Republic of Mauritius

THIRD NATIONAL COMMUNICATION

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ministry of Environment, Sustainable Development, and Disaster and Beach Management

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Third National Communication Report for the Republic of Mauritius

Republic of Mauritius

Third National Communication

Report to the
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Foreword

The Republic of Mauritius is among the first to ratify the 2015 Paris Agreement on climate change. It is yet another expression of heightened concern and continued commitment of Mauritius to address climate change and allay its threats not only to the Small Islands Developing States but also to hospitable planet Earth and human well-being and survival.

Climate change is already affecting the Republic. Accelerated sea level is causing severe coastal degradation and salinization, increased incidence of flash floods, more intense cyclones and a highly variable climate. The impacts may jeopardise the development initiatives aimed at poverty alleviation, sustainable development and building a more resilient nation, as envisaged in the nation's Vision 2030.

Mauritius has been taking actions to mitigate the many social, economic and environmental challenges arising from climate change, and implement its commitments in the Intended Nationally Determined Contribution (INDC). Its greenhouse gas emission is negligible but the Republic perceives mitigation, adaptation and integration of climate change into all national activities as an opportunity to re-engineer its development sustainably. In this undertaking, the Republic values the bilateral and multilateral collaboration and support that it continues to enjoy.

At the policy level, a Climate Change Bill will soon be introduced in Parliament. This bill will provide a strategic framework for focussing the nation's efforts and resources in meeting the challenges of sustainable development over the entire territory. In this undertaking the Republic will reinforce the engagement of the public and private sectors, NGOs and every citizen and work in close concert with all nations and regional and international organisations.

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Acronyms and Abbreviations

A1B	Scenario assuming a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies (a balance across all sources)
A1F1	Scenario assuming a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies (fossil intensive)
A2	Scenario assuming a very heterogeneous world with high population growth, slow economic development and slow technological change.
AAP	Africa Adaptation Programme
AD	Activity data
ADD	Association pour le Développement Durable
ADF	African Development Fund
ADSS	Agricultural Decision Support System
AFB	Adaptation Fund Board
AFOLU	Agriculture, Forestry and Other Land Use
AMSL	Above Mean Sea Level
APSIM	Agricultural Productions Systems Simulator
AREU	Agricultural Research and Extension Unit
ASCLME	Agulhas and Somali Current Large Marine Ecosystems
AWS	Automatic Weather Stations
B2	Scenario assuming a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental
BAU	Business as Usual
BEF	Biomass Expansion Factors
BIG	CC Biomass Integrated Gasification – Combined Cycle
bn	billion
BOD	Degradable organic component
BPO	Business Process Outsourcing
BUR	Biennial Update Reports
CBD	Convention on Biodiversity
CC	Climate Change
CCAP	Climate Change Action Plan
CCAPF	Climate Change Adaptation Policy Framework
CCC	Climate Change Committee
CCD	Climate Change Development
CCE	Climate Change Education
CCIC	Climate Change Information Centre
CCM	Climate Change Mitigation
CDM	Clean Development Mechanism
CEB	Central Electricity Board
CH_4	Methane
CLCS	UN Commission on the Limits of the Continental Shelf
CNG	Compressed Natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
CO2-eq	Carbon dioxide equivalent
COP	Conference of the Parties
COSMO-CLM	COnsortium for Small-scale MOdelling- **C**limate **L**imited-area **M**odelling
CSO	Central Statistics Office
CSR	Climate Reference Station
CTCN	Climate Technology Centre Network
CWA	Central Water Authority
DCCE	Department of Climate Change and Enforcement
DEM	Digital Elevation Model
DLL	Dry Lowland
DM	Dry mass
DOC	Degradable Organic Carbon
DOM	Dead Organic Matter
DOWA	Deep Ocean Water Application
DPV	Dual Purpose Vehicle
DRR	Disaster Risk Reduction
DSM	Demand Side Management
DWG	Dedicated Working Group
ECVs	Essential Climate Variables
EE	Energy efficiency
EEBC	Energy Efficiency Building Code
EEBCS	Energy Efficiency Building Code Compliance Scheme
EEMO	Energy Efficiency Management Office
EEZ	Exclusive Economic Zone
EF	Emission Factors
EIA	Environmental Impact Assessment
EPA	Environment Protection Act
EPZ	Export Processing Zone
ESA	Environmentally Sensitive Area
ESD	Education for Sustainable Development
EST	Environmentally Sound Technologies
ETPA	Education Training and Public Awareness
EU	European Union
e-waste	Electrical and Electronic Waste
FAO	Food and Agriculture Organisation of the United Nations
FAREI	Food and Agricultural Research and Extension Institute
GCAI	Green Cooling Africa Initiative
GCM	General Circulation Model
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFEI	Global Fuel Economy Initiative
Gg	Gigagram (10^6kg)
GHG	Greenhouse gas
GIS	Geographical Information System
GLOBE	Global Learning and Observation to Benefit the Environment (ARGO)
GNI	Gross National Income
GoM	Government of Mauritius
GSR	Global Solar Radiation
GWh	Giga Watt hour
GWP	Global Warming Potential
H_2O	Water
ha	hectare
HCS	Household Compost Scheme
HDPE	High density polyethylene
HFC	Hydrofluorocarbon
HFO	Heavy Fuel Oil
HPC	High Performance Computing

ICE	Internal Combustion Engine
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IE	Included Elsewhere
IEA	International Energy Agency
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IOC	Indian Ocean Commission
IOGOOS	Indian Ocean Global Ocean
IPCC	Intergovernmental Panel on Climate Change
IPDM	Integrated Pest and Disease Management
IPP	Independent Power Producers
IPPU	Industrial Process and Product use
ISWM	Integrated Solid Waste Management
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
KCA	Key Category Analysis
km	kilometre
km^2	kilometre square
KP	Kyoto Protocol
kt	kilotonne (1 000 tonne)
ktoe	kiloton of oil equivalent
kV	kilovolt
kVA	kilo volt-ampere
kW	kilowatt
kWh	kilowatt-hour
l	litre
LAVIMS	Land Administration, Valuation and information Management System
LCMR	Low Cost Must Run
LEAP	Long-range Energy Alternatives Planning System
LFG	Landfill Gas
LMU	Landslide Management Unit
LNG	Liquefied Natural Gas
LPA	Logical Problem Analysis
LPG	Liquefied Petroleum Gas
LRS	Light Rail System
LTES	Long term Energy Strategy
LTM	Long-term mean
LULUCF	Land Use, Land-Use Change and Forestry
M	Million
M	Million
MAED	Model for Analysis of Energy Demand
MAGICC	Model for the Assessment of Greenhouse Gas Induced Climate Change
MARENA	Mauritius Renewable Energy Agency
MAURITAS	Mauritius Accreditation Service
MCA	Multi-criteria Analysis
MCF	Methane correction factor
MCIA	Mauritius Cane Industry Authority
MEA	Multilateral Environmental Agreement
MECLEP	Migration, Environment and Climate Change: Evidence to Policy
MEPU	Ministry of Energy and Public Utilities
MESA	Monitoring for Environment and Security in Africa
MIC	Middle-Income Country
MICCP	Ministry of Industry, Commerce and Consumer Protection
MIE	Mauritius Institute of Education
MMS	Mauritius Meteorological Services
PMO	Prime Minister's Office, Defence, Home Affairs, Ministry of Rodrigues and National Development Unit
MT&EC	Ministry of Tourism and External Communications
MH&L	Ministry of Housing & Lands
MoE&PU	Ministry of Energy and Public Utilities
MoFED	Ministry of Finance and Economic Development
MoYS	Ministry of Youth and Sports
MI&LT	Ministry of Public Infrastructure and Land Transport
MLG	Ministry of Local Government
MoSI&EE	Ministry of Social Integration and Economic Empowerment
MoTC&I	Ministry of Technology, Communication and Innovation
MoAI&FS	Ministry of Agro Industry & Food Security
MoAC	Ministry of Arts and Culture
MIC&CP	Ministry of Industry, Commerce and Consumer Protection
MoGECD&FW	Ministry of Gender Equality, Child Development and Family Welfare
MoSSNS&RI	Ministry of Social Security, National Solidarity and Reform Institutions
MoA	Ministry of Agro-Industry and Food Security
MoE& SD	Ministry of Environment and Sustainable Development
MoE&HR,TE&SR	Ministry of Education and Human Resources, Tertiary Education and Scientific Research
MoEMRFSOI	Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island
MoESDDBM	Ministry of Environment, Sustainable Development, Disaster and Beach Management
MoHQL	Ministry of Health and Quality of Life
MOI	Mauritius Oceanographic Institute
MOU	Memorandum of Understanding
MPA	Mauritius Ports Authority
MPI&LT	Ministry of Public Infrastructure and Land Transport
MRC	Mauritius Research Council
MRV	Measuring, Reporting and Verification
MSC	Mauritius Shipping Company BAU
MSIRI	Mauritius Sugar Industry Research Institute
MSS	Mauritius Sugar Syndicate
MSW	Municipal solid waste
MUR	Mauritian Rupee
MW	Megawatt
MWF	Mauritius Wildlife Foundation
MWh	Megawatt-hr
N	Nitrogen
N_2O	Nitrous oxide
NA	Not available or Not Applicable
NAMA	Nationally appropriate mitigation actions
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategy and Action Plan
NCC	National Climate Committee
NCCPSAP	National Climate Change Policy, Strategy and Action Plan
NCG	National Coast Guard

