cultural capital to improve economic growth and reduce poverty.
- The Peace and Security Pillar aims at creating a secure, safer, and peaceful country through the establishment and consolidation of the National policy frameworks, institutions and strategic partnerships.
- The Infrastructure Pillar aims at improving connectivity and accessibility regarding economic and social infrastructure, namely transport and Information and Communication Technology (ICT) by improving access for higher effectiveness.
- The Governance Pillar targets the creation of a corruption-free society through consolidated national and traditional governance policy and legislative frameworks; fostering and strengthening the integrity and independence of institutions; strengthen strategic partnerships and institutionalise anticorruption and good governance principles in the public service and education systems of the country.

Furthermore, the Vision also lays emphasis on the importance of equity by giving special consideration to gender, youth, vulnerable groups, the disabled and partnerships. The Vision acknowledges the high vulnerability of the country to climate change which will need to be addressed to ensure successful implementation of the KV20. Mainstreaming of adaptation and mitigation into the sectoral programmes will attend to environment conservation, climate change and sustainable development. Environment conservation will be guided by the Kiribati Integrated Environment Plan (KIEP) and Strategic Environment Plan (SEP) of 2021 which covers the period 2021 to 2036 while the Kiribati Joint Implementation Plan, 2019-2028, (KJIP) has been developed within the framework of the CCP to address climate change mitigation, adaptation, cross-cutting issues, and disaster risk management. These two plans along with the other sectoral ones will be rolled out in an integrated manner towards meeting the low emissions agenda of the country and Sustainable Developments Goals.

The KJIP privileges a holistic approach to implementing climate actions across multiple sectors and with stronger linkages among climate adaptation planning processes at national, sectoral and island levels. The KJIP prioritises 104 climate mitigation, adaptation, and disaster risk reduction actions.

The **Vision** is *'I-Kiribati unique, culture, heritage and identity are upheld and safeguarded through enhanced resilience and sustainable development"*.

The **Goal** is *"to increase resilience through sustainable climate change adaptation and disaster risk reduction using a whole of country approach".*

Seventeen principles guide the KJIP, namely Integration, Accountability, Inclusiveness, Focus, Time-bound, Flexible to new issues, Thorough, Sense of belonging, Strategic community ownership, Integrity, Responsibility, Transparency, Good governance, Cultural values, People-centred, Effective and Efficient, and Sustainability.

KJIP's 12 key strategies for climate change and disaster risk reduction are:

1. Strengthening good governance, policies, strategies, and legislation.
2. Improving knowledge and information generation, management and sharing.

3. Strengthening and greening the private sector, including small and medium sized enterprises (SMEs).
4. Increasing water and food security with integrated and sector-specific approaches and promoting healthy and resilient ecosystems.
5. Strengthening health service delivery to address climate change impacts.
6. Promoting sound and reliable infrastructure development and land management.
7. Delivering appropriate education, training, and awareness programmes.
8. Increasing effectiveness and efficiency of early warnings, and disaster and emergency management.
9. Promoting the use of sustainable renewable sources of energy and energy efficiency.
10. Strengthening capacity to access finance, monitor expenditures and maintain strong partnerships.
11. Maintaining the existing sovereignty, and unique identity and heritage of Kiribati.
12. Enhancing resilience through strategic partnerships for community participation and engagement ownership, and inclusion of vulnerable groups.

The KJIP identifies clear results with indicators for each action to support appropriate monitoring and evaluation. The latter is yet to be fully developed and operationalized. The consolidation of the monitoring and evaluation system is under consideration within the framework of the BUR1 (In press) and will be further revised during its implementation when funds become available under the Capacity Building Initiative for Transparency project from the GEF. The KJIP is a living document and will be adjusted to fit changes in the national situation and sectoral development plans as well as the international context. The KJIP will be funded as per the present strategies with some funds coming from the national budget topped up with international development assistance, notwithstanding additional climate finance, compensation for losses and damage and disaster-related humanitarian aid.

## 4.3. The Scope of the Vulnerability and Adaptation Assessment

Paragraph 32 of the Revised guidelines for reporting in NCs to the UNFCCC contained in Decision 17/CP.8 states that non-Annex I Parties are encouraged to provide information on the scope of their vulnerability and adaptation assessment (V&A), including identification of most critical and vulnerable areas. The V&A assessment consisted of a desk review of existing literature on individual socio-economic sectors, the more recent integrated study on Climate and Ocean Risk Vulnerability Index (CORVI) undertaken by the Stimson Centre and stakeholder consultations. CORVI targeted Tarawa Island that hosts more than 50 % (Census 2020) of the total population, key economic activities and the administrative facilities of the country. The main cities of Kiribati as well as the main airport and seaport are located on this island.

A review of the most significant climate change risks, vulnerabilities, and adaptation for the sectors Agriculture and Fisheries which are directly linked to Food Security, Water Resources, Health, Coastal Zone, Infrastructure, Ecosystems and Biodiversity was undertaken. The analysis of vulnerability and adaptation in these sectors were restricted to literature and reports, available from ministries and international websites, and peer reviewed scientific publications. Therefore, the analysis done in this report builds on and updates the existing knowledge on vulnerability and adaptation in Kiribati.

The more recent Climate Risk Summary Report for the island of Tarawa using the Climate and Ocean Risk Vulnerability Index (CORVI) which assesses coastal cities to climate change using a holistic approach was also considered. The results are very much applicable and replicable for other islands of Kiribati, more so that Tarawa is the island where the main cities of the country are located.

Additionally, the high concentrations of people, economic activity and infrastructure arguably makes make Tarawa as the island potentially most prone to be impacted socio-economically. The vulnerability of settlements in Kiribati is impacted by various and complex socio-economic processes related to the cultural, political and institutional contexts and demographic pressure, as well as specific high-risk zones susceptible to inundation, droughts, floods, coastal erosion, and water scarcity. Resilient settlements can sustain themselves by coping with, or adapting to climate change threats, whereas vulnerable settlements are to varying degrees unable to cope with the adverse effects of climate change and will experience some form of harm when a hazard occurs.

## 4.4. Purpose and Objectives

Under the reporting framework of the UNFCCC, vulnerability and adaptation assessments are designed and undertaken to provide information on: (i) observed and expected impacts of climate change; (ii) vulnerabilities of specific human systems (livelihood), areas or sectors to current climate variability and future climate change; (iii) difficulties or barriers to adaptation in critical areas or sectors; and (iv) opportunities and priorities for adaptation. Therefore, this V&A contextualizes this information for key sectors of Kiribati. More specifically, the objectives were:

- To review and identify the most updated information on climate trends and projections for Kiribati to use in the adaptation assessment.
- To review and identify the most significant climate change risks, vulnerabilities, and adaptation for the Agriculture and Fisheries which are directly linked to Food Security, Water Resources, Health, Coastal Zone, Infrastructure, Ecosystems and Biodiversity.
- To conduct an integrated analysis of vulnerability to climate change impacts of coastal cities; and
- To provide updated information on responses to climate change.

## 4.5. Unit of Analysis

The units of analysis adopted for this assessment were the socio-economic sectors and islands (territorial) levels. Sectors and islands can be regarded as being representative of the country's situation and allow for the aggregation of vulnerability. Furthermore, sectors and islands are the lowest scale of development planning in Kiribati. Most climate change adaptation programmes in Kiribati are usually implemented at sector and whole of island levels.

## 4.6. General Methodological Approach

To provide information on climate trends and projections, the results of the analysis of climate (temperature and precipitation), sea level and sea surface temperature were extracted from a series of web-based and national sources.

- The World Bank Knowledge Portal for Kiribati. The data analysed are restricted to Kiritimati they are presented separately for that island. (https://climateknowledgeportal.worldbank.org/country/kiribati/climate-data-historical)
- A report from the Pacific Climate Change Science Program (PCCSP, 2013)
- The Current and Future Climate for Kiribati technical report published by CSIRO – SPREP in October 2021. This latest report analyses climate trends and projections for the three groups of islands separately.
- Data supplied for Tarawa by the KMS for the period 2001 to 2023.
- Information on current and expected future impacts of climate change based on the updated KJIP.

- The CORVI study supplemented with those from the IPCC sixth assessment report (AR6) as appropriate.
- Other literature sources were also retained as appropriate to complement this information.

Since the KJIP is the latest adaptation document which analyses exposure, sensitivity and adaptative capacity of sectors mentioned above and lays out National Adaptation Priorities including expected results for groups of actions and sub actions with indicators, identified stakeholders and potential supporting mechanisms, it has been retained for presenting adaptation in this NC3. Furthermore, the KJIP targets adaptation alongside mitigation using an integrated approach for suiting the evolving national development context.

### 4.6.1. Definition of Key Terms

The reporting guidelines contained in Decision 17/CP.8 of the UNFCCC defines vulnerability to climate change as a function of a system's exposure, sensitivity, and adaptive capacity. The definition of these components is:

- Exposure is the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be affected by climate change or the nature of climate change itself, e.g., change in sea level, temperature, and extreme events among others.
- Sensitivity is "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (McCarthy et al., 2001).
- Adaptive capacity is "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (McCarthy et al., 2001). Adaptive capacity is determined by economic resources; technology; information and skills; infrastructure; institutions; and equity (Smit et al., 2001). All these elements are necessary to enhance adaptive capacity. Limitation in one can affect the overall adaptive capacity (Yohe and Tol, 2002).

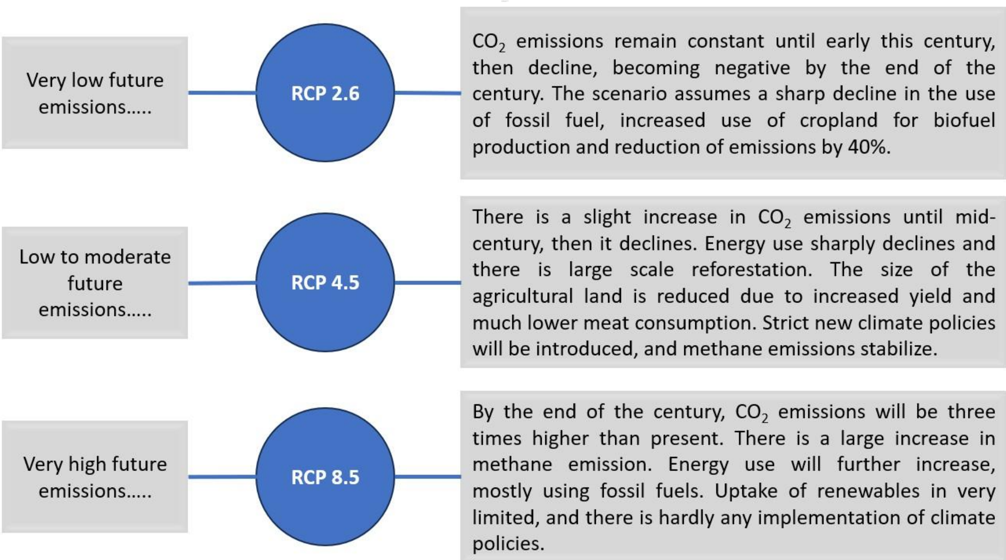
Therefore, vulnerability is defined by the IPCC as "*the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity*" (McCarthy et al., 2001). The greater the exposure or sensitivity, the greater the vulnerability; and the greater the adaptive capacity, the lower the vulnerability. An assessment of vulnerability must consider these components to be comprehensive.

An impact of climate change is typically the effect of climate change. For biophysical systems, it can be the change in productivity, quality, or population numbers or range. For societal systems, impact can be measured as change in value (e.g., gain or loss of income) or in morbidity, mortality, or other measure of well-being (Parry and Carter, 1998).

The IPCC defines adaptation as, "*adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*" (Smit et al., 2001). This definition includes "present" (experienced) as well as "expected" (future or anticipated) changes in climate. Thus, adaptation can be happening in response to perceived change in climate or anticipation of future change in climate. Autonomous adaptation is adaptation implemented by affected entities such as individuals, societies, or nature in response to observed or perceived changes in climate. Anticipatory or proactive adaptation is made to reduce impacts and risks from future changes in climate.

## 4.7. Current climate and projected changes

The following section provides information on the baseline climate (depending on source of information); the trend; and the projections for different future time steps (2030, 2050 and 2070). The data used in the analysis of Kiribati's climate were extracted from the sources referenced once only above and referred to again throughout the chapter. The data from the World Bank Portal, used for climate projection analyses, were produced by the Climate Research Unit of East Anglia University on a 50 km X 50 km grid with Kiritimati as reference location, while those in the CSIRO-SPREP report used data from five global observed datasets (HadCRUT5 (1850–2020), Berkeley Earth (1850–2019), NOAA GlobalTemp (1880–2019), Cowtan and Way (1850–2019) and GISTEMP (1880–2019)) for temperature while for rainfall they used the CMAP and GPCP merged gauge-satellite monthly precipitation datasets available from 1979 and ERA5 reanalysis rainfall data (1979-2020). The information in the report was disaggregated for the three main island groups. The information from KMS were recorded observations from Betio, Tarawa located in the Gilbert Island group. Kiribati population is concentrated on Gilbert and the Line groups of islands. The data in this report will thus focus on these two regions. The CSIRO-SPREP report supported the climate projections with an ensemble of 36 climate models for three Representative Concentration Pathways (RCPs). More in-depth analyses led to an improved selection of the best 21 models for the RCP4.5 and RCP8.5 scenarios while 17 only were retained for RCP2.6. These RCPs relate to low, moderate, and high global GHG emissions scenarios for simulations of future climate to the end of this century (Figure 4.1).




**Source: https://climateinformation.org/data-variables/what-do-different-rcps-mean/**

**Figure 4.1: RCPs for low, medium and high GHG emissions**

When undertaking the baseline and trend analyses, and projections, it is always important to address the uncertainties associated with results generated. These uncertainties are key to the interpretation and use of the analysis results for vulnerability assessment as well as management of climate change adaptation. However, uncertainty does not imply low confidence in the trend and projections, but rather lack of sufficient data points and observations to statistically validate the results. Indeed, all climate projections, including seasonal forecasts, are couched in terms of the probability of certain climate conditions appearing in the future. This is the framework within which humans often operate, allowing an assessment of future risks, e.g. consideration of financial and investment opportunities.

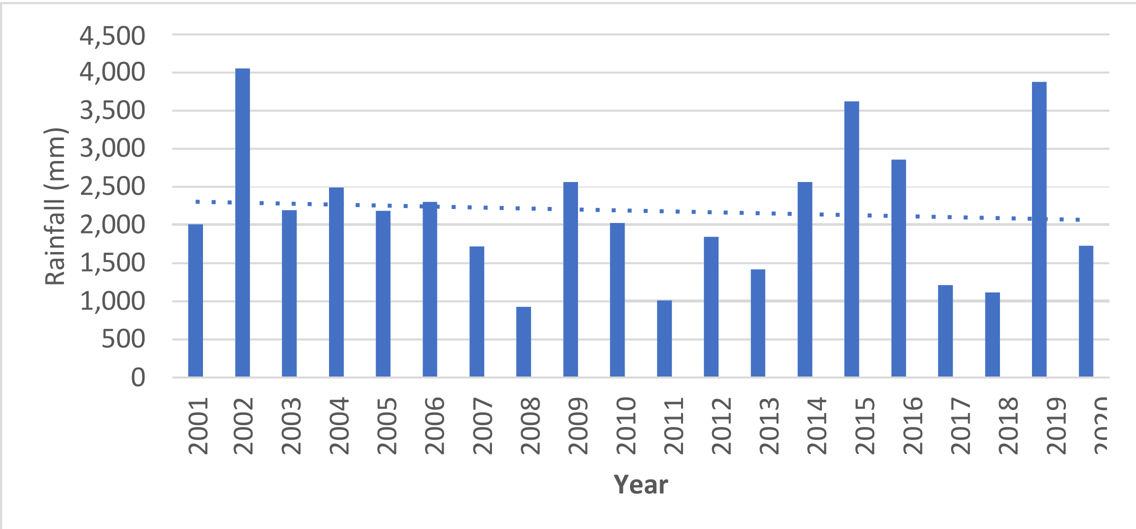
Uncertainties in climate trend analysis and climate projections arise from natural variability of climate parameters; future emissions scenarios; inherent uncertainty associated with climate change science; and the downscaling of climate data from General Circulation Models (IPCC, 2014). Therefore, to minimize the uncertainty associated with trend analysis and projections, one needs to consider all sources of information.

### 4.7.1. Baseline Climate

Data for the two major Island groups are available from different sources (KMS, World Bank, CSIRO-SPREP and PCCSP). The time periods for the various parameters discussed for the baseline climate are not the same. However, this lack of country data does not hinder a proper analysis of the actual situation of the two major Island groups.

**Baseline Precipitation**

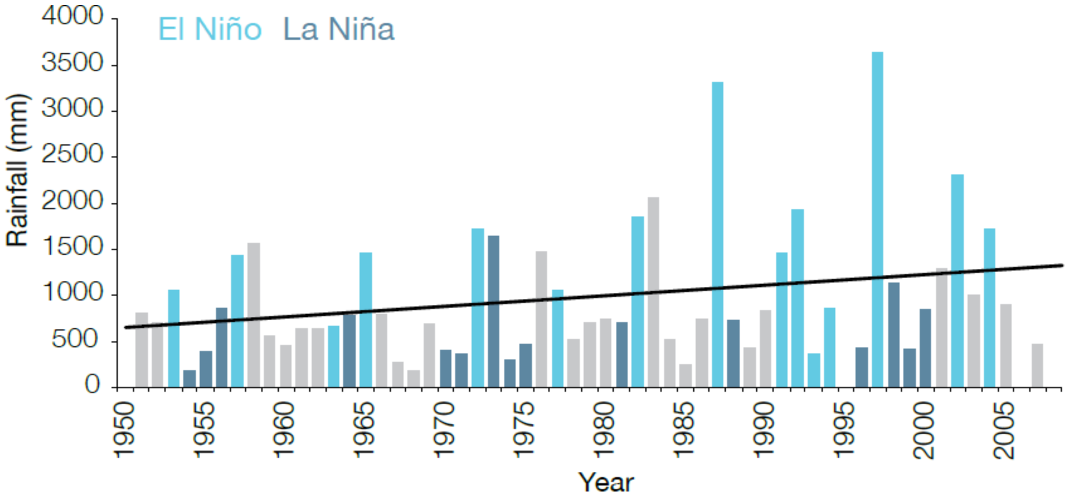
Annual rainfall in Kiribati is highly variable. This climate variable is affected by the El Nino Southern Oscillation (ENSO) index. The annual rainfall varied between 957 mm to 4055 mm in Tarawa during the past two decades (Figure 4.2). The 20 years data for Tarawa indicates 2,187 mm as the average annual total rainfall. A slight decreasing trend is observed for the period 2001 to 2020.




**Source: KMS**

**Figure 4.2: Annual rainfall (mm) in Tarawa, Gilbert Island 2001-2020**

Kiritimati rainfall is as variable as in Tarawa but generally lower with less than 500 mm in the dry years and more than 3500 mm in the very wet years (Figure 4.3). The latter also pictures the El Nino and La Nina years. The trend over the period 1950 to 2005 indicates an increase of 12.4 mm in the annual total rainfall. It is also observed that El Nino years are associated with higher rainfall than the normal and La Nina years with the opposite, and drought occurrences.

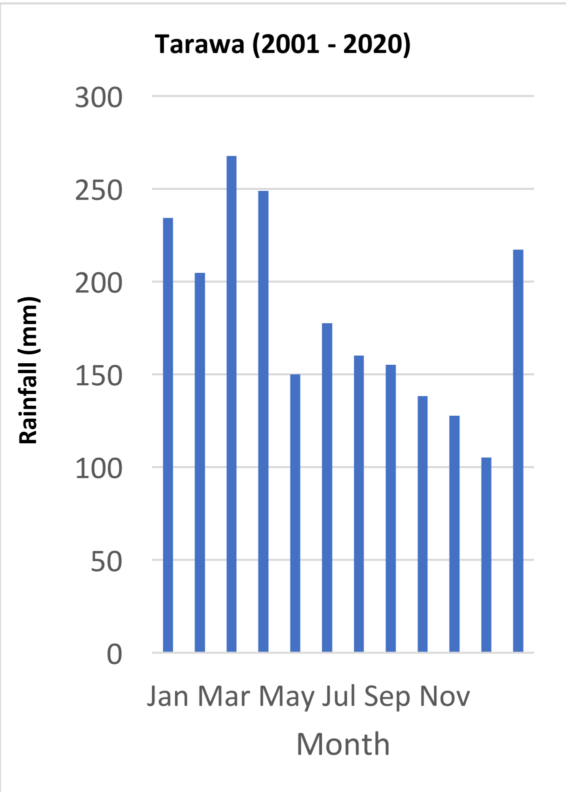


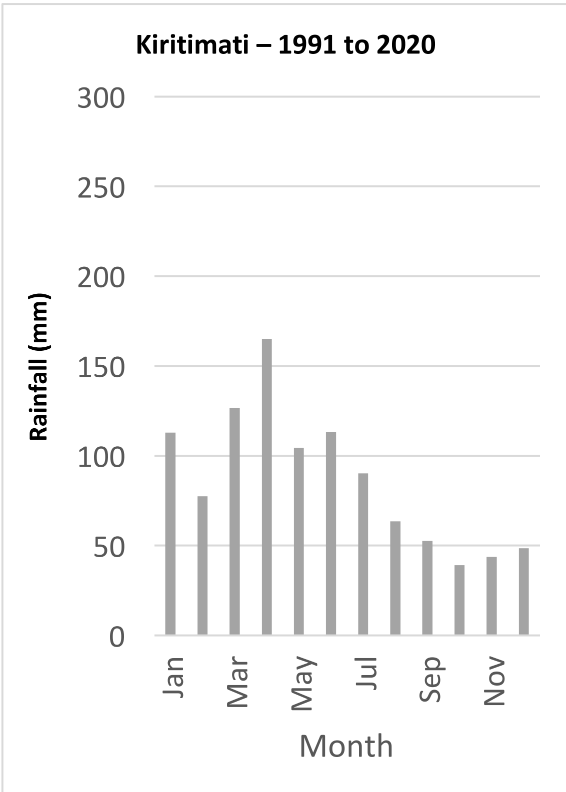

(Light blue bars indicate El Niño years, dark blue La Niña years, while grey bars are neutral years)

Source: PCCSP report

Figure 4.3: Annual rainfall (mm) in Kiritimati 1950-2007

The monthly distribution of rainfall in Figures 4.4 and 4.5 shows that the rainy season starts in December on Tarawa and in January in Kiritimati to end in June for both sites. The dry season extends from July to November in Tarawa while in Kiritimati it is between July to December.



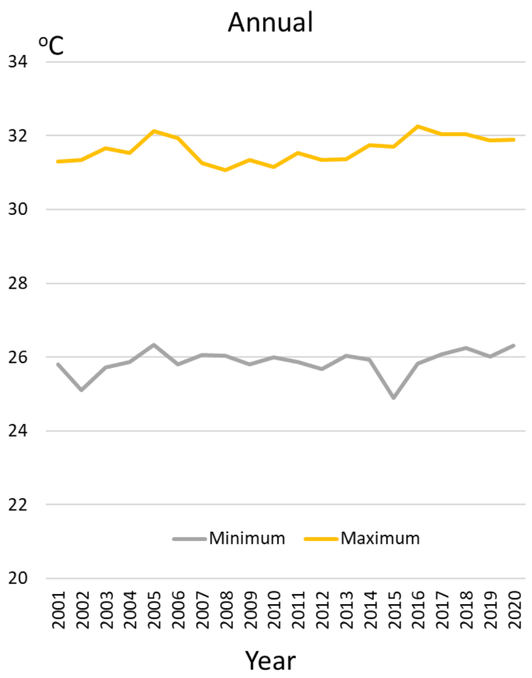

Source: KMS

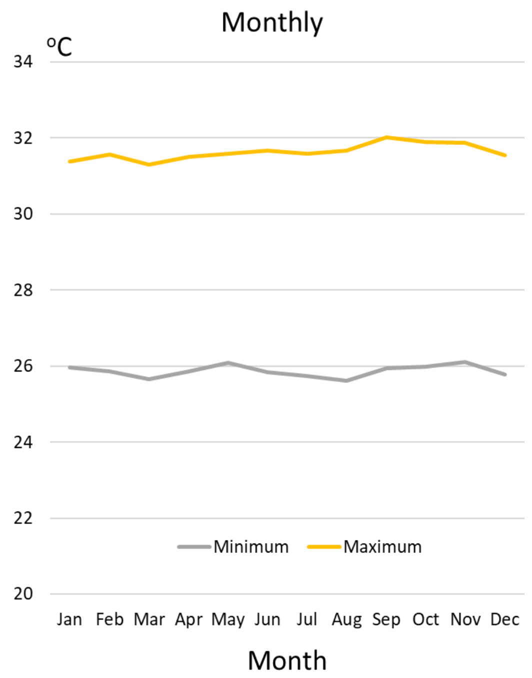
Figure 4.4: Average monthly rainfall at Tarawa

Figure 4.5: Average monthly rainfall at Kiritimati

## Baseline Temperature

Being small atolls with very restricted land masses which are also very low, air temperature on land is highly influenced by the ocean temperature. Both maximum and minimum temperatures vary slightly across the year and between years. Maximum temperature in Tarawa averaged 31.6 °C annually over the period 2001 to 2020 while the minimum was 25.9 °C (Figures 4.6 and 4.7).



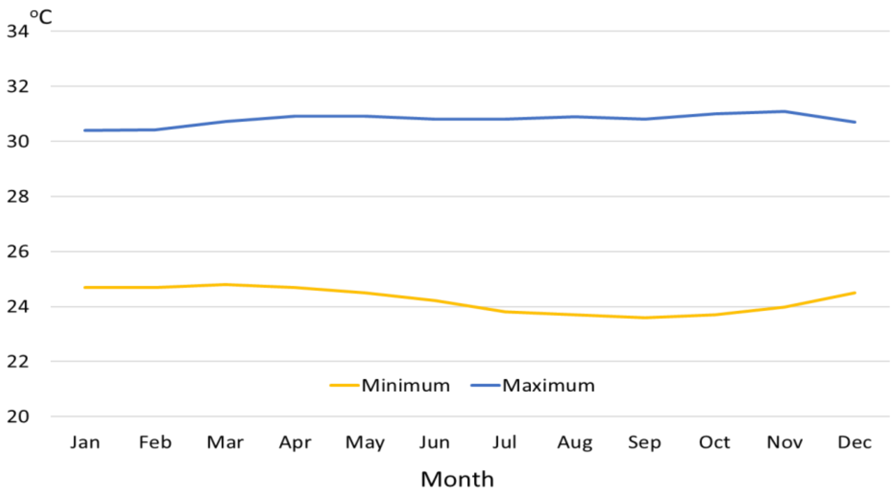




**Source: KMS**

**Figure 4.6: Average annual maximum and minimum air temperature of Tarawa (2001 - 2020)**

**Figure 4.7: Average monthly maximum and minimum air temperature of Tarawa (2001 to 2020)**

Kiritimati is slightly cooler with an average yearly maximum temperature of 30.8 °C and minimum temperature of 24.2 °C (Figure 4.8).




**Source: World Bank**

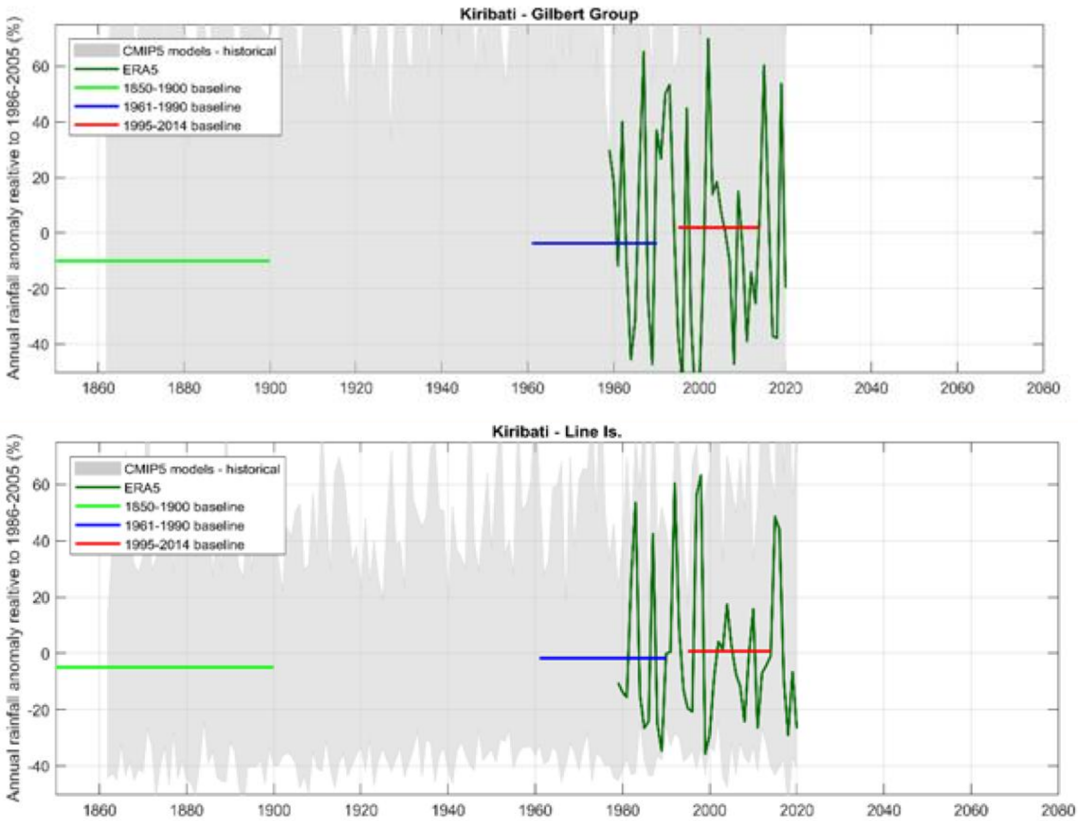
**Figure 4.8: Average monthly maximum and minimum temperature Kiritimati (1991 – 2020)**

### 4.7.2. Climate Trends

Climate trends from the analysis of the World Bank and CSIRO-SPREP reports indicate the same tendency for an increase in air temperature. The annual variation in precipitation induced by the ENSO weather pattern does not give a clear indication of the trend. There is a slight tendency for an increased rainfall as per figure 2 above. An overview of the data and information available from the various reports follows.

## Precipitation

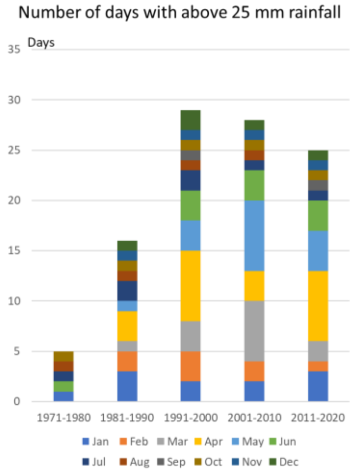
Generated rainfall from the models used in the CSIRO-SPREP study indicate a slight increase in annual precipitation when the 1961-1990 and 1995-2015 baselines are compared to the pre-industrial period 1850-1900 (Figure 4.9). The same tendency is observed for both sites but with a slightly higher increase for the Gilbert group compared to the Line group. There is however a high variability which is indicative of alternating dry and wet periods ranging from a reduction of about -55% to an increase of about 75% between years for the Gilbert group as opposed to the lower magnitude of about -35 to +65% for the Line group.

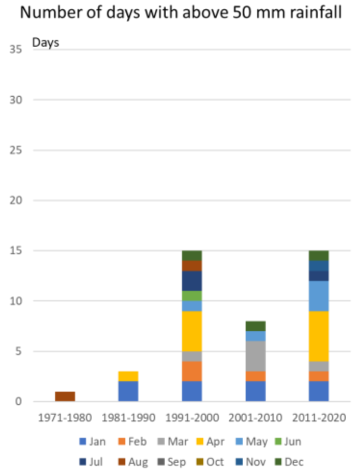



**Source: CSIRO-SPREP report**

**Figure 4.9: Area-average of Kiribati sub-region annual rainfall (%) since the pre-industrial period relative to the 1986-2005 period from gridded observations**

The World Bank Report analysed the occurrence of 1-day precipitation, and it is interesting to note that as per this study, an increase in the number of days with rainfall above 25mm or 50mm is observed over time. Figures 4.10 and 4.11 show the information for Kiritimati for the period 1971 to 2020. Cumulative monthly occurrences show a significant increase in daily rainfall during the post 1990 decades, that is the past 30 years. This has serious implications due to the floods arising from those events, especially the above 50mm ones.