NCSA	National Capacity Self- Assessment
NCV	Net calorific value
NDC	National Determined Contribution
NDRRMC	National Disaster Risk Reduction and Management Centre
NE	Not Estimated
NEL	National Environmental Laboratory
NGHGI	National Greenhouse Gas Inventory
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile organic compound
NO	Not Occurring
NODC	National Oceanographic Data Centre
NOx	Oxides of nitrogen
NTA	National Transport Authority
O_2	Oxygen
^oC	Degree Celsius
ODP	Ozone Depleting Potential
OIDC	Outer Islands Development Corporation
PANES	Protected Area Network Expansion Strategy
PAX	Passenger
PER	Preliminary Environment Report
PET	Polyethylene terephthalate
PFC	Perfluorocarbon
PGCE	Post Graduate Certificate of Education
PIP	Project Implementation Plan
PMU	Project Management Unit
PPG	Planning Policy Guidance
PPM	Parts per million
PPP	Public Private Partnership
PSC	Project Steering Committee
PT	Problem tree
PTC	Project Technical Committee
PV	Photo voltaic
QA	Quality assurance
QAS	Quality Assurance System
QC	Quality Control
RAC	Refrigeration & Air Conditioning?
RCCC	Rodrigues Climate Change Committee
RCM	Regional Climate Model
RCMRD	Regional Centre for Mapping of Resources for Development
RE	Renewable energy
RoM	Republic of Mauritius
rpm	revolutions per minute
RSO	Research and Systematic Observation
SADC	Southern African Development Community
SARUA	Southern African Regional Universities Association
SCENGEN A	Regional Climate ***SCEN***ario***GEN***arator
SEFA	Sustainable Energy Fund for Africa
SEMPA	South East Marine Protected Area
SIDS	Small Islands Developing States
SIPP	Small Independent Power Producers
SLM	Sustainable Land Management
SLR	Sea level rise
SM	Statistics Mauritius
SNC	Second National Communication
SO_2	Sulphur dioxide
SRES	Special Report on Emissions Scenarios
SSDG	Small Scale Distributed Generation
SSS	State Secondary School
SST	Sea Surface Temperature
STC	State Trading Corporation
SWH	Solar Water Heater
SWIO	South West Indian Ocean
SWM	Solid Waste Management
t	tonne
TA	Tourism Authority
TAP	Technology Action Plans
Tmax	Maximum temperature
Tmin	Minimum temperature
TNA	Technology Needs Assessment
TNC	Third National Communication
TPES	Total Primary Energy Supply
TWG	Technical Working Group
UDM	Université des Mascareignes
ULP	Unleaded Petrol
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
UNU-EHS	United Nations University Institute for Environment and Human Security
UoM	University of Mauritius
URGS	Unsolicited Research Grant Scheme
USD	United States Dollar
UTM	University of Technology Mauritius
VAA	Vulnerability assessments and adaptation
W	watt
WHO	World Health Organisation
WIOMAP	Western Indian Ocean Marine Application Programme
WMA	Waste Water Management Authority
WMO	World Meteorological Organization
WRI	World Resource Institute
WRU	Water Resources Unit
WTE	Waste-to-energy
WUL	Wet Upland

Executive Summary

E1 Introduction

The Republic of Mauritius (RoM) is among the first countries to ratify the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and one among the first 15 countries to sign and ratify the Paris Agreement on 22 April 2016. This demonstrates its willingness as a responsible member of the global community to seek and achieve global solutions on climate change matters.

In fulfillment to the reporting requirement under Article 12 of the UNFCCC, RoM has prepared its Third National Communication Report for the period 2010 to 2016, whereas for the greenhouse gas inventory, data for the period 2006 to 2013 were assessed. The sections that follow present concise findings of the assessment undertaken in line with the provisions of the Project Corporation Agreement signed between the United Nations Environment Programme and the Ministry of the Environment, Sustainable Development, and Disaster and Beach Management in 2013, and the UNFCCC reporting guidelines.

E2 National Circumstances

The Republic of Mauritius, is a small island developing state of about 2 040 km² in area, comprising the mainland Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago. On the other hand, its Exclusive Economic Zone (EEZ) is nearly 2.3 million km² as well as an Extended Continental Shelf of 396 000 km² managed jointly by RoM and Seychelles, outside the border of their respective EEZ (Figure ES1).

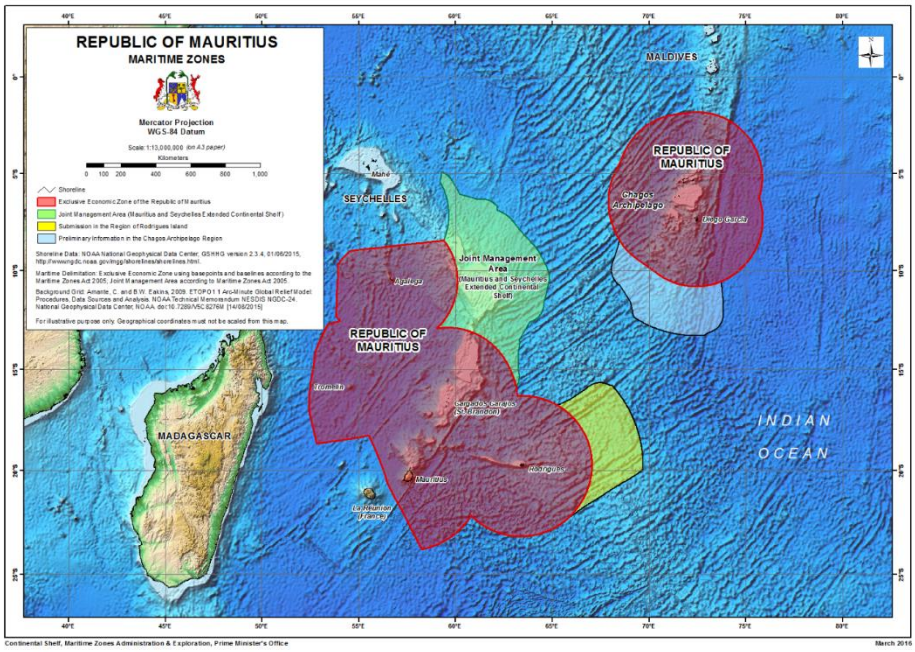


Figure ES1 Geographical location of Mauritius and Outer Islands with the EEZ (light red), Joint Management Area - Mauritius and Seychelles Extended Continental Shelf (light green), Extended Continental Shelf Submission to the UN Commission on the Limit of the continental shelf (CLCS) in the region of Rodrigues (yellow) and Preliminary Information in the Chagos Archipelago Region (light blue).

RoM enjoys a mild tropical maritime climate with a warm humid summer extending from November to April and a relatively cool dry winter from June to September. The adverse impacts of climate change are already being experienced in terms of temperature rise, decrease in rainfall amount, sea level rise, accentuated beach erosion and increase in frequency and intensity of extreme weather events such as flash floods. Climate records over the period 1951-2014 show a significant warming trend of about 1.2°C and a decreasing trend in rainfall amount of about 8%. Over the same period, the central plateau, the main recharge zone of the island has witnessed a decrease in annual precipitation from a maximum of 4000 mm/year to 3800 mm/year with drying being more pronounced to the north and west (Figure ES2.