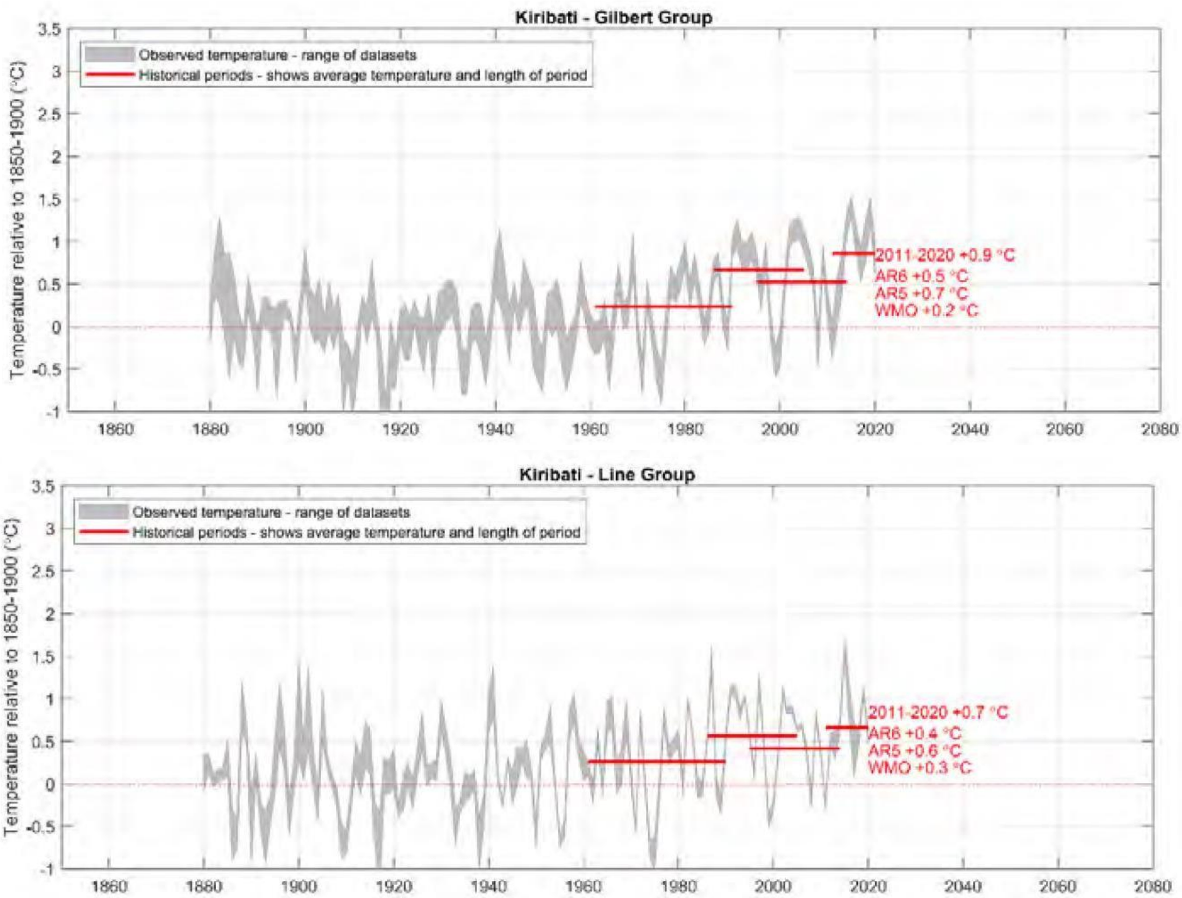




**Source World Bank**

**Figure 4.10 and Figure 4.11: Total occurrence of high rainfall events in Kiritimati for each decade (1971 –2020)**

## Air temperature

The evolution of air temperature from 5 research centres for the Gilbert and Line groups of islands relative to the 1850 to 1900 time period is displayed in Figure 4.12. The red line of the 4 time periods for WMO, AR5, AR6 and past 10 years are also shown. It is clear that there has been a sharper increase as from the 1980s for both groups of islands. Kiribati has warmed by about 0.6 °C to 0.7 °C on average compared to the pre-industrial period 1850 to 1900 while the global increase (land and ocean) has been 1.1 °C.



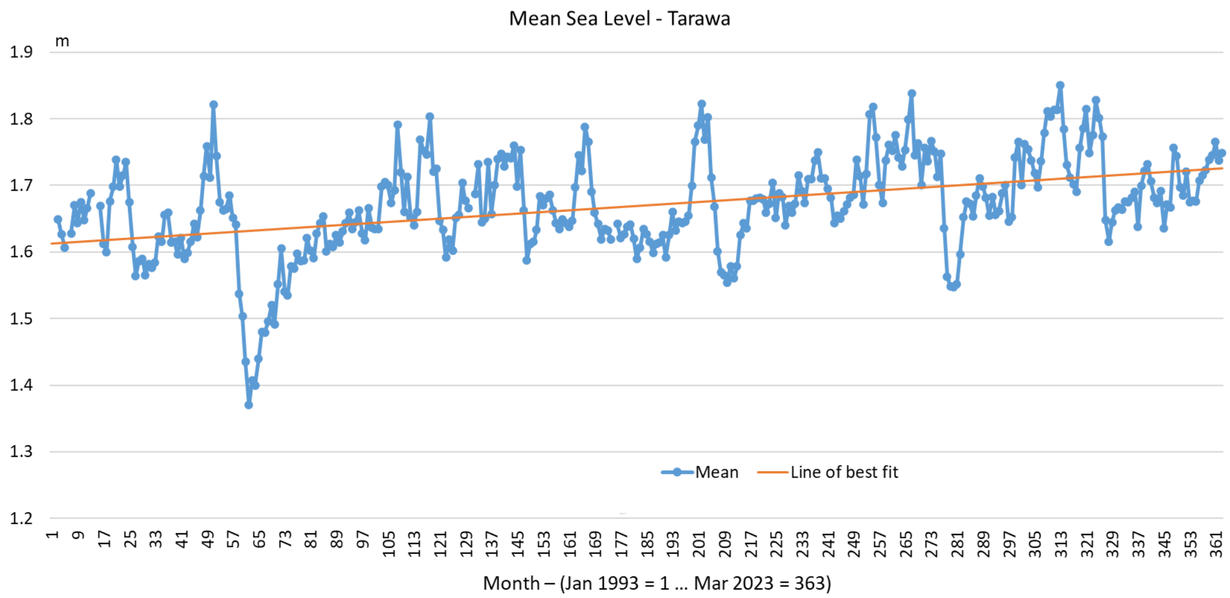

**(Source CSIRO-SPREP) (°C; grey band indicates the range of five global temperature datasets)**

**Figure 4.12: Average annual temperature of Kiribati regions relative to 1850-1900 and the climate average for four different historical periods (baselines)**

- WMO 1961-1990 is a common baseline used by the World Meteorological Organisation
- AR5 1986–2005 is the baseline used in the IPCC 5th assessment report (AR5), and PACCSAP
- AR6 1995-2014 is the new baseline that has been used in the IPCC 6th assessment report (AR6)
- 2011-2020 is a recent ten-year period

## Sea level rise

Observations of sea level for the Tarawa gauge are presented in Figure 4.13 for the period 1993 to 2023. There is clear evidence of a rise in sea level at the average rate of 3.6 mm annually.




**Source: KMS**

**Figure 4.13: Mean Sea level at Tarawa on a monthly basis (Jan 1993 – Mar 2023)**

### 4.7.3. Climate Projections

Despite the considerable progress made in climate change science, uncertainty is still an issue when projecting climate at the global, regional, and national levels. Several issues constrain projections of climate. Uncertainty regarding future global GHG emissions; limitations in the understanding of the dynamics of global climatic systems; natural climatic variability displayed in the baseline data; uncertainty pertaining to $CO_2$ 'fertilization' effect on plants; and limitations in the downscaling techniques employed to produce RCMs from GCMs. The simulations at best, produce only a possible evolution of future climate systems.

When making climate projections, several GCMs use global development storylines, i.e., the so-called Emission Scenarios, as inputs. Therefore, each Emission Scenario leads to a suite of possible futures and a plausible representation of future climate. The projections presented below are averages of statistically downscaled projections made from subsets out of 36 GCMs.

Projections of annual temperature (Table 4.1) and rainfall (Table 4.2), for 6-months periods May-October and November to April are presented below. The baseline is 1986 to 2005 data, and the projections are for the short term (2030), medium tern (2050) and long term (2070). Projections are for a low and a high emission scenario for the years 2050 and 2070, and only for a single scenario for the short term 2030.

## Temperature

For the Gilbert group of islands, the average annual temperature increases at the different time frames are slightly higher than those of Line Islands, by 0.1 °C. The short term 2030 increase is projected to be 0.8 °C. For the low emissions scenario, the projections are at 0.9 °C for both timesteps but 1.5 °C in 2050 and 2.3 °C in 2070 under the high emissions scenario. The magnitude of changes for the different scenarios and time steps are presented in Table 4.1.

For the Line group of islands, an average annual increase of 0.7 °C is projected to 2030 which increases to 0.8 °C in 2050 and 2070 for the low emissions scenario. A more substantial annual increase is anticipated under the high emissions scenario with averages of 1.4 °C and 2.2 °C to the 2050- and 2070-time horizons. The range of change for the different time steps and scenarios are depicted in Table4.1.

**Table 4.1: Projected changes (°C) in temperature for Gilbert and Line Island Groups**

**(RCP2.6 in white and RCP8.5 in light blue backgrounds)**

| | Gilbert Islands | | | Line Islands | | |
|---|---|---|---|---|---|---|
| | **2030** | **2050** | **2070** | **2030** | **2050** | **2070** |
| Temperature from 1986-2005 (°C) | 0.8 (0.4 to 1.2) | 0.9 (0.6 to 1.5) | 0.9 (0.5 to 1.4) | 0.7 (0.4 to 1.1) | 0.8 (0.6 to 1.3) | 0.8 (0.5 to 1.3) |
| | | 1.5 (1.0 to 2.2) | 2.3 (1.5 to 3.5) | | 1.4 (1.0 to 2.0) | 2.2 (1.5 to 3.2) |

**Source: CSIRO- SPREP**

## Rainfall

Projected changes for rainfall are shown in Table 4.2. Irrespective of emissions scenario and time step, a slight increase in rainfall, varying between 4 and 13%, is projected for the Line group compared to a more significant one for the Gilbert group which varies from 15 to 48%. On the same criteria, the projection ranges from a low of -4% to a high of 26% for the Line islands as opposed to -9 to 124% for the Gilbert islands. Overall, the average annual rainfall increases with time and intensity of emissions of emissions.

For the period May to October, the Line islands are expected to experience between a reduction of 10% to an increase of 20% under all emissions scenarios and time steps confounded. Similarly, the projections for the Gilbert islands for the same months varies from a reduction of 8% to an increase of 155%. The latter could have consequent sectoral and national impacts and should be appropriately considered in the vulnerability and adaptation assessments.

For the period November to April, a higher average annual increase is projected under each comparable scenario for the Gilbert islands compared to the Line islands. The projections vary between -8% to 31% when considering all scenarios and timesteps for the Line islands. Based on the same parameters, Gilbert islands are expected to receive from -21 to 107% more rainfall.

**Table 4.2: Projected changes (%) in precipitation for Gilbert and Line Island Groups**

| | Gilbert Islands | | | Line Islands | | |
|---|---|---|---|---|---|---|
| | **2030** | **2050** | **2070** | **2030** | **2050** | **2070** |
| Annual rainfall from 1986-2005 | 15 (-9 to 34) | 16 (-3 to 44) | 21 (-1 to 59) | 4 (-5 to 16) | 5 (-4 to 14) | 6 (-2 to 14) |
| | | 30 | 48 | | 9 | 13 |

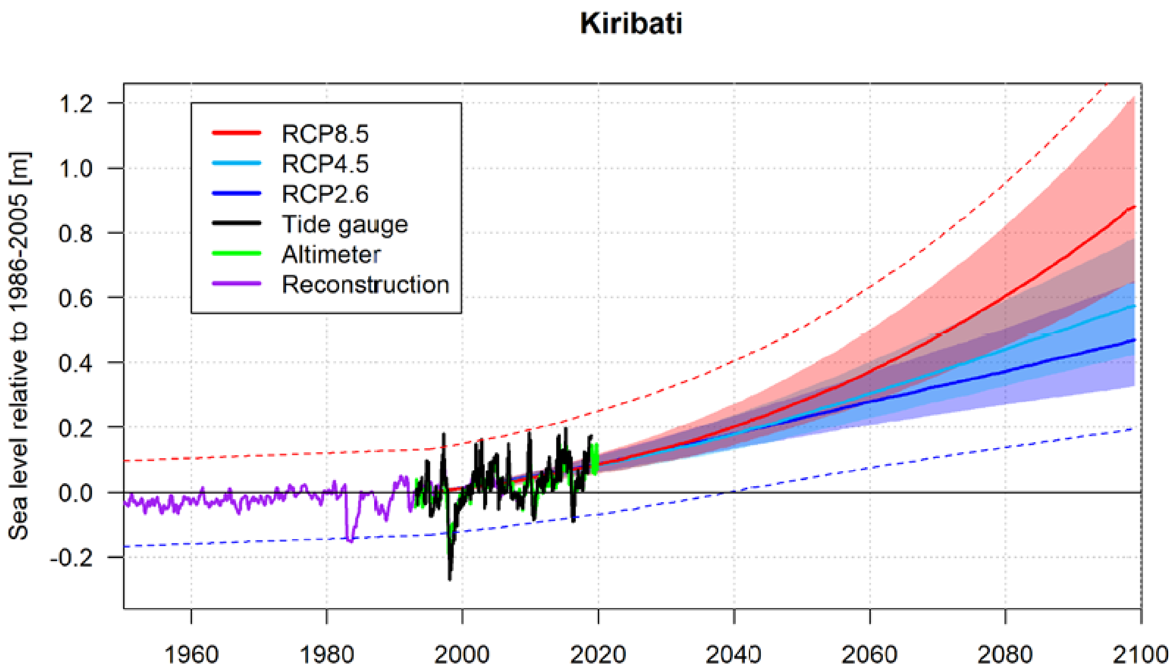
| | Gilbert Islands | | | Line Islands | | |
|---|---|---|---|---|---|---|
| | 2030 | 2050 | 2070 | 2030 | 2050 | 2070 |
| (%) | | (-2 to 70) | (-4 to 124) | | (-2 to 19) | (0 to 26) |
| May-Oct rainfall from 1986-2005 (%) | 18 (-3 to 58) | 20 (2 to 50) | 25 (-8 to 69) | 2 (-10 to 13) | 2 (-9 to 12) | 4 (-8 to 14) |
| | | 36 (7 to 87) | 64 (10 to 155) | | 5 (-4 to 14) | 9 (-7 to 20) |
| Nov-Apr rainfall from 1986-2005 (%) | 14 (-21 to 36) | 13 (-12 to 37) | 17 (-5 to 52) | 5 (-8 to 17) | 7 (-5 to 15) | 8 (2 to 17) |
| | | 25 (-7 to 73) | 34 (-8 to 107) | | 11 (-1 to 26) | 16 (2 to 31) |

**Source CSIRO- SPREP**

**(RCP2.6 in white and RCP8.5 in light blue backgrounds)**

## Sea level rise

Temperature and rainfall being more site specific compared to sea level rise, the analysis has considered Kiribati as a single entity for making projections. Observed sea level and projections are provided in Figure 4.14. Three potential evolutions are presented from RCPs based on a combination of tide gauge and altimeter measurements of the period 1992 to 2020, and reconstructed data for the period 1950 to 1991 relative to the baseline data of 1986 to 2005. The ocean level around Kiribati is projected to increase as a function of atmospheric levels of GHGs stemming from emissions intensities over time. Under RCP 2.6 which represents the lowest emissions increases, the mean rise is projected to be 13, 22 and 47 cm in 2030, 2050 and 2100. With RCP4.5, the mean sea level rise is anticipated to be 12 cm in 2030, 23 cm in 2050 and 57 cm in 2100. The worst expectations are at 13, 27 and 88 cm for the same time steps for sea level rise generated with RCP8.5. The ranges are 9 to 65 cm for RCP2.6, 9 to 78 cm with RCP4.5 and 9 to 122 cm with RCP8.5.




**Source CSIRI-SPREP report**

**Figure 4.14: Projected Sea level for Kiribati for different RCPs**

## 4.8. Vulnerability and integrated adaptation plan

This section presents the current drivers of climate change vulnerability; analysis of the vulnerability and integrated adaption addressing the key sectors to the observed and expected impacts of climate change.

### 4.8.1. Current Drivers of Climate Change Vulnerability

The country's vulnerability stems from its climate, socioeconomic and environmental characteristics including its geography. These have already been presented and is summarized here. Temperature is increasing, creating conditions with the heat index exceeding 35 °C and impacting negatively on the livelihoods of the population generally. Precipitation, though not regressing, is becoming more erratic with higher more intensive events causing floods and longer spells without rainfall resulting in drought. On the socioeconomic front, Kiribati is an LDC and a SIDS at the same time with limited economic resources to fuel the economy and cater for the well-being of the population at a reasonable standard. Thirty-two out of the 33 islands constituting Kiribati are atolls with the highest point being only about 3 metres exposing the people and the infrastructure to sea level rise, especially when this is coupled with storm surges. Ocean acidification resulting from the higher concentration of $CO_2$ in the atmosphere which diffuses into the sea water will negatively affect ocean productivity and hence the i-Kiribats who rely on fish and other marine resources as food and their major source of protein. Marine ecosystems are expected to be disbalanced thus affecting biodiversity negatively.

### 4.8.2. Vulnerability

Climate variability and change (in combination with the factors that make Kiribati particularly vulnerable to them) are affecting the environment and all socioeconomic sectors, including agriculture, education, fisheries, fresh water, health, infrastructure, tradeDRAFT and commerce. For an overview of sector-specific sensitivities and existing and potential future impacts in relation to climate change and disaster risks, it has been deemed best to retain the integrated assessment of the KJIP 2019 – 2028 that portrays very well the sensitivity alongside the observed and anticipated impacts. Table 4.3 to 4.10 adopted from the KJIP are reproduced below to present the vulnerabilities of the thematic areas or sectors Environment, Economic development, Trade and commerce, Infrastructure, Fresh water and sanitation, Fisheries and food security, Agriculture and food security, Health, and Education and human resources.

**Table 4.3: Sensitivity and impacts – Environment**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Low-lying atolls with limited land-based natural resources and biodiversity. High dependency on and demand for coastal and marine resources.<br>• Narrow and low-lying land, climate variability influencing ocean characteristics and components, thin underground freshwater lens.<br>• Negative impact of poorly designed infrastructure on the environment due to lack of capacity, understanding natural processes and resources; e.g., seawalls causing erosion or causeways harming marine habitats.<br>• Mining of beach sands and aggregates.<br>• Pests and invasive species.<br>• Low level of communication, education and public awareness and lack of priority given to conservation and management of biodiversity including habitats at all levels. | • Increasing coastal inundation, erosion and loss of land.<br>• Increasing loss of island biodiversity on land and at sea and degradation of important habitats (such as mangroves, coral reefs).<br>• Increasing environmental degradation and vulnerability of marine and terrestrial ecosystems and habitats to the additional stressors caused by climate change and hazards.<br>• Increasing outbreaks of invasive species, pests and diseases.<br>• Increasing water-, food- and vector-borne diseases. |

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Low level of budget allocation and integration of climate change, disaster risk management, gender, environmental conservation and biodiversity management considerations in development strategies.<br>• Limited capacity for integrated assessments of risks, including gaps in enforcement of environmental impact assessments, cost-benefit analyses and feasibility studies. | • Potentially high environmental costs of development or private sector projects that have yet to fully consider environmental and possible disaster and climate change impacts.<br>• Salinisation of groundwater lens and decline in size of groundwater lens |

**Table 4.4: Sensitivity and impacts – Economic development, trade and commerce**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Limited employment opportunities in-country and overseas, especially for youth, women and their families.<br>• Lack of access to capital and land for private sector development.<br>• Business environment is not conducive to investment due to excessive licensing and tariffs in current government service regulations and outdated laws.<br>• Increasing trade deficit.<br>• Increasing household hardship and rates of poverty.<br>• Potential of oceanic tuna fisheries not fully capitalised for private sector development.<br>• No insurance coverage is available for certain natural hazards i.e., erosion, loss of land, inundation and flooding (Kiribati Insurance Company). Also, there are gaps in obtaining existing insurance (such as fire).<br>• Low levels of financial literacy and gaps in training on business development.<br>• State-owned enterprises (which get government subsidies) benefit from unfair competition with private sector.<br>• Cultural barriers to conducting business: property and wealth traditionally belong to the community whereas private sector business development is building on individualistic profit principles.<br>• Low-quality and insufficient numbers of local private vessels that provide outer islands with basic food and other commodities.<br>• Private businesses sell low-quality imported food and equipment with short life cycles.<br>• Negative messages on the impacts of climate change (e.g., "Kiribati is sinking") affecting investment. | • Decline in remittances and GDP, thus limiting capacity to reduce vulnerability and increasing hardship and poverty.<br>• Outbreaks of fire are threatening businesses in urban areas, especially as fire trucks cannot access densely populated areas.<br>• Economic losses due to damage caused by fire, erosion, loss of land and flooding. Small retailers might also have to close down.<br>• Decreasing investment from overseas.<br>• Economic losses for small and medium-sized enterprises (e.g., in artisanal fisheries, agriculture, handicrafts and food processing) due to decreased productivity of agriculture and coastal fisheries, which in turn increases hardship and poverty.<br>• Bad weather conditions (such as heavy storms) cause delays of freight ships to Tarawa and smaller trade vessels to outer islands, leading to shortages in basic food commodities (sugar, rice, flour) and economic losses.<br>• Coral bleaching will make Kiribati less attractive to tourists and foreign investment in the tourism sector. |

**Table 4.5: Sensitivity and impacts – Infrastructure**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Costs of construction are high, with most materials, tools and equipment needing to be imported and transported long distances.<br>• Lack of financial resources needed to maintain key infrastructures such as causeways, seawalls, buildings, government houses, health clinics and schools.<br>• The salty, humid and hot environment leads to rapid deterioration of equipment, while lack of funds means that much plant and machinery is being used beyond its planned economic life.<br>• Infrastructure such as causeways, seawalls, buildings, government houses, health clinics and schools are sometimes built very close to the sea (both South Tarawa and outer islands).<br>• Causeways and other coastal infrastructure often do not take into account their potential negative impact on marine ecosystems and coastal fish productivity.<br>• Lack of access to environmentally safe aggregates and increasing practice of beach mining carried on by individuals, households, communities and building contractors.<br>• Conflicts around land ownership and demarcation. | • Increasing loss of usable land and existing investments.<br>• Increasing destabilisation of beaches contributes to erosion (especially in South Tarawa, but potentially also other islands except Banaba).<br>• Increasing risk of damage and/or loss of major transport facilities (airport, ports).<br>• Increasing costs and challenges for maintenance.<br>• Increasing risk of damage to government property, with negative impacts on basic services (hospital and health services, school and education, government housing).<br>• Increasing damage and interruption to roads, causeways and bridges, which might lead to isolation of communities, increased risk of accidents and increased costs for maintenance and repair of cars and road transport.<br>• Increasing risk of damage to civil society and cultural facilities (private schools, NGOs, churches, Maneaba).<br>• Increasing damage to services i.e., water mains, sewerage and electricity.<br>• Increasing conflicts among private landowners if private buildings have to be relocated.<br>• Increasing conflicts between private landowners and government about landdemarcation if public infrastructure andbuildings such as schools have to be relocated. |

**Table 4.6: Sensitivity and impacts – Fresh water and sanitation**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Availability of drinking water is inadequate.<br>• In urbanised areas with high population growth, demand for fresh water is growing.<br>• Lack of information on or systematic monitoring of the microbiological quality of water supplies, especially on rural outer islands.<br>• Industrial contamination, particularly leaking hydrocarbons from diesel power generators. | • Continued and increasing contamination of groundwater.<br>• Increasing water-borne illnesses and high infant mortality rates.<br>• Increasing socioeconomic costs of water-borne illnesses (loss of family members, work absences and general lack of well-being).<br>• Continuous and increasing tensions and conflicts between affected communities and the government because of declaration of water reserves over privately owned land, leading to costly ongoing disputes and vandalism of water infrastructure and |

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Despite regulations, encroachment is a continuing threat to water reserves especially in South Tarawa, Banaba and Tabakea.<br>• Lack of involvement of local landowners in management of water reserves.<br>• Reduced freshwater quality impacting on traditional women's domestic responsibilities (i.e., cooking, washing, bathing children and elders, fetching potable water, etc.).<br>• Increased temperatures can increase risk of water-borne (and vector-borne) diseases.<br>• Lack of regulations for protecting water sources in rural areas or outer islands.<br>• Traditional practices of defecating on the beach cause algal bloom and ultimately can lead to health problems.<br>• Risk of plume of sewage from the Betio outfall to enter into the lagoon, and some households on South Tarawa are not connected to the sewerage system.<br>• Cultural sentiments against composting toilets. | groundwater monitoring boreholes.<br>• Increasing risks of contaminating the Tarawa lagoon with sewage, with impacts on health of people and the marine habitat. Increasing pressure on women and their families from reduced access to freshwater.<br>• Women bear the burden of care for family sickness; impacts that are exacerbated as a result of increased risk of water-borne disease with increased temperatures.<br>• Frequent, long and severe droughts occurred regularly in the past (e.g., in South Tarawa and Banaba) causing severe shortages of fresh water and dramatic increases in salinity in domestic wells, death of some trees and dieback in others, and increasing demand for potable, reticulated water. Some islands were temporarily abandoned. It is still unclear, though, if and how the frequency and intensity of La Niña events will change.<br>• Increasing risks that the sea will overtop parts of or even whole islands, causing salinisation of some fresh groundwater |

**Table 4.7: Sensitivity impacts – Fisheries and food security**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • High dependence on coastal fisheries for subsistence (main protein source).<br>• Diminishing stocks of reef fish, especially for lagoon and coastal fisheries in South Tarawa, due to population pressure and associated socioeconomic and environmental problems.<br>• A lack of understanding of actual fisheries stock that will make it more difficult to set foreign fishing fees for the future.<br>• Bycatch of commercial oceanic tuna fisheries remains unused for food or for generating income.<br>• Coastal fisheries are largely unregulated, with existing management | • The productivity for coral reef fish and invertebrates is projected to decline by 20 per cent by 2050 due to both the direct effects (e.g., increased sea surface temperature) and indirect effects (changes to fish habitats) of climate change. Population growth is further reducing the potential supply of reef fish per person.<br>• Higher water temperatures and rainfall and/or increased ocean acidification are expected to progressively reduce the efficiency of culturing seaweed, giant clams, pearl oysters and sea cucumbers.<br>• Possibly increased incidence of ciguatera fish poisoning, shellfish contamination and algal blooms.<br>• Changes to the distribution and abundance of tuna: Concentrations of skipjack tuna will likely be located |

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| arrangements<br>focusing only on licensing revenue and island councils tending to discuss fisheries only in the context of infrastructure concerns (e.g., lights, wharves).<br>• Design and building of causeways and other coastal infrastructure often do not take into account their potential negative impact on marine ecosystems and coastal fish productivity.<br>• While women dominate marketing and sales of fish and are engaged in shore-based harvesting and gleaning for marine resources, they are not granted the same status or public recognition as fishermen.<br>• Trans-shipment activities in Tarawa have exacerbated alcohol abuse and increased the incidence of prostitution involving young women and teenagers.<br>• Periodic outbreaks of ciguatera, shellfish contamination and algal blooms.<br>• Gaps in monitoring of ciguatera outbreaks, other outbreaks and coral reef bleaching and collaborative actions with the Ministry of Health and MedicalServices (MHMS). | further to the east than in the past (potentially beneficial).<br>• Kiribati tuna-based revenue improves during El Niño years but drops during La Niña years.<br>• Sea level rise will progressively convert large areas of intertidal lagoon habitat in Kiribati to subtidal areas, with uncertain effects on the shellfish population.<br>• Mixed trends in aquaculture: Milkfish farming in earthen ponds is expected to be favoured by higher air temperatures and increased rainfall, but the effects of sea level rise are yet to be determined.<br>• Potentially increased damage to infrastructure: More powerful storms, inundations and potential tsunami can damage wharves and essential infrastructure. This may also increase financial risks for coastal aquaculture due to more frequent damage to equipment.<br>• Potential increase in social problems such as conflict between subsistence fisheries and commercial fishers over declining fish stocks and the risk o f more prostitution and higher HIV rates with increased transshipment.<br>• Loss of traditional fishing skills and knowledge if marine habitats change and also due to lifestyle changes.<br>• Potential discouragement of future national and overseas investors |

**Table 4.8: Sensitivity and impacts – Agriculture and food security**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
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| • Harsh agricultural conditions due to small and remote atoll islands with poor soil conditions, high salinity and limited groundwater supply.<br>• Limited crop and genetic diversity.<br>• Crop farming mostly for subsistence (trade and export limited to coconut products: oil and copra).<br>• High dependency on imported basic food commodities, with low-quality issues and public outcries when shortages occur (especially rice, sugar and flour).<br>• Lack of national food standard and quality policy.<br>• Supply constraints of agricultural produce and production level especially in the outer islands. | • Increasing risks that the sea will overtop parts of or even whole islands, causing salinisation of some fresh groundwater, destruction of infrastructure and the death of crops and livestock.<br>• Decline in production of food crops (already observed) due to increase in salinity, extreme weather events, spread of pests and diseases.<br>• Reduced livestock productivity due to heat stress, increased disease susceptibility, lack of fresh water, water- |

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| • Imported equipment and tools are expensive and of poor quality. Lack of vocational and academic training in agriculture.<br>• Loss of traditional agroforestry systems.<br>• Limited choices of livestock species for production, poor housing conditions and high imports of livestock products.<br>• Animal waste is polluting coastal land, contaminating underground water and transmitting diseases and parasites to humans.<br>• Rundown livestock and agriculture facilities and challenges in the distribution system at the Agriculture and Livestock Division (Tanaea).<br>• Urban migration. | borne diseases, decrease in production of feed, potential damage to livestock infrastructure, inundation.<br>• Diseases will interact with climate hazards to manifest in different ways. Some current disease problems will be exacerbated due to stress and nutrition-related immune challenges. Shifts in vector populations will change disease prevalence in different areas.<br>• Loss of traditional agriculture skills and knowledge.<br>• Poor nutrition and malnutrition.<br>• Increase in non-communicable diseases due to change of diet. |

**Table 4.9: Sensitivity and impacts – Health**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
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| • Existing high levels of diarrhoeal diseases, infant mortality and malnutrition among children and the elderly.<br>• Inefficient distribution of fresh water.<br>• Unprotected sources of drinking water (especially wells).<br>• A large proportion of households use the beach, bush, lagoon and sea for toileting.<br>• Difficulties in avoiding bacterial and chemical contamination of water reservoirs: coliform counts frequently exceed World Health Organization (WHO) guidelines, in both reticulated water supplies and wells.<br>• Difficulties in maintaining high standards of food hygiene.<br>• Presence of breeding sites for mosquito vector (Aedes aegypti), including abandoned vehicles and solid waste in proximity to settlements (e.g. South Tarawa).<br>• Changes in lifestyle, including poorer nutrition and less physical exercise, leading to a higher level of non-communicable diseases.<br>• Low immune status of the population and gaps in effective health care; access to health services especially limited in outer islands.<br>• Lack of specialised knowledge to conduct health assessments/tests and treat health problems, e.g., health staff lack capacity to differentiate between food poisoning and ciguatera.<br>• The health information system is still struggling to provide sufficient, accurate and timely information for decision | • Diminishing water safety and increase in water-borne diseases: Increasing risk of diarrhoeal diseases due to runoff following heavy rains and contamination of drinking water sources. Densely populated areas are at high risk.<br>• Diminishing food safety and increase in food-borne diseases: As temperatures rise, the risk of enteric infections transmitted by food increases (especially illnesses caused by salmonella, campylobacter and a wide range of enteroviruses). The risk is especially high in crowded conditions.<br>• High population density increasing risk of rapid transmission of infectious diseases.<br>• Increase in vector-borne diseases, especially dengue fever. During warmer and wetter conditions, outbreaks increase |

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
|---|---|
| making in planning, strategy and policy development. This is also true for disease surveillance and response systems, which are currently not meeting international agreed standards.<br>• Gaps in data storage and monitoring and collaborative actions with Ministry of Fisheries and Marine Resources Development (MFMRD),Ministry of Environment, Lands and Agriculture Development (MELAD) and Ministry of Public Works and Utilities (MPWU). | (already observed during El Niño events and wet season).<br>• Higher dependence on food imports with low nutritional value leads to increasing non communicable diseases.<br>• Increasing cost of healthcare. |