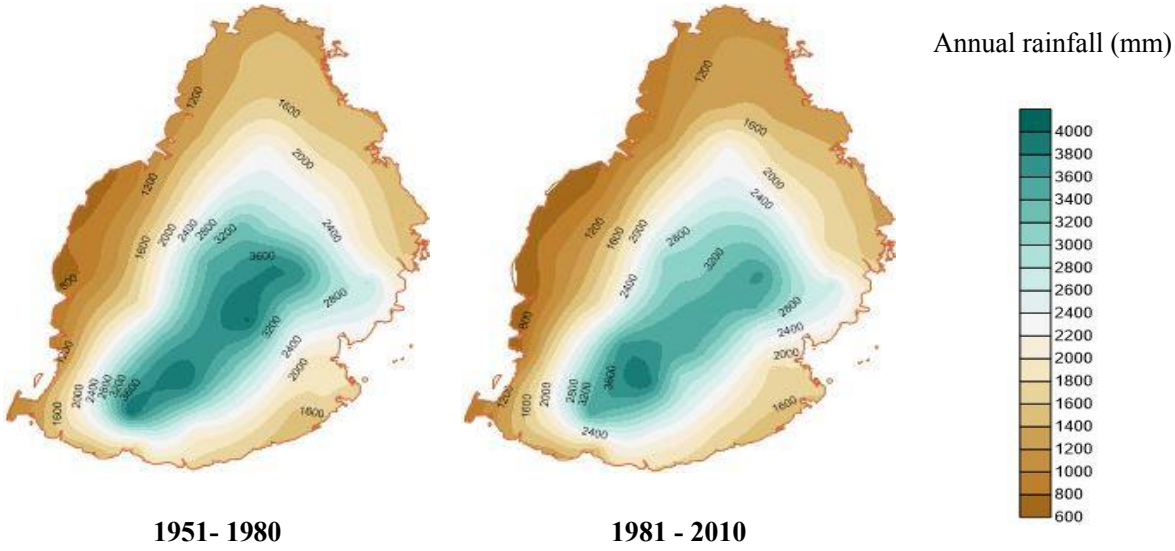


Figure ES2 Long-term rainfall in mm over Mauritius over the periods (a) 1951-1980 (b) 1981-2010

Sea level rise has been observed to be accelerating at an average rate of 5.6 mm/year in the last decade. RoM, is also situated in the tropical cyclone belt of the South Western Indian Ocean (SWIO) where rapid formations of high intensity tropical cyclones and super cyclones have been observed. It is therefore highly exposed to such extreme climatic phenomenon with serious risks to life and hard won development gain which includes basic amenities and properties.

The basic statistics on the Republic of Mauritius is provided in the Table below (Table ES1).

Table ES1 Republic of Mauritius at a glance

	Indicators	Units	2015
	ENVIRONMNENT INDICATORS		
1.	Irrigated land	ha	17 183 (2014)
2.	Cultivated land	%	42 (2014)
3.	Forest area (as a % of total land area)	%	25.2
4.	Native forest	%	2
5.	Marine and coastal protected areas	Ha	14,759
6.	Threatened plant species	%	88 (2014)
7.	Threatened animal species	%	89 (2014)
8.	Total fish production	Tonnes	14 208

9.	Total carbon dioxide emission	000 tonnes	3 976
10.	Per capita carbon dioxide emission	tonnes	3.1
11.	Mean annual rainfall	mm	2 377
12.	Mean of maximum annual temperature	^{0}C	27.9
13.	Mean of minimum annual temperature	^{0}C	20.6
14.	Annual fresh water abstraction	Mm^3	612
15.	Per capita daily domestic water consumption	litres	169
16.	Per capita daily solid waste disposed at landfill	kg	1.01
17.	Total electricity generation	GWh	2 996
18.	Electricity generated from renewable sources	%	22.7
19.	Total primary energy requirement	ktoe	1 534
20.	Per capita primary energy requirement	toe	1.22
21.	Primary energy requirement from renewable sources	%	16.4
22.	Per capita final energy consumption	toe	0.72
23.	Energy Intensity	toe per MUR.100,000 GDP at 2000	0.79
	SOCIO-ECONOMIC INDICATORS		
1.	Total Population	Number	1 262 862
2.	Population growth rate	%	0.1
3.	Gross Domestic Product (GDP) at current market prices	USD Billion	11.5*
4.	Per capita GDP at market value	USD	9 237*
5.	Growth rate	% of GDP	3.4
6.	Sectoral Contribution to GDP		
	Services sector, (of which Financial services ~15% Accommodation and food services ~6%)	% of GDP	80
	Manufacturing sector	% of GDP	16
	Tourism	% of GDP	7.5
	Agriculture	% of GDP	4
7.	Growth of household consumption	%	+2.9
8.	Total registered vehicles	Number	486 144
9.	Tourist arrivals	Number	1 151 252

Note* USD 1 = MUR 35.1

Source: Statistics Mauritius, 2016

E3 Mainstreaming climate change in Mauritius

In the wake of worsening climate change and accelerating sea level rise, RoM has developed a number of policies and taken several measures to enhance the resilience of the country and progress towards a low emission pathway. Climate change adaptation and mitigation are among the top priorities in Government's Programme 2015-2019. Some of the key legislative and policy measures set in place include the following:

i) National Disaster Risk Reduction and Management Act (2016)

ii) Master Plan for Energy Efficiency/Demand Side Management and Action Plan for the period 2016 to 2030 (2016)

iii) Marshall Plan Against Poverty (2016)

iv) Strategic Plan 2016-2020 for the Food Crop, Livestock and Forestry (2016)

v) A Guideline for Climate Change Adaptation Strategy Coastal Setback (2016)

vi) Action Plan for the implementation of measures in the Intended Nationally Determined Contribution (2016)

vii) National Biodiversity Strategy and Action Plan (2016 – 2020)

viii) Climate Change Charter for Local Authorities (2015)

ix) National Climate Change Adaptation Policy Framework (2012)

x) The Master Plan for "Development of the Water Resources in the Republic of Mauritius" (2012)

xi) Building Control Act (2012)

xii) Energy Efficiency Act (2011)

xiii) Long term Energy Strategy 2009 – 2025

The Government is also formulating a Climate Change Bill to establish a consolidated framework for climate change measures as well as the setting up of a National Climate Change Committee to strengthen coordination among key stakeholders.

E4 Greenhouse Gas Inventory

The Greenhouse Gas (GHG) inventory was carried out for the period 2006 to 2013 and the figures for the years 2000 to 2005 were checked for consistency and adjusted accordingly. The GHG inventory was clustered around four main sectors, namely, the energy sector which includes the power generation, transport, manufacturing industries and construction; waste sector (solid and liquid); Agriculture, Forestry and Other Land Use (commonly referred as AFOLU), and Industrial Processes and Product Use (IPPU). The emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as other minor gases were considered. The methodology was based on the 2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and the GHG emissions and removals (through carbon sink) were computed through the 2006 IPCC inventory software. The key findings are as follows:

- Total GHG emission in 2013 stood at around 5.1 million tonnes carbon dioxide equivalents (CO_2eq), as compared to 4.3 million tonnes carbon dioxide equivalents in 2006 representing an increase of 18%
- GHG removal for 2013 was 367,000 tonnes CO_2eq, representing a slight increase of 5,000 tonnes CO_2eq , that is, around 1.4%
- Carbon dioxide was the main GHG with 77%, followed by methane (20%) and nitrous oxide (2.5%)
- Hydrofluorocarbons (HFCs), perfluoro-carbons (PFCs) and sulphur hexafluoride (SF_6), though having high global warming potentials, occurred in very small amounts.

E4.1 Emission trend by sector

The energy sector remains the main source of GHG emission, amounting to 77% of overall GHG emissions (3.96 million tonnes CO_2eq) in 2013 followed by waste sector (19%). Agricultural activities contributed around 2.7% to the total emissions while the share of the Industrial Processes and Products Use (IPPU) is insignificant (<1%). The emission removal by forestry stood at around 7%. The Figure ES3 below illustrates the emissions trends sector-wise.