**Table 4.10: Sensitivity and impacts – Education and human resources**

| SENSITIVITY | OBSERVED AND POTENTIAL IMPACTS OF CLIMATE CHANGE |
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| • In primary education, the net enrolment ratio has fallen from 92 per cent to 84 per cent for boys and from 93 per cent to 87 per cent for girls between 2008 and 2010.<br>• More than a quarter of students do not make the transition to upper secondary levels.<br>• Gaps in the professional standards of teachers.<br>• The Ministry of Education (MOE), Marine Training Centre (MTC), Kiribati Institute of technology (KIT), Fisheries Training Centre (FTC), Kiribati Teachers College (KTC), schools, teachers and lecturers have insufficient capacities and resources to teach the students on matters relating to climate change (specifically on impacts and adaptation) and disaster risk management.<br>• Lack of training for police on preparedness and response to disasters, including operation of machinery such as fire trucks.<br>• Lack of effective early warning systems.<br>• Lack of disability-friendly resources on climate change and natural hazards and a lack of capacity to cope with and reduce risks among people with disabilities. | • General uncertainty and feelings of helplessness among the population about their country's future.<br>• Schools, students, teachers and trainers are affected by climate change and hazards in relation to their safety, food security, access to drinking water, ability to commute and health.<br>• School infrastructure might have to be relocated due to coastal erosion and retrofitted to withstand harsher conditions such as drought, heavy rain or heavy storms.<br>• Increasing maintenance costs for school infrastructure (also due to salt spray and rising temperatures).<br>• Lower rates of enrolment and secondary education limit opportunities for human resource development and employment (including overseas).<br>• The potential loss of life and damage due to lack of early warning systems and limited capacity to cope, especially for vulnerable groups (such as children, people with disabilities and women). |

### 4.8.3. Adaptation

The KJIP is aligned with the Climate Change Policy (CCP), the Kiribati Development Plan 2016–2019 and the Kiribati 20-Year Vision 2016–2036. The KJIP is a comprehensive plan for multisectoral and multilevel action on CCA & DRM. Within this plan, there are Key National Adaptation Priorities (KNAPs) that have been identified in the CCP and have now been further developed with actions in the KJIP for implementation. Given its national importance and the level of details it incorporates as well as the integrated approach to tackle adaptation and build resilience, the strategies targeting adaptation are reproduced in Table 4.11 after slight adaptations to fit the reporting context. Only the strategy, results and actions have been retained here and the full set of information on indicators, responsible and supporting agencies for implementing and potential partners can be obtained by consulting the KJIP 2019 – 2028 (Ref)

**Table 4.11: Adaptation strategies with results and actions retained in the KJIP 2019-2028.**

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| **STRATEGY 1. STRENGTHENING GOOD GOVERNANCE, POLICIES, STRATEGIES AND LEGISLATION.** |
| Result 1.1: Result 1.1: All policies, strategies, sector operational plans, ministry annual workplans, ministerial plans of operations, project proposals and monitoring andevaluation systems enable the proactive and inclusive reduction of climate change and disaster risks. |
| Action 1.1:<br>1. Integrate climate change adaptation and disaster risk management considerations in existing and new national sector strategic plans, ministries' policies and strategic plans, Ministerial Plans of Operations (inclusive of vulnerable groups; identified frameworks). |
| Result 1.2: Appropriate national and sector legislation is providing an enabling environment to enforce climate and disaster risk reduction |
| Action 1.2:<br>1. Review and develop enabling legislation and enforcement mechanisms to support effective risk reduction, legal responses to impacts (identified legislations) and enhanced coordination between climate change adaptation and disaster risk management legislation |
| Result 1.3: Enhance coordination between climate change adaptation and disaster risk management programmes and legislation, by government departments, island councils, NGOs, FBOs and the private sector in a collaborative manner across sectors and link these to our development aspirations |
| Actions 1.3:<br>1. Establish and strengthen mechanisms to coordinate, communicate and collaborate on climate change and disaster risk management programmes and initiatives (KJIP Secretariat, climate change communication plan) and decentralize project development and implementation.<br>2. Develop and implement a climate change and climate risks communications plan.<br>3. Establish and enhance formal mechanisms for gender equality in CCA & DRM governance, planning and implementation.<br>4. Establish and enhance formal mechanisms for partnerships with NGOs. Government and the private sector in KJIP governance, implementation and monitoring. |
| **STRATEGY 2. STRENGTHENING GOOD GOVERNANCE, POLICIES, STRATEGIES AND LEGISLATION.** |
| Result 2.1: An integrated and up-to-date national database providing all relevant information for resilient development is available and accessible for all. |
| Action 2.1:<br>1. Develop a National Data and Information Centre (including a geographic information system – GIS) to coordinate, share and manage information related to disaster risk, climate change, and loss and damage for improved decision making and increased effectiveness and efficiency (Centre to cover socioeconomic, environmental and species migratory data, GIS and maps). |
| Result 2.2: Capacities to communicate science and best practices are strengthened by developing and disseminating effective and relevant information,communication and awareness products for decision making and awareness raising across sectors and at all levels (see also Strategy 7) |
| Actions 2.2<br>1. Develop and interpret integrated data sets for dissemination to support planning and decision making at all levels (including information and awareness products).<br>2. Build a stronger evidence base of successful and unsuccessful CCA & DRM initiatives for learning and continuous improvement. |

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| Result 2.3: Capacities for data collection, assessment, analysis, interpretation, monitoring and reporting are strengthened across sectors. |
| Actions 2.3<br>1. Strengthen the capacity of the Kiribati Meteorological Service (KMS) to collect and manage data and information on weather and climate variability—especially severe weather and natural hazard events and impacts.<br>2. Strengthen capacities to collect, analyze, monitor and manage environmental data to establish the state of the environment, the trends and environmental outlook as a basis for decision making and learning in climate change adaptation initiatives.<br>3. Strengthen the capacity to collect, assess and analyze relevant agrometeorological data and impacts on crop yields, diversity and seasonality of local crops, agricultural pests and diseases, invasive species, soil productivity and livestock.<br>4. Strengthen the capacity to regularly monitor the salinity, water quality, and thickness of freshwater lenses in locations that are used for water supplies (water reserves) on South Tarawa and the outer islands.<br>5. Develop a national hub for GIS information to improve decision making on sustainable development in the context of disaster risk reduction and climate change impacts (especially minerals, land-use planning and management, and fisheries planning and management).<br>6. Establish and formalize an interdepartmental national monitoring team on coastal changes.<br>7. Build technical capacities at national and sub-national levels to undertake broad-based vulnerability assessment. |
| **STRATEGY 3: STRENGTHENING AND GREENING THE PRIVATE SECTOR, INCLUDING SMALL TO MEDIUM-SIZED ENTERPRISES** |
| Result 3.1: Increased investment by businesses, including small and medium-sized enterprises and women in value-adding marine and agricultural products for the domestic and export niche markets, and benefit women and men equally. |
| Actions 3.1<br>1. Strengthen and promote "green" and gender-inclusive businesses, particularly small and medium-sized enterprises focusing on value-added agricultural and marine products.<br>2. Strengthen capacities of existing export companies to increase export of locally made products.<br>3. Support the development of social enterprises and community-based business ventures to diversify local incomes, particularly for women.<br>4. Establish a value chain development project for agricultural production,processing, enterprise development, markets development and marketing. |
| Result 3.2: Private sector implements greening and risk management initiatives (in areas such as tourism, trade, transport, import and export). |
| Actions 3.2<br>1. Explore and implement opportunities of greening import-based private sector (especially in South Tarawa and Kiritimati).<br>2. Strengthen and achieve ecotourism initiatives that support CCA and DRM (e.g., bonefish tourism) and can encourage investment through climate risk management measures.<br>3. Develop and strengthen local businesses and artisanal fisheries to capitalize on the likely increase in skipjack tuna stocks and to better use bycatch for food security.<br>4. Develop Fisheries Management Plans for key commercial species, including: *beche-de-mer*, aquarium, bonefish (sport fishing and subsistence), arc shells, giant clams, seaweed etc., to strengthen sustainable management and resilience, and ensure the increase of revenue from fisheries, considering the likely effects of climate change and disaster risks on these commercial |

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| resources.<br>5. Review aquaculture activities and develop aquaculture development strategy to maximise food security and to benefit livelihoods. |
| Result 3.3: Private sector incorporates climate change and disaster risks into its strategic and business plans (and assesses feasibility of insurance) |
| Action 3.3<br>1. Incorporate the consideration of risks and responses to climate change andhazards into strategic and business plans and explore options to transfer risks to third parties (micro insurance) to protect local businesses from loss of business and/or profit due to damage caused by fire, inundations, storms, coastal erosion and tsunami. |
| **STRATEGY 4: INCREASING WATER AND FOOD SECURITY WITH INTEGRATED AND SECTOR-SPECIFIC APPROACHES AND PROMOTING HEALTHY ANDRESILIENT ECOSYSTEMS** |
| Result 4.1: Communities with island councils manage and implement climate change adaptation and disaster risk reduction measures as an integral part oftheir development efforts and inclusive of vulnerable groups. |
| Actions 4.1<br>1. Develop and implement a programme for community-based integrated vulnerability assessment, climate change adaptation and disaster risk management (such as the Whole-of-Island Approach, WoI).<br>2. Develop community-based protected areas and protected species at outer island level. |
| Result 4.2: Salt-, drought-, rain- & heat-stress resilient crops, fruit, vegetables and livestock breeds are identified and promoted, and communities preserve local food (fruit trees and seafood). |
| Actions 4.2<br>1. Conduct agricultural research programmes on sustainable and resilient food crop and livestock production systems (including soil–water management techniques in vegetable production, grey water use and wastewater treatment, livestock waste management, pest and disease control, construction, wetlands).<br>2. Design, test, implement and evaluate agriculture production systems and household-level gardening to establish food-secure communities in the face of climate changes and disaster risks at community level.<br>3. Improve agriculture services to promote sustainable agriculture management systems and resilient crops and livestock. |
| Result 4.3: Communities manage coastal fisheries taking into consideration sustainability of marine resources as well as climate change and disaster risks. |
| Actions 4.3<br>1. Implement Community-Based Fisheries Management (CBFM) in three pilot communities to increase resilience to climate change and make use of potential benefits (such as likely increase of skipjack tuna).<br>2. Deploy networks of nearshore FADs to increase access to pelagic fish andreduce pressure on coastal fisheries |
| Result 4.4: communities have constant access to local produce and basic food commodities. |
| Actions 4.4<br>1. Ensure constant and adequate supply of basic food commodities (such as rice, sugar, and flour) to increase food security on South Tarawa and outer islands.<br>2. Enhance domestic trade to strengthen Producer–Market Linkages.<br>3. Ensure timely arrival and distribution of local produce and basic food commodities.<br>4. Strengthen the institutional and technical capacities of various key sectors for a coordinated |

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| whole-of-government approach to improve local food production and address issues with imported food commodities. |
| Result 4.5: Communities manage their water resources (including during extreme events such as drought, heavy rain and storm surges) (see also Strategy 6) |
| Actions 4.5<br>1. Develop incentives and strategies for engaging local communities in harvesting and protecting water sources for public water supply and form village water and sanitation committees.<br>2. Strengthen management of water resource during drought.<br>3. Strengthening communities' engagement in safeguarding water sourcesand improving water systems. |
| **STRATEGY 5: STRENGTHENING HEALTH-SERVICE DELIVERY TO ADDRESS CLIMATE CHANGE IMPACTS** |
| Result 5.1: The public is aware of water safety and proactively reduces the spread of vector-, water- and food-borne diseases. |
| Action 5.1<br>1. Develop and provide communities with health information necessary toaddress health risks of climate change (including specific information targeting young people, people with disabilities, women and men). |
| Result 5.2: Routine systems for surveillance of environmental health hazards and climate sensitive diseases are strengthened, and the capacity of national and local health systems, institutions and personnel to manage climate change anddisaster-related health risks are enhanced |
| Actions 5.2<br>1. Strengthen routine systems for surveillance of environmental hazards and climate-sensitive diseases.<br>2. Strengthen health intervention programmes for monitoring, surveying and responding to climate-sensitive, climate-induced and disaster related diseases |
| Result 5.3: Capacities are enhanced, and equipment provided to the MHMS Central Laboratory and Environmental Health Laboratory to test water and food,conduct vector control activities and analyse results. |
| Action 5.3<br>1. Strengthen preparedness for response to outbreaks of climate-sensitive diseases |
| Result 5.4: I-Kiribati population's general health status is enhanced to be more resilient to climate-related diseases and health impacts. |
| Action 5.4<br>1. Reduce incidence of noncommunicable diseases and mental health issues (research and publicise nutrition content of local foods) |
| Result 5.5: A national climate change, disaster risk, outbreak preparedness governance framework, response plan and a sectoral environmental health plan,which incorporate surveillance and response to climate-sensitive diseases and disaster risks, are in place |
| Actions 5.5<br>1. Develop a governance framework to guide the health sector's work on climate change and disaster risk reduction;<br>Improve management, coordination and implementation of health security programmes.<br>2. Strengthen coordination, planning and budgeting mechanism within the health sector. |
| Result 5.6: Strengthened support for retrofitting medical facilities and health infrastructure adversely affected by, or susceptible to, the impacts of climate change. |
| Actions 5.6<br>1. Undertake a vulnerability and/or loss and damage assessment to identify climate change-related |

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| impacts and prioritize interventions.<br>2. Develop a comprehensive formal asset maintenance, retrofitting and replacement programme for health infrastructure. Planning and identification of funding for the maintenance and replacement of infrastructure.<br>3. Improve and expand hospitals and clinics to meet the health needs of the community. |
| Result 5.7: Enhanced Chemical waste management and alternatives to reduce contamination and pollution. |
| Action 5.7<br>1. Facilitate long-term planning and preparations to respond to the impacts of global climate change in order to build the resilience of the environmentthrough integrated waste management and pollution control programmes undertaken at a national level through MELAD. |
| **STRATEGY 6: PROMOTING SOUND AND RELIABLE INFRASTRUCTURE DEVELOPMENT AND LAND MANAGEMENT** |
| Result 6.1: The livelihood of I-Kiribati is improved through public buildings, infrastructure and utilities that are well maintained and resilient to climate changeand disasters (climate proofing). |
| Actions 6.1<br>1. In alignment with the national programme of school upgrades, retrofit school infrastructure where required to withstand extreme weather events (climate proofing) and relocate if required.<br>2. Establish a revolving fund (not the Revenue Equalization Reserve Fund) to sustain infrastructure projects and their resilience to climate change and hazards.<br>3. Retrofit coastal infrastructure (roads, causeways, jetties) to sustain it against threats of climate change and disaster risks.<br>4. Retrofit or relocate public, essential services buildings and emergencies and evacuation centres (including power, fuel and renewable energy installations and facilities).<br>5. Enhance air transport infrastructure and security to better withstand impacts of climate change and disaster risks.<br>6. Enhance sea transport infrastructure to better withstand climate change and disaster risks and provide food and water security. |
| Result 6.2: Land and marine planning and management for all islands that provides clear regulations on land development14 with competent planning authorities strengthened to implement & enforce land and marine use regulatory frameworks and water regulations (see also Strategy 1). |
| Actions 6.2<br>1. Formulation of land-use plans and development guidelines for all Kiribati islands and strengthen competent land planning authorities at the central and local levels for effective management of contemporary land planning issues considering CC and DRM.<br>2. Formulation of marine spatial plans (MSPs) for priority Kiribati waters and strengthen competent marine planning authorities at the central and local levels for effective management of contemporary marine planning issues consideringCC and DRM. |
| Result 6.3: Building coastal resilience through strategic coastal protection initiatives |
| Actions 6.3<br>1. Strengthen national capacity to manage, monitor and protect coastal areas in a coordinated manner;<br>Develop planning processes and programmes for climate proofing infrastructure throughout Kiribati.<br>2. Engage communities in becoming active partners in building coastal resilience and reducing hazards and risks related to climate change.<br>3. Develop bold and innovative engineering solutions to address coastal management issues (coastal |

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| protection) andlong-term measures to build up our islands through collaborative efforts with potential partners) |
| Result 6.4: Water reserves are protected, and communities have access to sufficient and adequate fresh water at all times (including during extreme events such as drought, heavy rain and storm surges; see also Strategy 4) and to improved sanitation facilities. |
| Actions 6.4<br>1. Strengthen national water governance so all key stakeholders are enabled to perform their allocated functions in a coordinated manner to address all water issues, including the impacts of climate change, climate variability and natural disasters.<br>2. Identify and assess potential groundwater sources (and capacity), taking into consideration current variability and climate change projects on all islands.<br>3. Identify and implement most appropriate technological and sustainable management measures to increase water safety (quality and quantity) at village level based on assessments of groundwater resources (see action above) and assessment of rainwater catchment capacity on outer islands (private households, public buildings such as schools, government offices, health centres, churches and Maneaba).<br>4. As part of the South Tarawa Drought-Response Plan, reduce water wastage and losses and rehabilitate and increase the coverage of reticulated water supply on South Tarawa (including protection and refurbishment of the Bonriki Water Reserve).<br>5. Develop sanitation and an open defecation-free environment for improved health in support of adaptation initiatives. (SMEC project).<br>6. Develop and implement asset management plans for water and sanitation resources |
| Result 6.5 Establish financial mechanisms to address the risks facing community and public assets (with a focus on climate risk insurance and building on existing initiatives and programmes) |
| Actions 6.5<br>1. Identify private and public lands and property at risk of reduction/disappearance due to climate change impact.<br>2. Develop policy options for compensating landowners for loss of property due to climate change impact |
| **STRATEGY 7: DELIVERING APPROPRIATE EDUCATION, TRAINING AND AWARENESS PROGRAMMES** |
| Result 7.1:Students and professionals have capacities to take action on adaptation,and risk reduction and coping strategies before,during and after disasters and emission mitigation. |
| Actions 7.1<br>1. Define, specify and monitor climate change and disaster risk management learning outcomes and content in the national curriculum for formal primary and secondary education, including agriculture and livestock, fisheries, water, environment and health (based on Education for Sustainable Development principles – ongoing).<br>2. Incorporate climate change, DRM and other related areas such as ICT, agriculture, livestock, environment, fisheries, water and health into KTC's preservice primary, junior secondary and senior secondary school (JSS & SSS) teacher training programme and teacher professional development training (in-service programmes – ongoing).<br>3. Integrate relevant climate change and disaster risk management content and skills into Technical and Vocational Education and Training.<br>4. Develop and implement a human resource development plan to support long-term climate change adaptation and DRM. |
| Result 7.2: The I-Kiribati population is well informed, and all stakeholders have access to up-to-date and accurate, contemporary and traditional informationon climate change and disaster risk |

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| management (see also Strategy 2) and communities take voluntary action to reduce climate change and disaster risks. |
| Actions 7.2<br>1. Increase formal and informal capacity-building programmes, which will contribute to awareness and resilience building for Kiribati. These may include competencies, skills and expertise that are needed to support climate change adaptation, mitigation and disaster risk reduction.<br>2. Strengthen the capacity of community-based organizations to provide training and awareness on climate change and disaster risk management to communities (churches, NGOs, etc.).<br>3. Strengthen capacities of media outlets, government departments, NGOsand FBOs to deliver messages on climate change and DRM. |
| Result 7.3: The I-Kiribati population (inclusive of vulnerable groups) are well qualified with formal and TVET forms of qualification to improve employability in country and outside of Kiribati. |
| Action 7.3<br>1. Generate further employment opportunities in international markets. |
| **STRATEGY 8: INCREASING EFFECTIVENESS AND EFFICIENCY OF EARLY WARNINGS AND DISASTER AND EMERGENCY MANAGEMENT** |
| Result 8.1: Strengthening disaster risk preparedness (through innovative technology), response and recovery across all sectors including, importantly, at the island and at the community level to reduce loss of life, injuries, damage to infrastructure and properties |
| Actions 8.1<br>1. Enhance governance institutional arrangements for disaster management at national and local levels (National Disaster Management Office; Island Disaster Committee).<br>2. Strengthen effective preparedness, response and recovery arrangements by reviewing the airport and other communication; developing Sector Operational Plans, hazard support plans, training and awareness campaigns; and establishing stock distribution centres, emergency evacuation plans and trialing them.<br>3. Effective enforcement at Kiribati's ports of entry to safeguard its fragile environment from external threats.<br>4. Increase the capacity of services to address the specific needs of people with disabilities and other vulnerable people during times of emergency (training, shelter availability, disability mainstreamed in disaster action plan).<br>5. Ensure all emergency and disaster management initiatives are responsive to gender.<br>6. Enshrine principles of "humanitarian assistance" and "building back better" when responding to, or recovering from the impact of disasters and ensure that these efforts take into consideration the risks associated with climate change.<br>7. Enhance understanding of loss and damage (through data collection and vulnerability analysis) to better position Kiribati to engage with and receive support from regional and international initiatives that will address national priorities and concerns.<br>8. Enhance understanding of loss and damage (through data collection and vulnerability analysis) to better position Kiribati to engage with and receive support from regional and international initiatives that will address national priorities and concerns. |
| **STRATEGY 10: STRENGTHENING CAPACITY TO ACCESS FINANCE, MONITOR EXPENDITURES AND MAINTAIN STRONG PARTNERSHIPS** |
| Result 10.1: Strengthened coordination and collaboration in-country on climate finance and climate change and disaster risk management initiatives. |
| Actions 10.1<br>1. All national CC and DRR policies, plans and strategies linked to KCFD climate finance strategic |

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|---|
| framework and country programme (SF&CP) to enhance access to climate finance.<br>2. Capacity of existing coordination and approval mechanisms strengthened through KCFD engagement.<br>3. Review of financial project management arrangements in line ministries, SOEs, the private sector and CSOs through NEPO and KCFD engagement.<br>4. Consistent awareness and information sharing between KCFD and its external audiences, thus, uplifting climate finance portfolio and enhance multilateral partnerships. |
| Result 10.2: Increase efforts to mobilize and scale up various sources of financing to implement climate change adaptation, mitigation and disaster risk management needs and priorities. |
| Actions 10.2<br>1. Integrate access to climate financing into training for relevant ministries.<br>2. Institutional strengthening (finance sector).<br>3. Establish financial mechanisms toaddress the risks facing community and public assets (with a focuson climate risk insurance and building on existing initiatives and programmes) (See also Result 6.5). |
| Result 10.3: Line ministries' monitoring, evaluation and performance measures of climate change adaptation and disaster risk management, including budgeting, expenditure, institutional capacity, and internal systems, are strengthened through MFED engagement, as coordination office for climate finance through KCFD to increase Kiribati's access to, and engagement with, various sources of climate finance |
| Actions 10.3<br>1. Strengthen the integration of climate change and DRM into monitoring and evaluation at national and local levels within MFED, line ministries,MIA and KJIP Secretariat. |
| **STRATEGY 11: MAINTAINING THE EXISTING SOVEREIGNTY, AND UNIQUE IDENTITY AND HERITAGE OF KIRIBATI** |
| Result 11.1: The rights of Kiribati over its existing EEZ and the resources within it are protected forever for the people of Kiribati. |
| Action 11.1<br>1. Safeguard Kiribati sovereignty (EEZ) on impacts of sea level rise |
| Result 11.2: The cultural heritage of Kiribati are protected, preserved and promoted. |
| Action 11.2<br>1. To conserve and promote I-Kiribati cultural heritage and practices |
| **STRATEGY 12: TO ENHANCE RESILIENCE THROUGH STRATEGIC PARTNERSHIPS FOR COMMUNITY PARTICIPATION, OWNERSHIP AND INCLUSION OF VULNERABLE GROUPS** |
| Result 12.1: Communities are active partners in building resilience and members of vulnerable groups are increasingly engaged in climate change and disaster risk management initiatives and their needs are addressed. |
| Actions 12.1<br>1. Facilitate the participation of children and young people (girls and boys) in climate change adaptation and disaster risk management initiatives and conduct youth empowerment.<br>2. Promote the equal participation and influence of women and men in climate change and DRM initiatives.<br>3. Develop and conduct climate change and disaster risk management training and awareness programmes targeting communities and tailored to the specific needs and priorities of women and men, youth, people with disabilities, on with a specific focus on safety, security and livelihoods issues.<br>4. Increase knowledge and awareness of climate change and DRM among people with disabilities in |

CC and DRM initiatives.

5. Build successful community mobilisation approaches into a national approach for strategic community partnerships.
6. Developing community ownership and accountability system over climate change and disaster risks related projects to ensure the effectiveness and sustainability of these projects.

### 4.8.4. The CORVI assessment

Sea level rise coupled with wave surges which are direct outcomes of the global increase in temperature will severely affect coastal urban areas. The risks associated with sea level rise and storm surges on specific coastal cities are serious challenges that are difficult to unravel. For coastal cities to prepare and develop adaptation strategies, including sufficient resources, it is primordial that policymakers comprehend the risk and its multidimensionality. Most of the time, this proves very difficult for developing countries because of a dearth of appropriate data sets. Lack of technical, financial and capacity further complicates the issue and renders difficult the development of appropriate strategies for coping with the risks and building resilience. CORVI is city-based, adopts a holistic approach and is data driven in the sense that it is based on available existing data coupled with surveys across a wide range of indicators. Data gaps are filled using expert judgement to meet the holistic approach goal.

Decision-makers do not have many options but to either delay actions until better knowledge becomes available or use results from elsewhere after adapting them to their special context. Both options are not effective climate change adaptation. This problem of data availability is more serious in the case of LDCs and SIDS that usually lack resources to address this issue.

The Stimson Center has developed the Climate and Ocean Risk Vulnerability Index (CORVI) to support decision makers develop adaptation strategies to adapt and build the resilience of coastal cities. CORVI is a decision support tool which compares a diverse range of climate-related risks across the land-seascape to produce a coastal city risk profile. There are 10 risks categories, grouped under ecological, financial, and political risk areas. The 3 risk areas and their associated categories are provided in Figure 4.15.

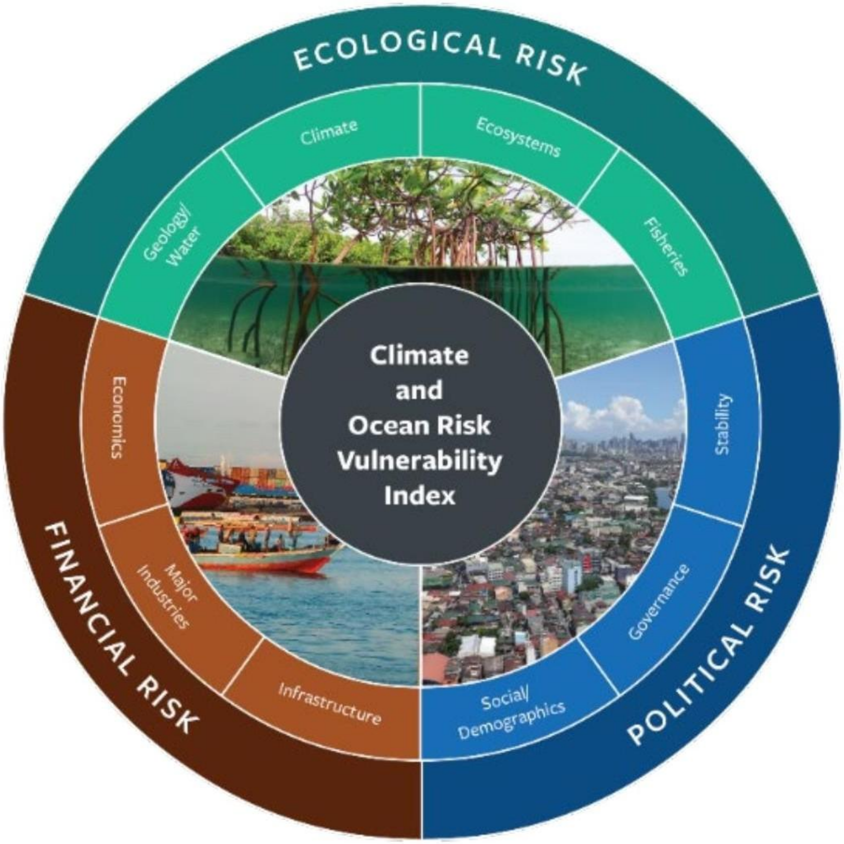



**Figure 4.15: The CORVI wheel, risks and categories**

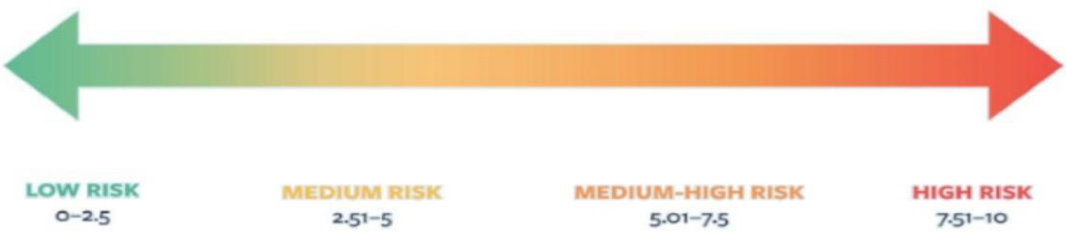
The 10 categories in turn comprise about 10 indicators each for a total of some 100 indicators, available in the Stimson CORVI report _Full report (2020). These indicators cover multiple issues such as the vulnerability of critical infrastructure, the health of marine ecosystems, and urbanization dynamics of the identified coastal city. Each indicator and category are scored using a 1-10 scale relative to other cities in the region, offering an easy reference point for decision-makers to use for categorizing climate risks. A description of the way to interpret the risk on the scale is reproduced below.

**Low risk** scores mean that the either coastal city has built resilience in the issue area, or the indicator is not as relevant for understanding risk in that city.

**Medium risk** scores indicate that while resilience has been built to address the specific risk, future changes could destabilize resilience gains.

**Medium-High risk** scores mean that current measures are insufficient, and more attention is required to build resilience against future climate security impacts.

**High risk** scores indicate that the issue area represents a key threat to the coastal city with the potential to undermine the security of its residents.



CORVI risk scores, which form the basis of a coastal city risk profile, are strengthened with existing academic and grey literature, government documents, and key informant interviews to develop a comprehensive narrative and understanding of the coastal city's climate risks which serve to identify priority policy recommendations. The indicators used for each category for each risk along with their scores are reproduced in Table 4.12 to 4.14.

On ecological risk, the highest indicator is Percent of island at risk of flooding followed by Rate of coastal erosion within the category Geology/Water. The latter also tops the four categories with 2 out of 3 indicators at the highest risk level with Climate having one indicator also at the same level. All 3 indicators ranked Ecosystems at the medium to high risk level and Fisheries scored 2 indicators at the same level. None of the indicators for all categories of Ecological risk is at the low level.

**Table 4.12: Ecological risk category, indicators and their scores**

| Category | Indicator | Score |
|---|---|---|
| Climate | Change in sea surface temperature | 7.67 |
| | Cases of vector borne disease infections | 7.00 |
| | Number of people affected by extreme weather events | 3.64 |
| Ecosystems | Health of existing mangroves | 5.80 |
| | Health of existing sea grass beds | 5. 57 |
| | Health of existing corals | 5.36 |
| Fisheries | Number of incidents of foreign vessels fishing in EEZ | 7.12 |
| | Capacity of fisheries enforcement institutions | 5.36 |
| | Near shore fish stock status | 4.90 |
| Geology/Water | Percent of island at risk of flooding | 8.77 |
| | Rate of coastal erosion | 8.60 |
| | Piped water supply continuity | 6.53 |

The Financial risk is worse with 5 out of the 9 indicators used for the 3 categories Economics, Infrastructure and Major industries having a score falling under the high-risk level while the remaining 4 present medium to high risk. Percent of people living below 5 metres is the highest of all indicators of all categories confounded with 9.2 out of a maximum of 10. Once more none of the indicators score at the low risk level.

**Table 4.13: Financial risk category, indicators and their scores**

| Category | Indicator | Score |
|---|---|---|
| Economics | National GDP per capita | 8.00 |
| | National youth unemployment rate | 7.67 |
| | National unemployment rate | 6.80 |
| Infrastructure | Per cent of people living below 5 metres above sea level | 9.20 |
| | Renewable energy share in total energy consumption | 6.91 |
| | Per cent of population with adequate access to electricity | 5.56 |
| Major industries | Per cent of national economy based in offshore fisheries | 8.87 |
| | Per cent of national economy based in nearshore fishing industry | 7.68 |
| | Per cent of national economy based in agriculture | 7.07 |

With regard to Political risk, the 2 indicators Island population density and Percent people employed in artisanal and subsistence fishing scores at high-risk but on the bottom part of the scale. Five indicators fall within the medium to high risk level and the remaining 2 at the medium risk level. This third risk also presents no indicator exhibiting the low risk level.