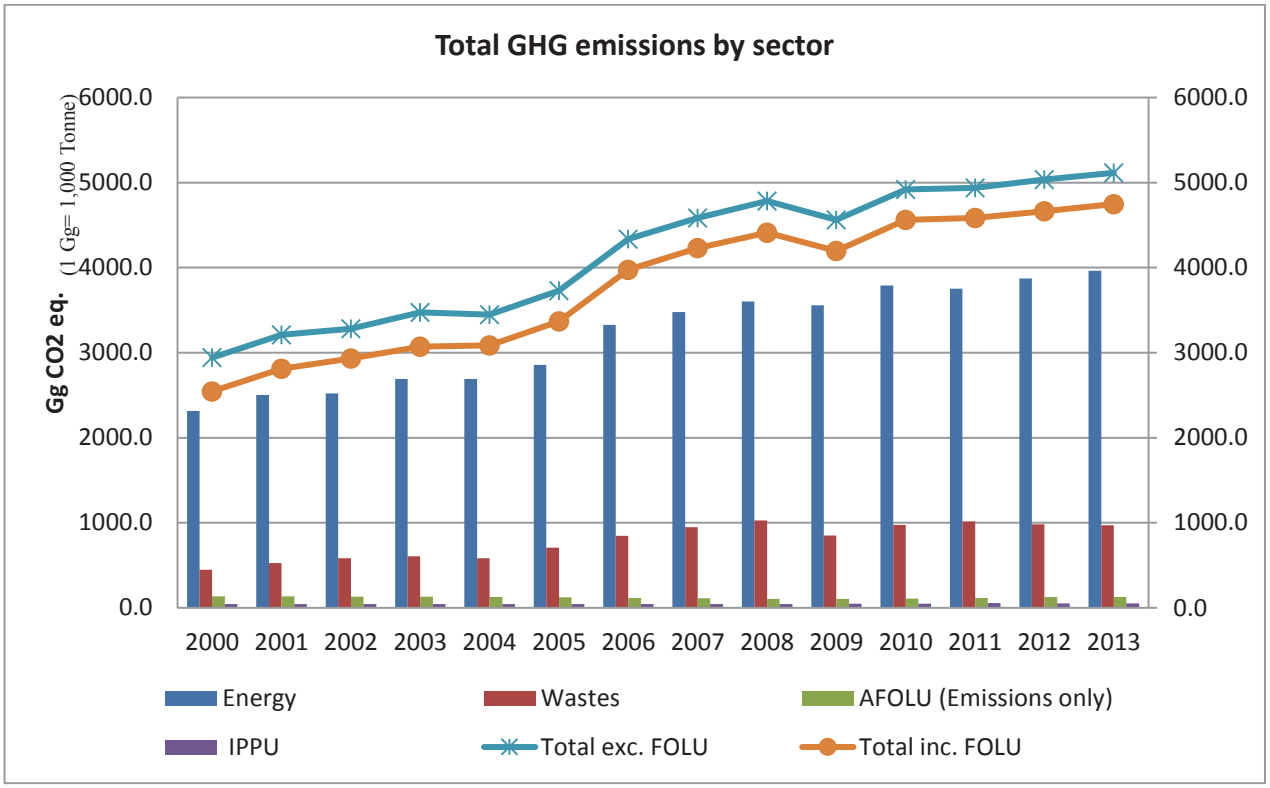


Figure ES3 GHG emissions and removals by sector

E4.1.1 Energy sector

The biggest emitter within the energy sector is the energy industries (60%), followed by transport (25%). Emission from the energy industries increased from 1.8 million tonnes CO_{2e} in 2006 to attain 2.4 million tonnes CO_{2e} in 2013. Around1.0 million tonne CO_{2e} was emitted in the transport sector in 2013 while 0.8 million tonnes CO_{2e} was released in 2006.The increase in the emission in the energy sector can be attributed to the change in lifestyle, increased demand for electricity in households and industries and increase in number of vehicles. Figure ES4 shows the trend of emissions for the various components of the energy sector.

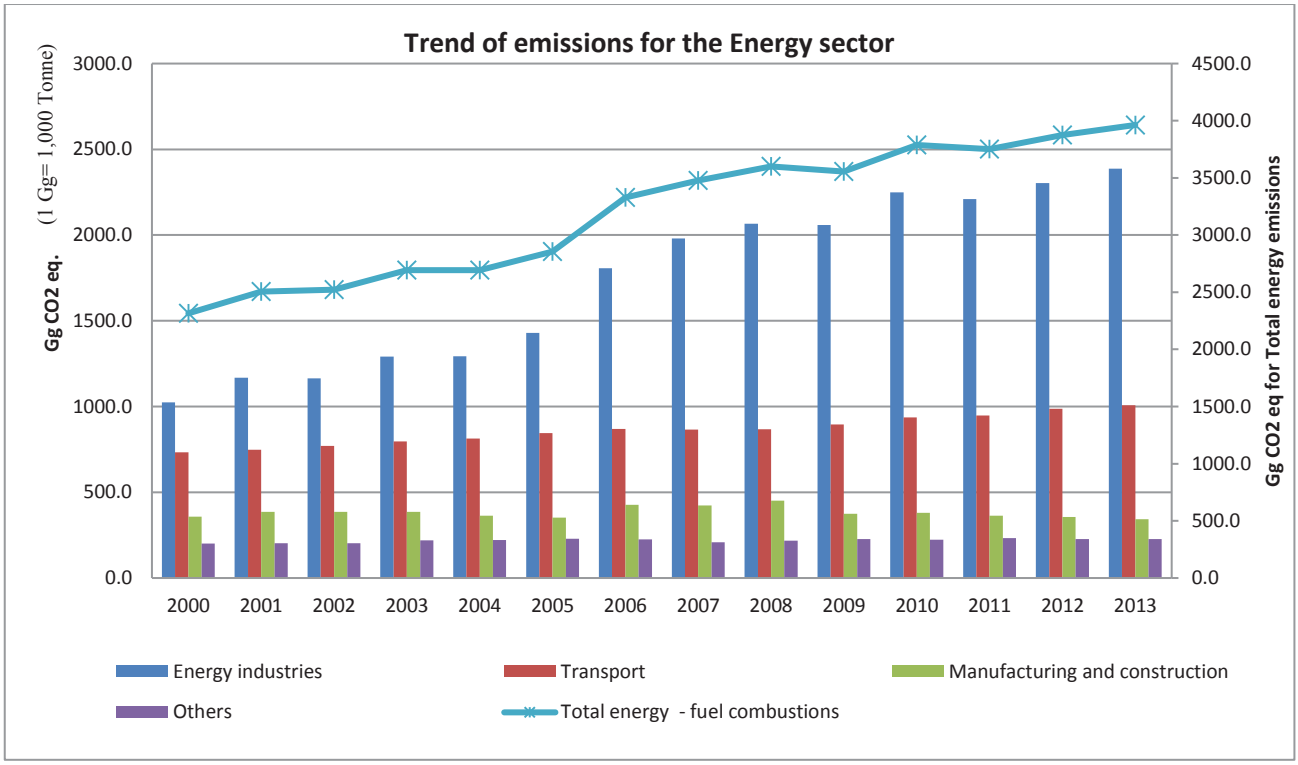


Figure ES4 Trend of emissions for the energy sector

E4.1.2 Non-energy sectors

(a) Waste sector

The waste sector contributes mainly in terms of methane. GHG emissions from solid waste increased from 0.8 million tonnes CO_2 eq in 2006 to 0.9 million tonnes CO_2 eq in 2013, representing an increase of 15%. Emissions from liquid waste also rose from 57,000 tonnes CO_2 eq in 2006 to 61,000 tonnes CO_2 eq in 2013, corresponding to an increase of 7.2%. Solid waste contributed the higher share (94%) due to the increased in amount of waste generated and landfilled. On the other hands, liquid waste was treated by aerobically and hence less emission occurred. Figure ES5 shows the trend for the waste sector.