**Table 4.14: Political risk category, indicators and their scores**

| Category | Indicator | Score |
|---|---|---|
| **Governance** | Capacity of current disaster response | 6.17 |
| | National climate adaptation plan | 6.02 |
| | Level of perceived transparency within government | 5.82 |
| **Social and Demographics** | Island population density | 7.58 |
| | Per cent of people achieving proficiency in literacy and numeracy | 4.20 |
| | Per cent of population below poverty line | 3.92 |
| **Stability** | Per cent of people employed in artisanal and subsistence fishing | 7.80 |
| | Per cent of people employed in commercial fishing industry | 6.20 |
| | Per cent of people in port and shipping industries | 6.00 |

This rapid assessment specified three high-level recommendations that the government and the people of Tarawa could work on within the KJIP. The full CORVI assessment will provide more specific, and targeted recommendations once completed. The 3 recommendations are Implement Integrated Flood Management and Mitigation, Move Towards a Circular Economy and Diversify Kiribati's Economy.

Within Ecological risk, the assessment identified the main climate risks as coastal flooding coupled with coastal erosion. A mix of hard and nature-based infrastructure such as consolidating the monitoring and health of marine, coastal and ocean ecosystems, managing terrestrial changes, and improving infrastructure across the island are potential means of managing these risks. It is widely accepted that hard infrastructures may not be the ideal solution, but they can't be waived off in particular cases for Kiribati. However, it is recommendable that options that are more nature-based be privileged for long term sustainability.

To circumvent the Financial risk, the assessment recommends the adoption of a circular economy to overcome the problems. The high financial risk stems from the high dependence of the country on the fishing industry to both generate national income as well as for subsistence purposes while being responsible as a major employment avenue of the population. Due to its isolation and the widespread territory, it is not obvious for Kiribati to integrate the world development system. Additionally, critical issues are linked to the development of the circular economy such as sanitation and waste generation.

The Political risk is less severe with fewer high-risk indicators. The recommendation to build resilience in response to the risks is to diversify Kiribati's economy, moving away from the primary GDP earnings from selling fishing rights and using its natural and human capital more effectively. Potential economic engines are coastal tourism, adding value in processing of the fish caught and ecosystems services.

#### 4.8.5. The adaptation challenge

Kiribati is an environmentally fragile country and highly vulnerable to the direct and indirect impacts of climate change. The country is limited in capacity to manage and react to climate change risks as portrayed in the CORVI assessment. Some of the causes impeding successful adaptation are the highly vulnerable society, inadequate resources and geographical situation. Climate change and the resulting sea level rise are anticipated to progressively affect the coastal zone and therefore the livelihood of the whole population.

Kiribati apprehensions on the effects of climate change are coastal erosion, coastal inundation, critical vulnerability of infrastructure, loss of mangroves, coral reefs and the marine ecosystems, severe impacts on freshwater resources, serious impacts on agriculture, fisheries and the associated food security and meaningful impacts on public health. The higher incidence of extreme climate events and weather events such as drought, floods and cyclones signify more significant risks to the ocean resource base which is vital for the provision of basic needs to the population.

Government has developed the KJIP for climate change and disaster risk management in line with the KV20 and the KDP as well as strategic ministerial plans and sectoral policies. However, implementation of the KJIP remains problematic due to the severe lack of resources. This is so despite the support received from development partners to date. Kiribati will need further financial, technical, and capacity building assistance to implement the KJIP, including the adaptation activities of its revised NDC. The rough estimate of some 69 M USD (INDC, 2015) for adaptation to the 2030-2035 time horizon is on the conservative side. More details on the needs of the country for adaptation relative to financial, technical, and capacity building needs of Kiribati is available in the BUR1 (In press) inclusive of ongoing actions. As well, Kiribati must develop an appropriate system for monitoring and reporting on adaptation to the international community. This is non-existent and the country is looking forward to funding from the GEF within the Capacity Building Initiative for Transparency framework for developing and operationalizing an M&E system for adaptation.

# 5. Other information considered relevant to the achievement of the objective of the Convention

## 5.1. Introduction

In accordance with Article 4, paragraph 1 (f) of the Convention, non-Annex I Parties are encouraged to provide information on any steps they have taken to integrate climate change considerations into relevant social, economic, and environmental policies and actions to facilitate the formulation and implementation of sustainable development programmes. Kiribati has so far adhered to these principles.

## 5.2. Technology transfer

The transfer of, and access to, environmentally sound technologies and know-how, the development and enhancement of endogenous capacities, technologies and know-how, and measures relating to enhancing the enabling environment for development and transfer of technologies are critical to the achievement of both adaptation and mitigation to achieve the objective of the Convention. This has indeed been stressed upon in the PA in its Article 10 to improve resilience to climate change and to reduce GHG emissions within country's low emissions development strategies.

Given the lack of funds and capacities, Kiribati has not made an exhaustive assessment of its technology needs and transfer. An ad hoc assessment was performed within the framework of the NDC, particularly for measures and actions identified to mitigate climate change in the energy sector and repeated within the framework of preparation of the BUR1 (In press). The lack of a full technology needs assessment is impeding the development and implementation of adaptation and mitigation projects.

Some transfer of technologies has been realized, especially the adoption of the PV technology which can be considered as successful. Considering the updated mitigation and adaptation needs to fit the ambitious programmes for the transition to a low carbon economy and resilience building in the medium term, there exist a significant gap to fill to achieve readiness for implementation of the actions identified in the NDC.

The most urgent needs relating to technology, soft and hard, assessment and transfer for mitigation are:

- In-depth Technology Needs Assessments for mitigation
- Technologies for conversion of biomass to electricity
- Latest road transport technologies
- Low emissions sustainable urbanization
- Solid and liquid waste treatment systems
- Waste conversion to electricity

Regarding adaptation, the need also arises for the transfer of a multitude of technologies for various economic sectors. The key areas necessitating urgent attention to safeguard livelihood and welfare of the poorer most vulnerable segment of the population are water resources, integrated coastal zone management and fisheries.

Adaptation in the water resources sector includes water recycling for reuse, increased water use efficiency, rainwater harvesting, drought mitigation strategies and desalination amongst others.

Regarding the coastal zone, an integrated management programme must be developed and implemented to cope with coastal erosion and inundation stemming from sea level rise and wave surges. One key issue is adaptation and resilience building of coastal cities as they are home to most of the population.

New technologies need to be transferred to make the fishing industry, a major contributor to the national economy, sustainable in the long term.

## 5.3. Research and systematic observation

Kiribati, as a LDC and SIDS nation is very limited in capacity for in-depth research on climate change and its impacts. However, research to enhance resilience of the population through better adaptation and for technology transfer are of utmost importance. On the other hand, Kiribati must develop a good systematic observation system to provide robust data for research to better understand its vulnerability to climate change and eventually develop and implement foolproof adaptation actions to cope with the impacts of climate change on its socio-economic sectors. Additionally, the country is in a dire need to have an appropriate weather observation network to provide real time data for implementing Early Warning Systems and manage risks associated with climate extremes and disasters. Concurrently, Kiribati must provide the most accurate information on its emissions and sinks in the national GHG inventory. To achieve this, the country must collect data/make systematic observations and undertake research to develop country specific emission factors for use in the compilation of its GHG inventory. Some of the identified observations to benefit the country are:

- Collect data, model climate change and generate scenarios at island level because of the vast expanse of ocean over which it extends.
- Monitor ecosystem and biodiversity changes and their impacts.
- Make observations on sea level rise over the country's territory for improved planning.
- Establish a centre for research and training on climate change.
- Make an inventory of traditional / indigenous knowledge and practices used for coping with environmental stresses, including those from climate change.
- Undertake studies on the cost of adaptation and mitigation.
- Study macroeconomic and sectoral impacts of climate change.

## 5.4. Education, training and public awareness

Climate change is factual and so important nowadays that addressing it does not rest on government and public authorities only but on the population at large. Article 12 of the PA recognizes the importance to enhance climate change education, training, public awareness, public participation and public access to information and invited Parties to cooperate in taking appropriate measures to enhance actions on these. Kiribati is conscious of its restricted actions to-date on these issues and has a strong will to remedy to the limitations but cannot do so without the support of the international community.

Everyone must be properly educated on the cause and effects of climate change to enable them to contribute at their respective levels. Thus, education must be formal and informal. Presently, climate change has only been introduced within some disciplines in the primary and secondary education curricula. The intent is to gradually include climate change as an integral component of the primary and secondary education curricula to prepare the coming generations to adapt and mitigate. Concurrently, climate change will be introduced in the vocational training programmes and informal education will be resorted to with the support of faith organizations, NGOs and CSOs, the objective being to inculcate the basic knowledge and understanding of climate change to the adults outside of the educational system.

It is recognized that a significant portion of the population lacks awareness of climate change issues they are exposed to, notwithstanding their role in mitigation. This is due to lack of resources for a good coverage of the widely distributed islands constituting the country and a limited number of national experts to effectively deliver on this issue. It is planned to enhance public awareness programmes to maximize outreach, the final objective being to cover all segments of the population countrywide. This is deemed essential as the public needs to have access to the latest information to integrate them in the process and enable them to successfully participate in actions to be implemented. The medium to long term strategy for raising public awareness to the required level will be achieved through the following:

- Awareness raising and public education on climate change.
- Promote and facilitate development of public awareness materials on climate change in local languages.
- Facilitate access of climate change information to the public.
- Promote public participation, with emphasis on gender, for addressing climate change and develop adequate responses.

## 5.5. Capacity Building

As a developing country, Kiribati needs robust institutional structures to take on and implement programmes and activities on climate change. Building human and institutional capacity to address climate change will be a fundamental component of the NDC implementation. Capacity building for climate change will thus include further development and strengthening of personal skills, expertise and capacity of relevant institutions and organizations on adaptation, mitigation and reporting. Capacity building targets a wide group of stakeholders, including the government, NGOs, local communities, and the private sector.

Technical capacity is still insufficient to-date to enable Kiribati to smoothly implement the identified strategies for mitigating and adapting to climate change. Kiribati has achieved some progress in enhancing the technical capabilities of a restricted number of national experts through capacity building for reporting to the Convention within the framework of GEF funded enabling activities for producing NCs and recently the BUR1 (In press). Since Kiribati has prepared only 2 NCs and is in the process of finalizing its NC3 and BUR1 (In press) presently with the latter two reports dragging over quite a long period of time due to severe lack of capacities, it is imperative that the country invests in capacity building with support from the international community and development partners.

## 5.6. Information and networking

Climate change is a global problem requiring the cooperation of all to tackle it successfully. Kiribati, as a Party to the UNFCCC, the other Multilateral Environmental Agreements and various other Protocols aims to preserve its rich heritage, namely its marine ecosystems and its biodiversity within the sustainable development agenda. To achieve this objective, Kiribati has identified some key actions on the international and national fronts. They are:

- Strengthen and enhance international collaboration, linkages and networking among stakeholders involved on the environment and climate change related issues, namely the Pacific Island nations.
- Participate in regional and international cooperation programmes and activities on climate change.
- Organize a data and information sharing platform for information and results on the implementation of its NDC to inform and raise awareness of stakeholders at large of achievements.
- Create a national database on climate change for use by scientists, government, the private sector and students.

# 6. Constraints and gaps, and related financial, technical and capacity needs

## 6.1. Introduction

UNFCCC reporting requirements have evolved substantially and despite the progress made on numerous fronts when preparing the national reports, Kiribati still faces significant challenges. The context has changed drastically with the advent of the enhanced transparency framework of the PA which is more demanding while implementation of both NDC mitigation and adaptation actions to respond to climate change is now more pressing and critical. It is presently very difficult for Kiribati to meet the challenges described below as they are very ambitious and require meaningful financial, technical and human resources.

## 6.2. Preparation of UNFCCC reports

Kiribati prepared its INC and SNC when needed with funds from the GEF and contributions from development partners. The development and operationalization of a permanent reporting framework was not seen as a must and has not been possible because it is too costly for the country to sustain, given the scarcity of resources, and the other development priorities. Enhancement of the reporting requirements, namely the enhanced transparency framework of the PA in accordance with its Article 13 now demands for higher standards and a permanent framework to enable the sustainable production of these reports for compliance. That is, submission of the BTR and NC every two and four years respectively. In addition, there is a need to develop and establish permanent MRV systems for tracking and reporting emissions, implementation of NDC mitigation activities, support received and needed, including capacity building needs, and a robust M&E system for tracking and reporting implementation of adaptation actions. Full operationalization of the MRV systems will enable Kiribati to comply with the enhanced transparency framework when fully operationalized in the medium term.

Conscious of this situation and eager to improve compliance and the transparency level, Kiribati seeks to develop and strengthen existing institutional arrangements to enable it to meet the standards set by the MPGs laid out under Decision 18/CMA.1 of the COP. The challenges, being numerous and very daunting, will take time to be met through the development of the appropriate systems and processes along with the accompanying tools and extensive capacity building of the institutions and the national experts. Key challenges are:

- Inadequate capacity of the coordinating entity as well as lack of institutional and technical skills of the principal partners, namely institutions which will be called upon to implement NDC mitigation and adaptation actions.
- Maintaining an appropriately staffed permanent coordinating entity.
- Staff scarcity / unavailability in collaborating institutions due to their already overloaded schedules and insufficient capacity.
- Thematic technical working groups with appropriate capacity still to be developed.
- Lack of staff in ECD and resources, including adequate funds to develop, operationalize and maintain the appropriate systems in place.
- Lack of a centralized data collection and sharing network for UNFCCC reporting purposes.
- Inexistence of a central archiving system for storage of data and other information related to climate change actions and reporting.

Presently the Climate Change Unit of ECD comprises an adaptation and a planning section. This is not suitable to report in accordance with Article 13 of the PA. It is highly recommendable that an additional section be created under mitigation to oversee the 3 MRVs on emissions, tracking of mitigation and tracking of support as depicted in Figure 6.1.

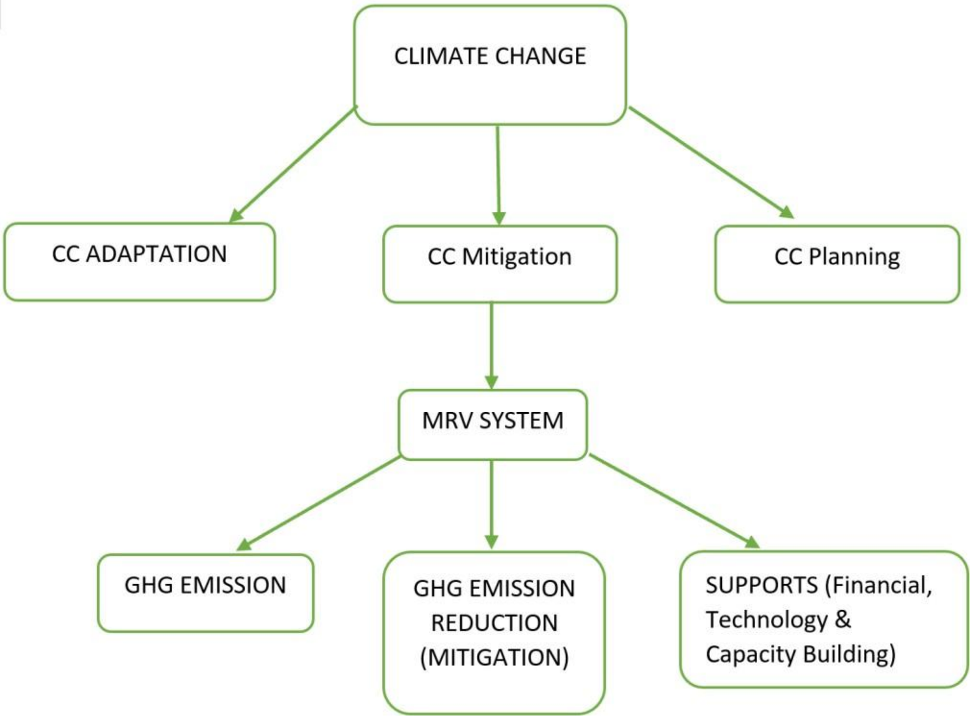



**Figure 6.1: Recommended improvement in the Climate Change Unit**

Already, government budget is strained due to the numerous national priorities, especially after the toll taken by the COVID-19 pandemic and it will prove difficult to allocate enough funds to cover all these expenses. It is hoped that funds will be made available through multilateral organizations like the GCF and the GEF to support activities, including the very urgent capacity building needs, to enable Kiribati to develop, establish and implement the systems to comply with Article 13 of the PA.