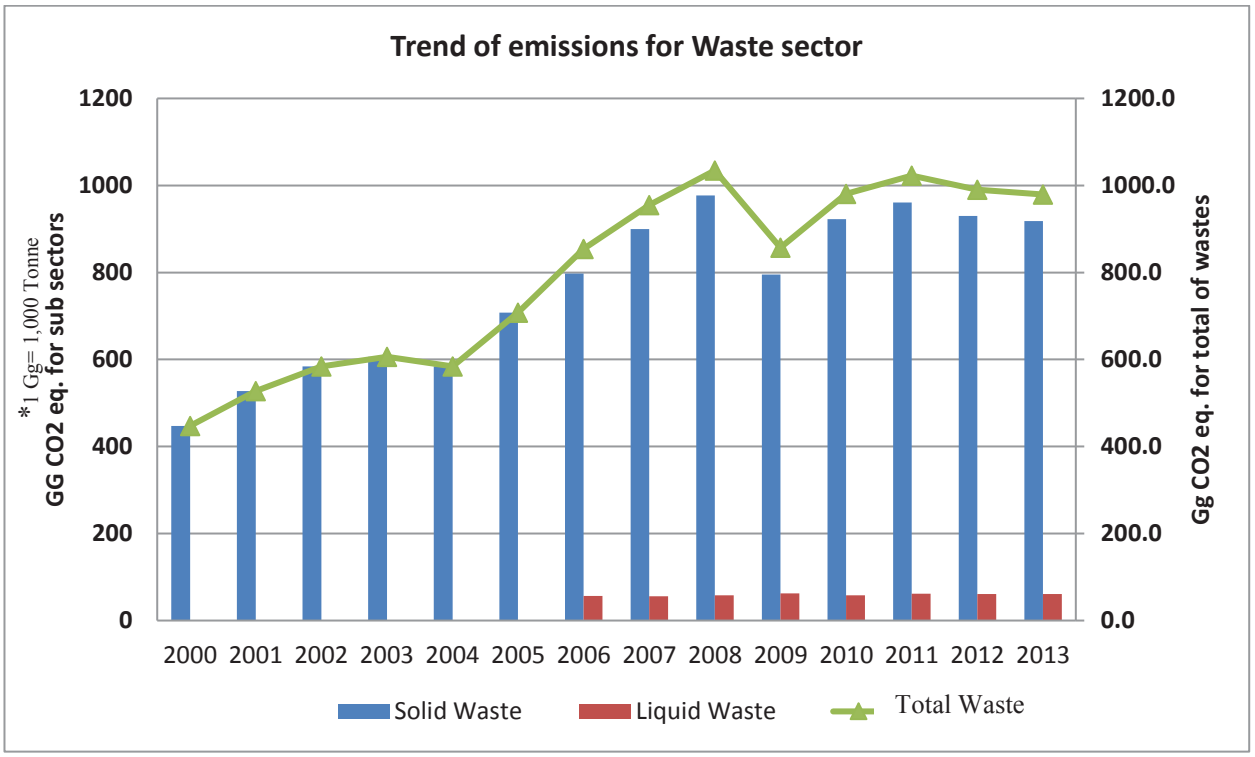


Figure ES5 Trend of emissions for the waste sector

(b) Agriculture, Forestry and Other Land Use (AFOLU) sector

The AFOLU sector is particularly important as it also accounts for carbon sink. CO_2 removals increased from 361,000 tonnes to 367,000 tonnes during the period 2006 to 2013. Emissions from agricultural activities, mainly as N_2O emission, occurred from the use of fertilizers amounted to an average of 83,000 tonnes CO_2eq yearly. Livestock comprising of enteric fermentations and manure management contributed in the emissions of methane. Agriculture practices (soil and livestock) emitted 127,000 tonnes CO_2eq in 2013 compared to 115,000 tonnes CO_2eq in 2006, representing a rise of 10%. Figure ES6 shows the trend of emissions as well as sink for the AFOLU sector.

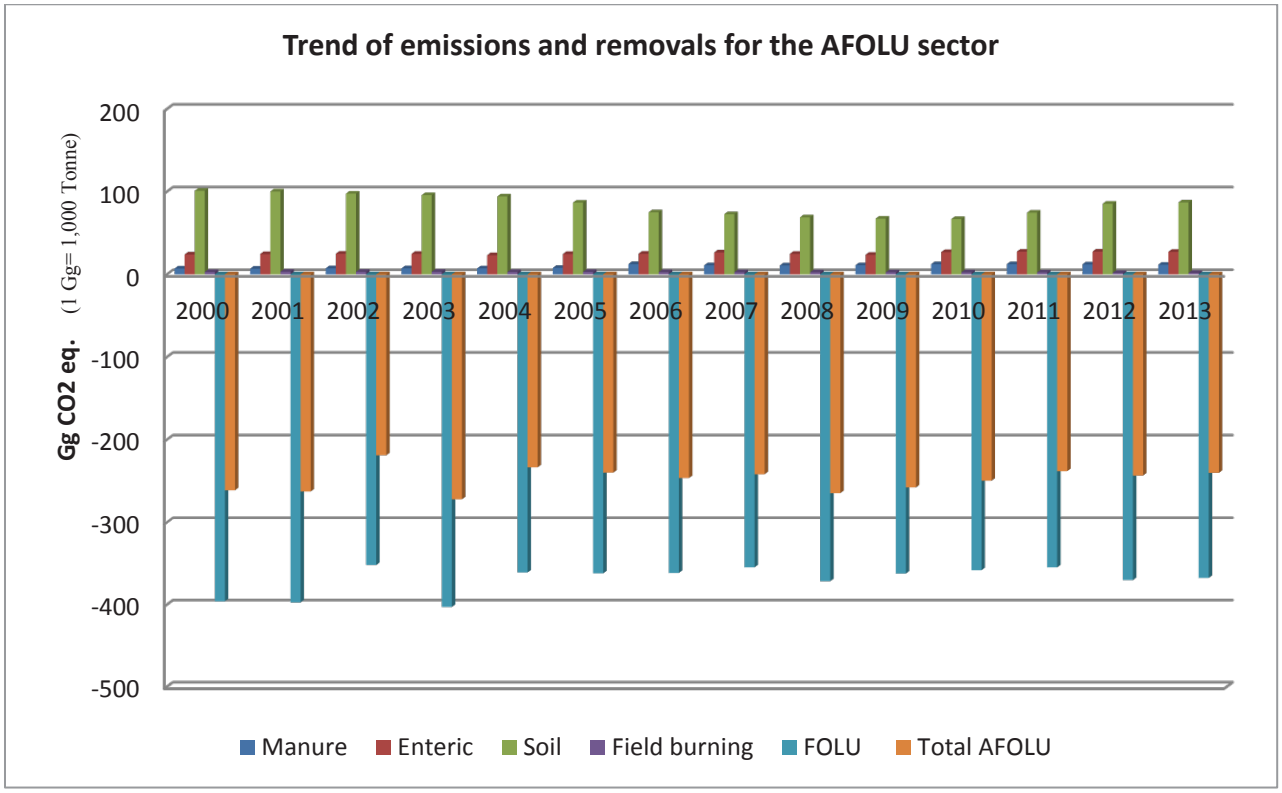


Figure ES6 Trend of emissions for AFOLU Sector

E5 GHG Reduction Assessment (Mitigation)

Potential mitigation measures were assessed for the energy industries, transport, solid waste and AFOLU sectors.

E5.1 Energy sectors

(a) Energy industries

The baseline emissions analysis has been carried out using the system dynamics model that simulate electricity generation using a 3.8% GDP growth rate (the 10-year average GDP growth rate). The mitigation scenarios propose to achieve 35% renewable energy target in 2025 and maintain up to 2030. The technologies envisaged to reach these targets comprise energy efficiency and renewable energy technologies (e.g. solar PV, wind, renewable biomass, and waste-to-energy). The results of the Business-As-Usual (BAU) and mitigation scenarios analysis are shown in Figure ES7. The difference between successive curves (starting with the 'Energy efficiency' option) gives the potential GHG emission reduction for the listed mitigation action. For example, implementation of all the proposed measures could result in reduction of 1.23 million tonnes CO_2eq in 2030 to reach 2.61 million tonnes CO_2eq in 2050 compared to the BAU pathway.

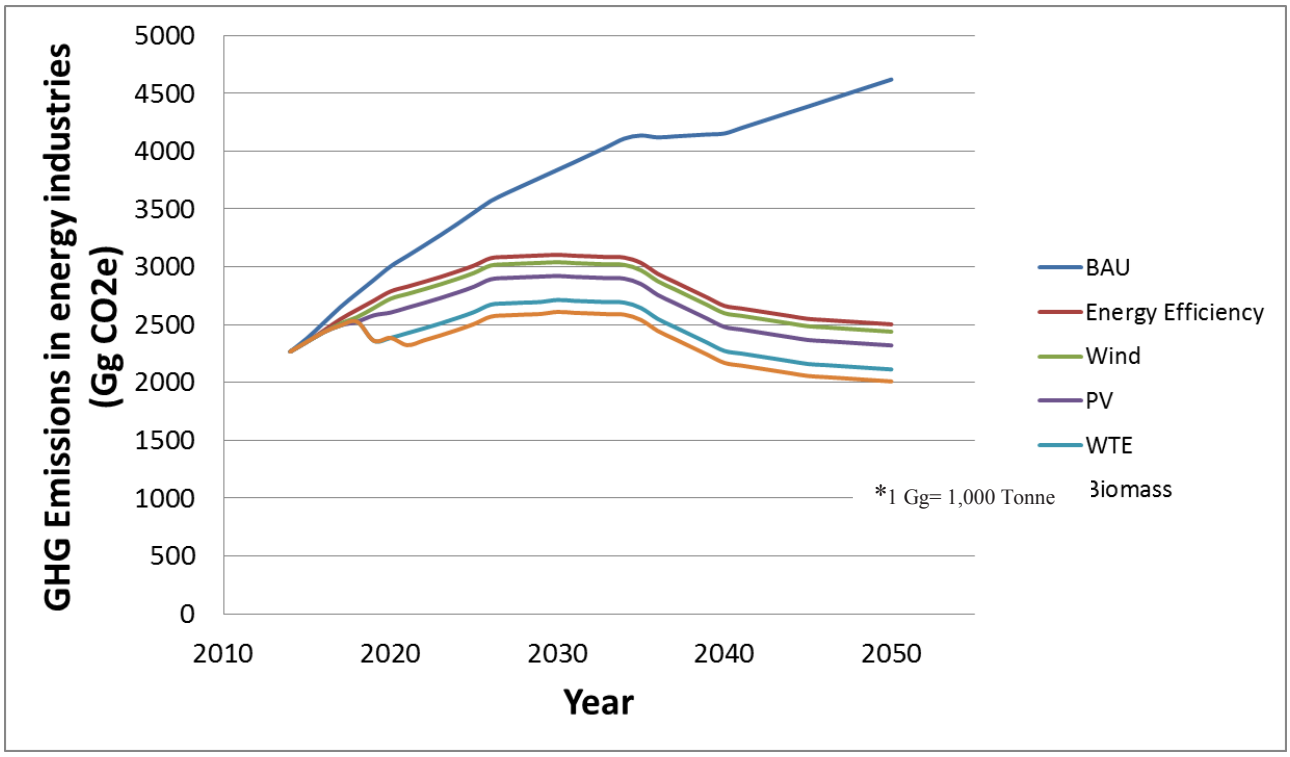


Figure ES7 Mitigation scenarios in the energy industries

(b) Transport

Three mitigation actions have been modelled to reduce GHG emissions (as depicted in Figure ES8:

i) Improvements in the fuel intensity of vehicles at the rate of 1% per year pre-2020, and increasing to 1.5% per year post-2020 yield 19,000 tonnes CO_2eq emissions reductions in 2030 and 25,000 tonnes CO_{2e} in 2050 relative to the BAU scenario

ii) Privatisation of vehicle inspection centres started in 2016 leads to an overall reduction in GHG emission reductions of 5% in 2019. Relative to the BAU scenario, the resulting emission reductions are: 64,000 tonnes CO_{2e} in 2030 and 82,000 tonnes CO_{2e} in 2050

iii) A low-carbon option has been modelled that combines three technologies, namely: (1) blended bioethanol produced in Mauritius; and an increasing penetration of (2) hydrid and (3) electric cars. In all three cases, it is assumed that the low-carbon option will impact gasoline-fueled cars. Assuming there is a total available potential of 20 ML bioethanol per year, the low-carbon scenario accounts for a 25% penetration in 2020, and increasing by increments of 5% in subsequent years until 100% penetration is reached in 2035 (i.e. 50% in 2025 and 75% in 2030).

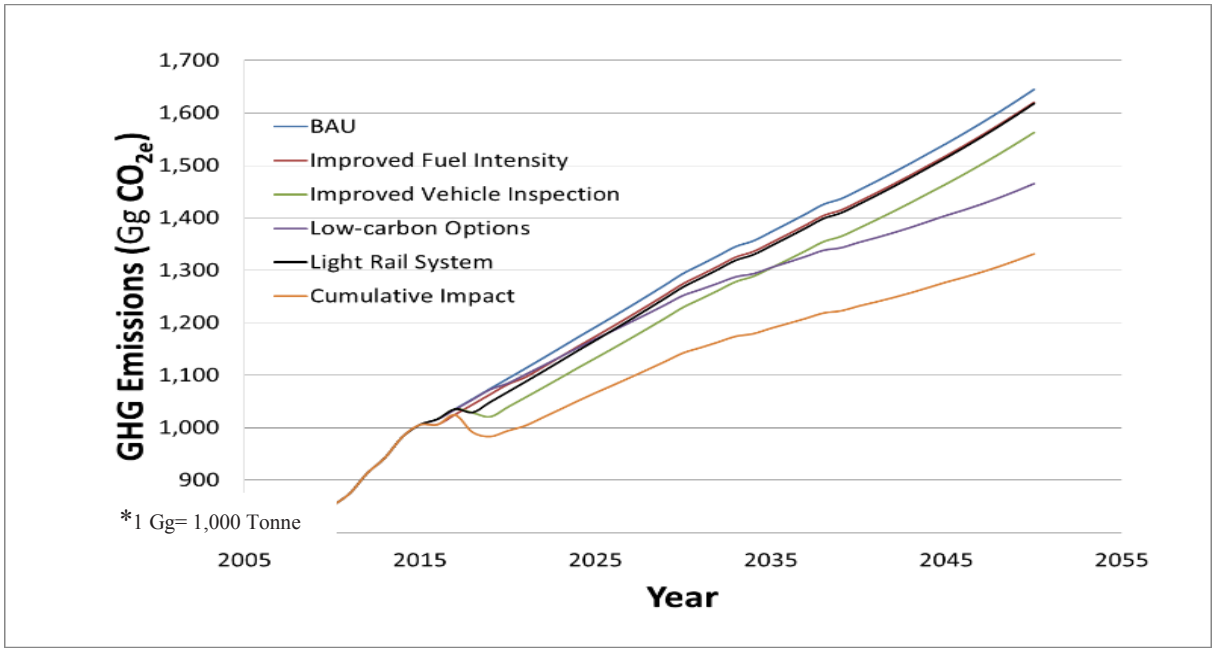


Figure ES8 GHG emissions scenarios for land transport

E5.2 Non-Energy Sectors

E5.2.1 Solid waste

Four mitigation scenarios have been modelled as shown in Table ES2, indicating the net emission reductions relative to the BAU scenario in brackets.

Table ES2 GHG Emission (thousand tonnes CO_{2e}) reductions in the Solid waste sector

	2020	2030	2040	2050
BAU	1,290	1,691	2,168	2,745
Enhanced LFG capture	1,175 (115)	1,289 (402)	1,444 (724)	1,602 (1,144)
Composting of food, garden and paper waste	1,256 (34)	1, 298 (393)	1,297 (870)	1,342 (1,403)
Recycling of paper and textiles waste	1,289 (0.8)	1,680 (11)	2,139 (29)	2,694 (51)
Waste to Energy (WTE)	1,135 (155)	907 (784)	1,270 (897)	1,824 (921)

E5.2.2 Agriculture

(a) Crop

Three mitigation scenarios have been modelled as per the options proposed in the Strategic Plan 2016 – 2020 for Food Crop, Livestock and Forestry. GHG emission reductions (in thousand tonnes CO_2eq) from the crop, with the net emission reductions relative to BAU scenario in brackets is shown in Table ES3.

Table ES3 GHG Emission reductions in from agricultural crop

	2020	2030	2040	2050
BAU	109	110	111	112
Decreasing field burning from its present level of 10% of total area cultivated to 8% between 2020 and 2024, and to 5% after 2025	109 (0.4)	109 (0.4)	110 (0.8)	111 (0.8)
Reduction in the use of chemical fertilisers only (climate smart agriculture). 1% of the baseline value in 2015, and decreases by 1% absolute per year until 2020. After 2020, the annual decrease is an absolute 2% to reach 75% in 2030.	107 (2.7)	98 (13.4)	94 (18.8)	91 (24.1)
Bio-farming (decreased use of fertilisers + uptake of compost in crop production)	108 (1.4)	101 (8.8)	101 (10.2)	102 (10.0)
Cumulative reductions	108 (1.8)	101 (9.2)	100 (11)	101 (10.8)

(b) Livestock

Under the BAU scenario, the total livestock GHG emissions (combined emissions from enteric fermentation and manure management) are relatively small changing from 34,000 tonnes CO_2eq in 2020 to 37,000 tonnes CO_2eq in 2050. Over this period, emissions from enteric fermentation accounts between 57% (2020) and 52 % (2050) of total emissions.

Under the Policy scenario that favours enhanced livestock rearing for increasing the national food security, there is a significant increase in GHG emissions from 36,000 tonnes CO_2eq in 2020 to 50,000 tonnes CO_2eq in 2050. Emissions from enteric fermentation occupy a higher share in total livestock emissions at between 59 % (2020) and 61% (2050).

(c) Forestry and other Land Use (FOLU)

Two scenarios were modelled relative to the BAU scenario. The first scenario involves the implementation of Tree Planting as per the Strategic Plan 2016 – 2020 for Food Crop, Livestock and Forestry. The second scenario concerns the afforestation of 5,000 ha of ex-sugar cane land between 2021 and 2050. The increase in GHG sequestration relative to the BAU scenario for the two scenarios is summarized below (Figure ES9).