## 6.3. GHG inventory

Kiribati has progressed in the compilation of its GHG inventory, especially the ones reported in this NC3 and the BUR1 (In press) towards meeting the TACCC principles. The country has added new categories and improved its timeseries which is more consistent now. However, being both a SIDS and an LDC, it still confronts numerous constraints and gaps that need to be addressed to produce better quality GHG inventories for informing mitigation strategies and reporting. The following constraints were encountered during the preparation of the national inventory of GHG emissions presented in this report:

- Absence of a fully-fledged GHG Inventory Management System for institutionalization of the inventory process.
- Insufficient documentation of past inventories for institutional memory due to no proper archiving.
- Information required for the inventory were collated from various sources as the appropriate system has not yet been developed and operationalized even if MELAD has been endorsed with the responsibility for the collection of specific AD needed for estimating emissions according to IPCC methodologies.

- Almost all the AD are not in the required format for feeding in the IPCC software to estimate emissions.
- End-use consumption data for most of the sectors and categories are not available and had to be generated based on scientific and consumption parameters.
- Reliable data on biomass consumed were not available. Fuelwood data were adopted from the FAO database while other biomass data was derived using statistical techniques.
- There were frequent inconsistencies in the available data, even when collected by the same institution.
- Lack of a well-defined QA/QC process.
- Insufficient solid waste characterization data, amount generated, while wastewater generated are not available and had to be derived based on demographic data.
- Lack of EFs to better represent national circumstances and provide for more accurate estimates.
- Emissions for some categories have not been estimated due to lack of AD.
- Insufficient capacity of national experts to compile an inventory.

The improvement of the GHG inventory component requires the development and implementation of a NIIP. This plan will be developed and key elements it must address are:

- A robust GHG inventory management system.
- Appropriate tools for collecting AD for computing inventories.
- An adequate and proper data capture, QC, validation, storage, and retrieval mechanism.
- National EFs to better represent national circumstances and improve estimates for key categories.
- National procedures for compilation of the inventory.
- Mobilization of the necessary resources to establish a GHG inventory unit within ECD for permanent inventory coordination and compilation.
- Improve the completeness of the inventory through the inclusion of categories not covered so far.
- A QC/QA plan as per the 2006 IPCC Guidelines to reduce uncertainties.
- Disaggregated data to improve inventory quality and address key categories at Tier 2 level.
- Maps for 1990 to 2020 to provide land use change data over 5 years periods for optimal estimation of emissions in the Land sector.
- Forest inventories to supplement available data on the Land sector.
- The missing years 1990 to 2009 to complete the full timeseries.

## 6.4. Mitigation

Mitigation measures and actions are under implementation in the country despite the multiple constraints and gaps that Kiribati is facing, namely at the legal, institutional, and procedural levels. There is a need to improve the enabling environment in the country. Needs also exist for improving the technology assessment and transfer for mitigation, notwithstanding building of the necessary technical capacity of national experts for smooth and effective technology transfer. More in-depth mitigation assessments must be conducted to identify the most important measures and actions as well as prioritize those with the highest potential for successful implementation.

Barriers must be removed to speed up the process of implementation of mitigation actions, and the preparation of project proposals for funding.

Kiribati is a SIDS and LDC and is already facing difficult challenges to maintain the welfare of its population due to various constraints and this has worsened following the economic downturn resulting from the COVID-19 pandemic. Appropriate funding and timing within the schedules earmarked by the COP are important features to take into consideration when these measures and actions, especially the implementation aspect, are aligned with the country's development strategy and agenda. A sustainable flow of required funds is crucial to develop and implement mitigation projects. Up to now, Kiribati has secured some funding to support the implementation of NDC mitigation actions. This is not adequate and there is need for the international community to further consolidate the GCF and develop new instruments for availing the necessary funding and other support needed in a timely manner to Non-Annex I Parties to enable them to play their role in meeting the objectives of the Convention, and urgently because of their higher exposure and vulnerability to the impacts of climate change. The updated estimate for identified projects is around 77 M USD for the short term. A combined list of actions for mitigation and adaptation requiring support, including funding, technology transfer and capacity building with the estimated amounts is provided in Table 6.1.

The main constraints and gaps obstructing the implementation of mitigation actions, tracking and reporting thereon are:

- Insufficient stakeholder consultation and engagement.
- Lack of an appropriate system to track and report on implementation of NDC mitigation actions.
- Absence of a centralized data collection and sharing network, specifically for addressing the implementation of NDC mitigation actions.
- Lack of appropriate tools for collecting AD and indicators for tracking and reporting on the implementation of mitigation actions.
- Lack of resources, inclusive of technology, technical knowhow, and capacity.
- Limited ability of the country to mobilize resources.

## 6.5. Adaptation

Kiribati is highly vulnerable because it is both a SIDS and an LDC. The pace at which adaptation measures are being implemented is too slow to enable the country to build its necessary resilience to climate change. Major constraints and gaps preventing optimal adaptation and resilience building in the different socio-economic sectors are:

- Inadequate stakeholder consultations and engagement to buy them all in the process.
- Lack of an appropriate system to track and report on implementation of NDC adaptation actions.
- Lack of tools for tracking progress in implementation of NDC adaptation actions.
- Lack of a centralized data collection and sharing network, specifically for addressing adaptation.
- Insufficient detailed vulnerability and risk assessments of key socio-economic sectors of the country to inform adaptation strategies.
- Inadequate in-depth adaptation assessments of key socio-economic sectors of the country.

- Lack of sufficient observations such as meteorological, hydrological and sea level rise data to inform vulnerability and adaptation assessments and develop risk management strategies.
- Early Warning Systems for informing the population of hazards.
- Timely dissemination of information to prevent losses and damage.
- Insufficient resources to implement adaptation actions.
- Limited capacity of the country to mobilize resources.

**Table 6.1: Financial support needed**

| Activity/Project | Status | Estimated Cost ($10^3$ USD) |
|---|---|---|
| Preparation and submission of combined BTR2/NC4 and preparation of appropriate land use and land cover maps for the period 1990 to 2020 | Planned | 617 |
| Mobilization of resources to establish a GHG inventory, a mitigation and an adaptation unit within ECD for the sustainable preparation of NCs and BTRs. | Understaffed | 24 annually |
| Develop tools for tracking and reporting on GHG emissions, mitigation, adaptation and support received and needed | Planned | 200 |
| Generate national Efs | Planned | 100 |
| Develop and implement MRV systems | Non-existent | 300 |
| Enhancing Whole of Islands Approach to Strengthen Community Resilience to Climate and Disaster Risks in Kiribati | Planned | 45,000 |
| Promoting Outer Island Development through the Integrated Energy Roadmap (POIDIER) | Project under assessment | 5,379 |
| Climate Information and Early Warning Systems, One Pacific Programme | Concept note Regional | 106,000 |
| The Vaka Motu (boat for the islands) building indigenous community resilience with low emission sea transportation in the Micronesian region | Concept note Regional | 10,000 |
| Strengthened weather and climate services for resilient development for Pacific Islands | Concept note | 10,000 |
| Capacity Building and Sector Reform for Renewable Energy Investments in the Pacific | Project under development Regional | 6,225 |
| Building Coastal Resilience through Nature-Based and Integrated Solutions | Project under development Regional | 6,500 |
| Development of the Pacific Energy Regulators Alliance | Project under development Regional | 600 |
| Development of Pacific Power Utilities Reform Network | Project under Development Regional | 900 |
| Pacific Renewable Energy Investment Facility | Project under development | 200,000 |
| Preparing Projects to Enhance Transport Connectivity and Resilience in the Pacific, Phase 2 | Project under development | 5,000 |
| Rural Women Solar Electrification – Tabonibara Village Project | In abeyance | 36 |
| Strengthening good governance, policies & legislation | Planned | 4,500 |
| Improving knowledge and information generation, management and sharing | Planned | 3,700 |
| Strengthening and greening the private sector including small business | Planned | 3,305 |

| Activity/Project | Status | Estimated Cost ($10^3$ USD) |
|---|---|---|
| Increasing water and food security with integrated and sector specific approaches and promoting healthy and resilient ecosystems | Planned | 3,145 |
| Strengthening health service delivery to address climate change impacts | Planned | 317 |
| Promoting sound and reliable infrastructure development and land management | Planned | 35,159 |
| Delivering appropriate education, training and awareness programmes | Planned | 5,011 |
| Increasing effectiveness and efficiency of early warnings and disaster emergency management | Planned | 3,021 |
| Promoting use of sustainable renewable sources of energy and energy efficiency | Planned | 10,278 |
| Strengthening capacity to access finance, monitor expenditures and maintain string partnerships | Planned | 237 |
| Maintain the sovereignty and unique identity of Kiribati | Planned | 121 |
| Enhancing the participation and resilience of vulnerable groups | Planned | 280 |
| Solar PV mini grid system for Southern Kiribati Hospital – design, procure and install off-grid PV systems for the Southern main hospital (265kWp) to a level to support the fully equipped needs to operate the hospital | Planned | 1,608 |
| Outer Island Clinic solar system rehabilitation – design, procure, and install 58 systems in total on 20 outer Islands to provide power for lighting and for HF communication radio | Planned | 154 |
| Junior Secondary School (JSS)system – design, procure and install off-grid PV systems for lighting and Charging Laptop computers of 2 classrooms and staff room in all JSS in the Outer Islands (410 Wp each) | Planned | 191 |
| Outer Island Council solar PV mini grid system – design, procure and install off-grid PV systems (5 kWp each) for island council administrative centres in the Gilbert and Line Group | Planned | 476 |
| Outer Island Fish Centres – design, procure and install off-grid PV systems for the Fish Centres (3.75kWp each) in all the Islands to a level to support a fully equipped centres lighting, refrigeration and other equipment | Planned | 409 |
| Desalination Plant for vulnerable rural community – 19 systems for 12 community systems for solar water desalination plant will be procured and installed on 9 selected Islands. This activity will improve quality of life in households by providing portable water supply to the most vulnerable Islands in Kiribati | Planned | 77 |
| Outer Island Police Station solar system rehabilitation – 23 solar systems (120 Wp each) will be procured and installed in all of the outer Islands for communication, lighting, etc at the Police stations and an additional 8 Police posts | Planned | 40 |

## 6.6. Capacity Building

Kiribati requires technical capacity to implement its NDC mitigation and adaptation actions to meet the objectives of the Convention and report on these as per Articles 7 and 9 of the PA. Capacity building concerns mainly mitigation and adaptation technologies to be identified in relation with the measures that are most prominent and prioritized for implementation in the NDC implementation plan and strategy. Several other overarching issues such as information sharing and networking, knowledge sharing, and sensitization also must be addressed for successful implementation of the NDC mitigation and adaptation actions. Some of the current priority technical and capacity building needs are:

- Mainstreaming of climate change in national, local and sectoral policies, development plans and programmes, including gender consideration.
- Preparation of UNFCCC reports.
- Compilation of GHG inventories
- International market mechanisms and mobilization of resources.
- wastewater treatment.
- Develop disaster risk reduction plans and programmes.
- Undertake in-depth sectoral vulnerability and adaptation assessments.
- Develop educational and awareness materials on climate change.

### 6.7. Financial

Avenues concerning funding to the 2030 and 2035 time-horizons respectively have been identified in the First NDC (NDC, 2022) and further detailed in the implementation roadmap for the Transport and Energy Efficiency sectors. These sums amount to some 210.5 M USD (NDC, 2022) for mitigation and 69.0 M USD for adaptation (INDC, 2015). The updated financial needs as per the projects listed in Table 6.1 above for the short-term amounts to around 77 M USD. A small percentage of these have been mobilized so far and a few activities completed. In this context, the Climate Finance Division of the Ministry of Finance and Economic Development is now accredited with the GCF to mobilize finance from this entity for implementing projects on climate change.

The need also exists to develop assessment tools to inform decision-making, and to establish partnerships among national and local government agencies, business, professional and other private groups, community-based organizations, academic and scientific organizations and civil society organizations in order to realize Kiribati's objectives. Policy and incentive mechanisms must be introduced to facilitate and leverage private sector investment in climate actions, and it is expected that Public Private Partnerships will contribute both monetary and human resource capacity to implement the required actions. So far, the private sector has contributed only marginally to climate actions.

Substantial funding is required to enable Kiribati to meet its reporting obligations and implement the Convention. Timely funding is crucial for preparing the necessary reports for the country to comply with the COP decisions. Human and other resources are still lacking. Countries should also be endowed with operational MRV systems to track emissions, mitigation, and support. Kiribati intends to make use of CBIT funds from the GEF to develop and implement its MRV systems to track the implementation of the NDC. Funding by the GEF for the preparation of the future BTRs within a 2-years cycle will be problematic.

## 7. References

Erftemeijer, P L A Dr. (2020), Mangrove Planting Guidelines for Kiribati, Secretariat of the Pacific Regional Environment Programme March 2020, 15 p.

FAO (2010), Global Forest Resources Assessment Country Report 2010 Kiribati, Forestry Department, 53 p.

FAO (2014), Global Forest Resources Assessment Country Report 2015 Kiribati, Forestry Department, 76 p.

IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T., and Tanabe K. (eds). Published: IGES, Japan.

Jazayeri, A. et al. (2019), A Groundwater Modelling Investigation of Greywater Disposal: South Tarawa, Kiribati. The World Bank Group. 100 p.

Kiribati (2007), Kiribati Environmental (Amendment) Act 2007, 40 p.

Kiribati (2013), KIEP Kiribati Integrated Environment Policy, 76 p.

Kiribati (2015), Kiribati Intended Nationally Determined Contribution, 27 p.

Kiribati (2016a), KV20 Kiribati 20-year Vision 2016-2036, 70 p.

Kiribati (2016a), KV20 Kiribati 20-year Vision 2016-2036, 70 p.

Kiribati (2016b), KDP Kiribati Development Plan 2016-2019, 68 p.

Kiribati (2016b), KDP Kiribati Development Plan 2016-2019, 68 p.

Kiribati (2019a), Disaster Risk Management and Climate Change Act, 34p.

Kiribati (2019b), Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management 2019-2028, 178 p.

Kiribati (2020), Disaster Risk Management and Climate Change Act Regulations, 177p. (Draft)

Kiribati (2021), KIEP SEP Kiribati Integrated Environment Policy and Strategic Environment Plan 2021-2036 (Draft), In Press, 175 p.

Kiribati (2021), Kiribati Integrated Environment Policy (KIEP) & Strategic Environment Plan (SEP) _2021-2036, 183 p. (Final draft)

Loco, A. et al. (2020). Groundwater investigation on Onotoa Island, Republic of Kiribati. Pacific Community. ISBN: 978-982-00-1314-8. 140p.

Mc Nicol, G. et al. (2020) Climate change mitigation potential in sanitation via off-site composting of human waste. University of California. Nature Climate Change. Downloaded from https: // escholarship.org/uc/item/4852h4zr. Accessed 03rd August 2021

MELAD (2021a), Kiribati Third National Communication (TNC, 2021). In press.

MELAD (2021a), Kiribati Third National Communication (TNC, 2021). In press.

MELAD (2021b), First Biennial Update Report (BUR1), National circumstances Chapter, In press.

MELAD (2021b), First Biennial Update Report (BUR1), National circumstances Chapter, In press.

Montes, F et al. (2013), Mitigation of methane and nitrous oxide emissions from animal operations: II. A review of manure management mitigation options. Journal of Animal Science. 2013.91:5070–5094

Mourits, L. (1996). An assessment of saltwater intrusion in babai pit and some water supply projects on Makin, Butaritari and Abaiang, Republic of Kiribati. SOPAC Technical Report 229. SOPAC. 39p.

NSO (2007), 2005 Census of Population Volume 1, Kiribati National Statistics Office, Ministry of Finance, 159 p.

NSO (2012), Kiribati Population Census 2010 Volume 1, Kiribati National Statistics Office, Ministry of Finance and Economic Planning, 227 p.

NSO (2021), Kiribati Population Census 2020 Volume 1, Kiribati National Statistics Office, Ministry of Finance and Economic Planning, 183 p.

Piguet, E. (2019). Climatic Statelessness: Risk Assessment and Policy Options. Population and Development Review, 45(4), pp.865–883. doi:https://doi.org/10.1111/padr.12295.

Spalding, Mark D and Leal, Maricé (editors), (2021) The State of the World's Mangroves 2021. Global Mangrove Alliance. 79 p.

Sydney Catchment Authority (2012), Designing and Installing On-site Wastewater Systems, https://www.waternsw.com.au/_data/assets/pdf_file/0009/114759/Designing-and-Installing-On-Site-Wastewater-Systems-complete-document.pdf. Accessed on 03rd August 2021

UNEP (2012), Technologies for Climate Change Mitigation – Agriculture Sector – UNEP Riso centre, UNEP and GEF. 138 p.

UNFCCC (2019), Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on the third part of its first session, held in Katowice from 2 to 15 December 2018. Decision CMA/18.1. pp 18-52.