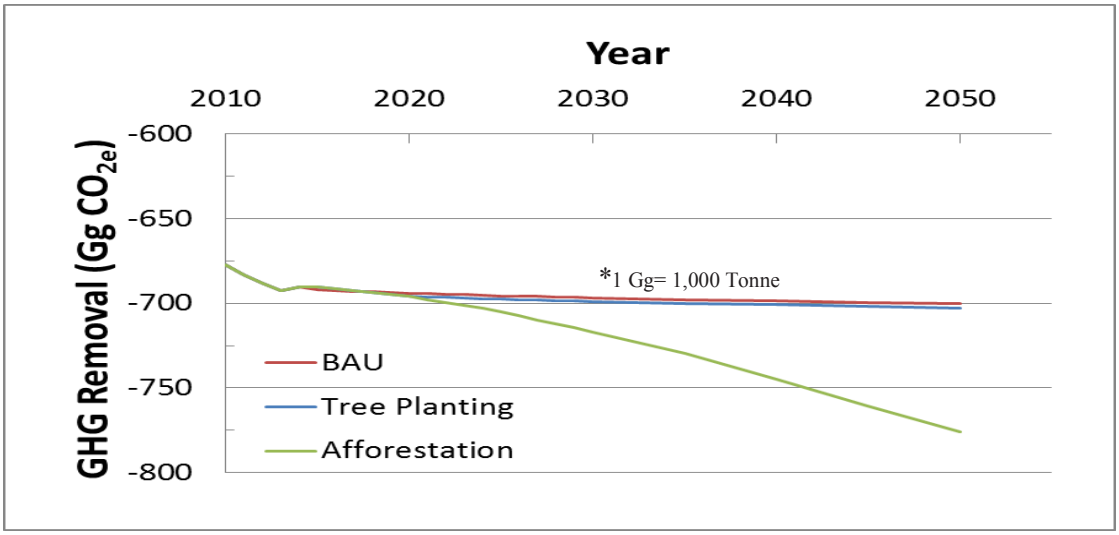


Figure ES9 Carbon sequestration scenarios in LULUCF

E6 Vulnerability Assessment and Adaptation

E6.1 Observed and projected temperature and rainfall pattern

E6.1.1 Temperature

Climate records over the period 1951-2014 show a significant warming trend of about 1.2°C in Mauritius and Rodrigues. Analysis of temperature records indicate that the observed rate of temperature change is on average 0.020°C/yr and 0.023°C/yr for Mauritius for the period 1951-2014 and for Rodrigues for the period 1961-2014 respectively. Projections made on the basis of RCP 4.5 and RCP 8.5 (the business as usual scenario and the worst case scenario respectively) indicate an increase in temperature of up to 2 °C over both Mauritius and Rodrigues for the period 2051-2070. The results are shown in Figure ES10a and ES10b.

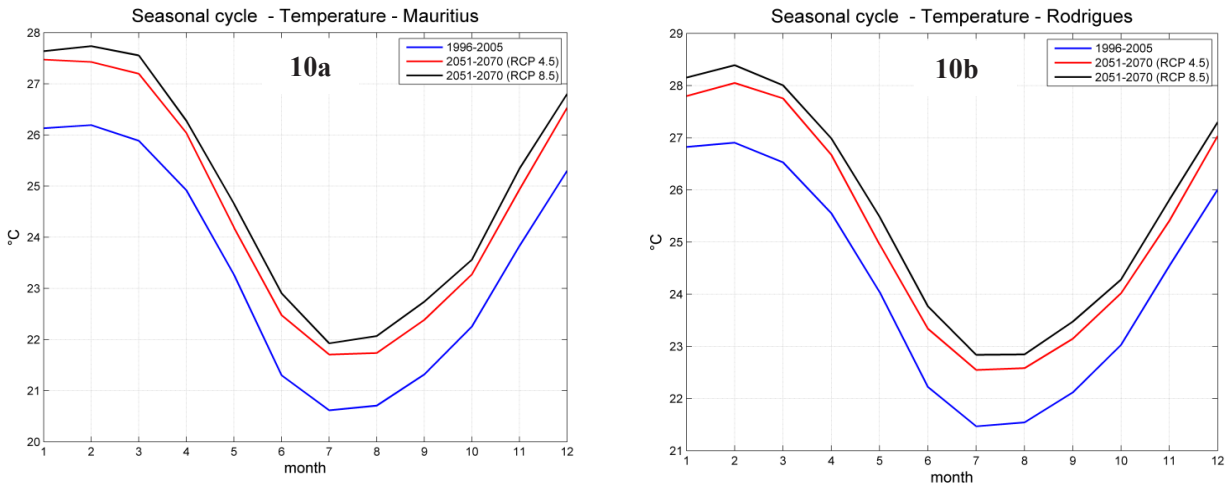


Figure ES10a and ES10b: Temperature Projections for Mauritius and Rodrigues for RCP 4.5 and RCP 8.5

E6.1.2 Rainfall

Analysis of rainfall over the period 1951 -2014 shows a decreasing trend in rainfall amount of about 8% for Mauritius. For Rodrigues which is a water scarce island, a downward trend has also been observed in the rainfall. However, projections for RCP 4.5 and RCP 8.5 scenarios, does not show significant variation with respect to the present rainfall pattern (Figure ES11b). Nevertheless, for Mauritius, the precipitation seasonal cycle shows an increase in monthly precipitation during the period from May to October as depicted at Figure ES11a for Mauritius.

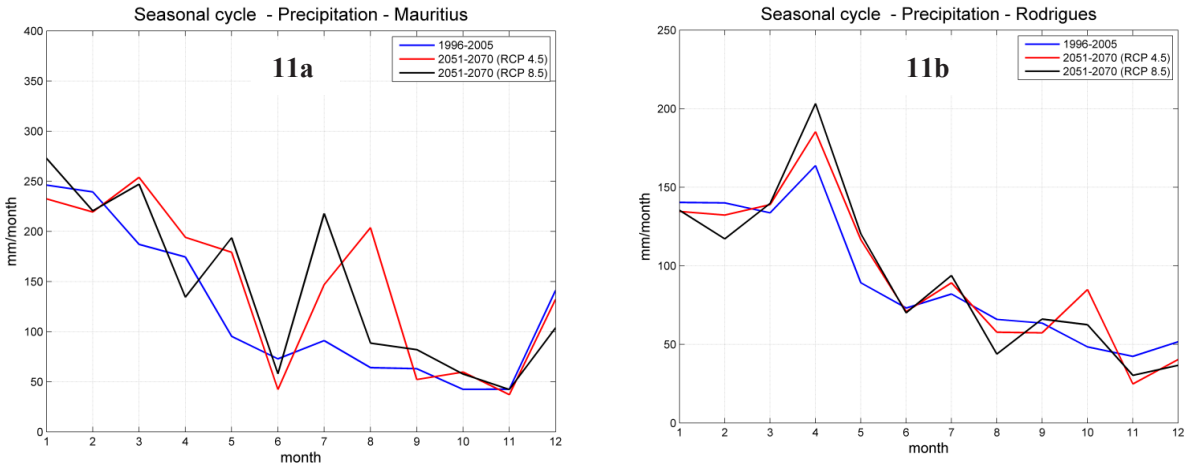


Figure ES11a and ES11b: Precipitation Projection for Mauritius and Rodrigues for RCP 4.5 and RCP 8.5

E6.1.3 Sea level rise

An analysis of sea level record available indicates an accelerated rise of 5.6 mm/yr for, strikingly, both Mauritius and Rodrigues since 2003, much higher than the global average of 3.2 mm/yr.

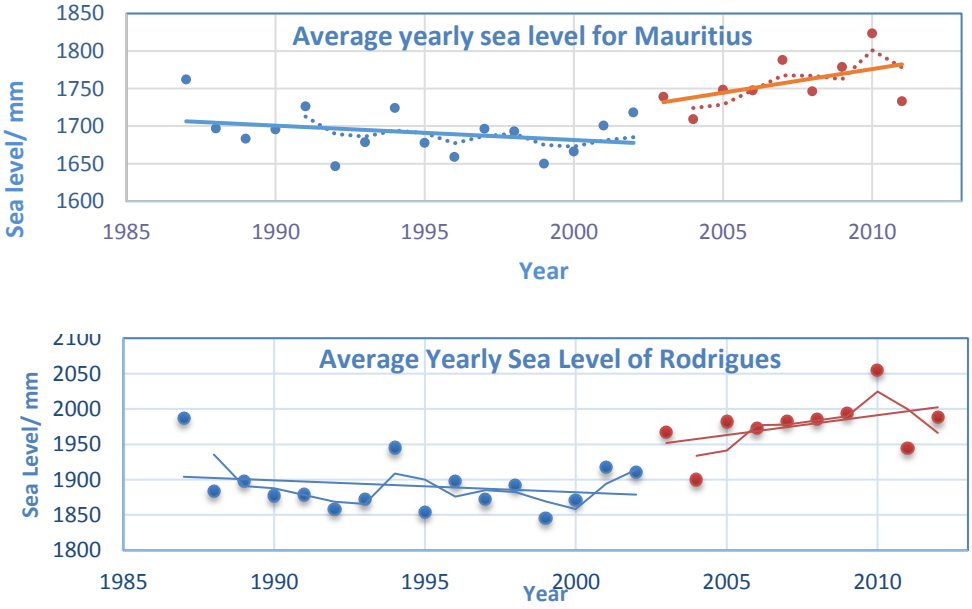


Figure ES12 Sea level in Mauritius and Rodrigues

E6.2 Impacts of climate change and projected vulnerability on key sectors

The following seven key sectors, namely, agriculture, coastal resources and tourism, water resources, marine and terrestrial biodiversity, fisheries, human health and infrastructure are highly vulnerable to climate change including sea level rise. The observed impacts and adaptation strategies are presented in Table ES4. The adverse impacts will also have profound socio-economic implications.

Table ES4 Observed impacts of climate change on key sectors and projections for Mauritius

Sector	Impacts and Projections
Agriculture	Increase mortality in poultry and incidence of pests and crop diseases leading to a decrease in crop productivity, due to heat stress have been observed. Saltwater intrusion has also been affecting agricultural farms situated in certain low lying coastal zones. A projected reduction in rainfall and an increase in evapo-transpiration may lead to as much as 15 to 25% decline in agricultural production by 2050. With a decrease in rainfall of 10 to 20 % and an increase in temperature of 2 ^{0}C, reductions in cane yield is expected to range from 34 to 48% while reductions in sugar yield is expected to range from 47 – 65 %.
	As for Rodrigues, many incidences of crops damage from irrigation, due to salt-water intrusion in coastal boreholes have been observed. Flowering of fruit trees is occurring earlier and shifting of planting rain-fed beans and onions in February/March instead of April/May.
Coastal areas and tourism	Accentuated beach erosion has shrunk the width of beaches around certain coastal areas in Mauritius by up to 10 meters over the eight years. Coral reefs are in a state of deterioration. Sea level has been rising at a rate of 5.6 mm/yr since 2003. A projected increase in mean annual temperature extremes coupled with beach erosion can lead to a reduction in tourist arrivals accounting for a revenue loss of up US$ 50 million by 2050.
	In Rodrigues, more severe bleaching may lead up to 75% of corals mortality at some sites resulting in a decline in fish population, loss of the protective function of the reef, and loss of sandy beaches of the order of about 5 m every decade.
Water	There has been a decreasing trend in annual precipitation of about 8% compared to the 1950s coupled to an increase in rainfall variability and water scarce periods. Projections indicate that the utilizable water resources may decrease by up to 13 % by 2050 if no action is taken to restore catchment areas.
	Desalination from 3 plants is being resorted to resolve the water shortage in spite of high cost generating a very concentrated and continuous stream of brine to the sea and new desalination projects envisaged.
Biodiversity	In both Mauritius and Rodrigues, breeding and reproductivity of various plants and animals species are suspected to have already been affected by the changing climate. It is projected that there will be a greater proliferation of invasive alien species at the expense of native species, a decrease in pollinator activity due to shifts in plant phenology and coastal vegetation, turtle nesting, and wader visitation on low lying islets will be affected.
Fisheries	Frequent fish mortality suspected to be linked to climate change observed in the nearshore around Mauritius. Projected increase occurrence of coral bleaching, would reduce coral biodiversity and fish species for both Mauritius and Rodrigues while algal blooms due to high sea surface temperature would result in mass mortality of marine biodiversity and resources.
Health	An increase in frequency of vector borne diseases, particularly dengue, linked to variabilities in temperature, has been observed over the last decade. Climate change may increase the vulnerability of the health sector in the coming decades leading to higher disease burden with associated health cost and impaired socio-economic development in the Republic of Mauritius.
Infrastructure	Properties, buildings and roads have been affected or damaged due to flooding, erosion and landslide. For instance, Mauritius Port's operations was suspended for 10 days in 2014 due to adverse weather conditions leading to USD 54M loss. It is projected that there will be accelerated softening and deterioration of bituminous pavement, surface and thermal cracks to concrete, increased corrosion of steel, scouring of foundations and embankment collapse and damage to buildings and power transmission masts in both Mauritius and Rodrigues.

E6.3 Adaptation Strategies

The following adaptation strategies (Table ES5 for Mauritius and Table ES6 for Rodrigues) are proposed to enhance the resilience of the various sectors in the face of climate change.

Table ES5 Strategies and opportunities emerging from cross sectoral linkage for Mauritius

Sector	Strategies	Direct Cross cutting issues/ benefits	Other benefits and remarks
Agriculture	Enhance bio, smart and ecological agriculture practices	• Reduction of runoff of chemical fertilizers and pesticides • Improvement of water quality and coastal habitat • Better food quality and health.	Policies implemented in other sectors can have a positive impact on the agricultural sector, including the development of climate resilient infrastructure, which can ensure access to the road network for delivery to markets;
	Raise awareness to increase the demand for organic products	• Creation of a new domestic market as well as to the development of export opportunities.	
Coastal areas and tourism	• Restore wetlands for fisheries and protection of infrastructure from storms and sea level rise • Replenish dunes	Such steps prevent the salinization of rivers, and development of eco-tourism that fosters investments in biodiversity conservation.	Policies implemented in other sectors can have a positive impact on the coastal and tourism sector including the integrated management of fisheries that will improve the health of coastal ecosystems and investments in resource efficiency (through R&D and infrastructure) that will reduce the ecological footprint of coastal resorts.
Water	• Protect and restore water catchment areas. • Increase awareness on water consumption	• Can lead to a reduction in costs for households and the tourism sector.	Policies implemented in other sectors can have a positive impact on the water sector, such as the adoption of smart agriculture practices that can reduce the amount of water needed for irrigation and reduce chemical contamination of underground aquifers by leaching.
	Reduce soil erosion	• Reduction in costs associated with water pumping– and on biodiversity –because of the value that freshwater ecosystems have on biodiversity conservation. • Reduction in the costs associated with infrastructure maintenance and coastal erosion as it impact negatively on coastal areas and tourism.	
Biodiversity	Eradicate invasive species in catchment areas	Positive impacts on freshwater quantity and quality	Policies implemented in other sectors can have a positive impact on the biodiversity sector include the reduction of fertilizers and pesticides that negatively impact species

	Expand protected areas	Positive effect on tourism	diversity, as well as the adoption of integrated land use planning (with a reduction of land conversion).
	R&D on impacts of climate change and benefits of native species/ forest	Would support bio-farming and agro forestry	
Fisheries	Rehabilitate and expand coastal and marine habitats	• Enhancement of biodiversity conservation, • Improvement of leisure activities and tourism. • Improvement of governance for protected areas, and incentivizes eco-tourism	Policies that have cross-sectoral benefits include the integrated management of coastal ecosystems that benefit fish stocks, as well as tourism and other leisure activities. Another area of intervention that benefits the fishery sector is the management of terrestrial biodiversity, as well as the utilization of sustainable agriculture practices, averting the increasing challenges being faced for coastal livelihoods.
	Improve monitoring of coastal areas	Reduction in climate related impacts on infrastructure.	
Health	Upgrade the health system for the monitoring of climate-sensitive disease surveillance and food security	would benefit households and the tourism sector, in addition to the private sector (through higher labor productivity).	Policies implemented in other sectors can have a positive impact on the health sector include better water and land use management, to avoid the growth of carriers of vector borne diseases
Infrastructure	Use climate resilient materials and techniques	Decrease the health risks associated with natural hazards	
	Restore landscape integrity	Can benefit biodiversity	
	Upgrade drains	Improvement of water quality	
	Better manage water (e.g. restoration of water catchment areas)	Reduction in floods and damage to infrastructure as well as the restoration of marine habitat	
	Restore marine habitat	Reduction in coastal vulnerability	

Table ES6 Adaptation strategies to address climate change in Rodrigues

Sector	Strategies
Agriculture	Improve water conservation and expand rainwater harvesting; implement integrated pest and disease management and promote bio production, increase the number, resilience and height of retaining walls to terraces for crop plantation.
Coastal areas and tourism	Preserve natural landscapes through the establishment of natural parks for eco-tourism; plant mangroves, build wave breakers at sea and flood wall on the coastline to protect vulnerable on-land infrastructure and build elevated roads or relocate coastal roads more inland.
Water	Increase water use and production efficiency; promote integrated flood management, rehabilitate and improve the distribution system of potable water, the construct desalination plants powered by wind energy, and identify potential small dam sites to cater for medium and long term water needs of the population.
Biodiversity	Restore/recreate native forests, conserve biodiversity, and improve ecosystems services such as regulation of water supply, soil conservation and air quality and promote the creation of local capacity to undertake research on the effects of climate change on biodiversity, and on ecosystems valuation.
Fisheries	Improve governance and enforcement over the existing marine protected areas; expand protected areas; adopt and promote sustainable fishing practices; improve capacity of institutions and fishers in understanding and managing the marine ecosystem.
Health	Strengthen preventive measures to avert disease burden attributable to climate change; target response for triggering effective and timely response in order to reduce incidence of morbidity and mortality from disease burden associated with climatic changes.
Infrastructure	Build new interceptor and road-side drains to channel surface run-off to the sea, rehabilitate / upgrade existing drains, reinforce the wearing surface of roadways by the use of fabric reinforcement, replace cladding, flooring and linings with water resistant materials and construct levees or floodwalls around them, and encourage air conditioning optimisation.

E7 Other Information for Achieving Convention Goals

Other initiatives implemented to achieve the objectives of the Convention.

E7.1 Technology Transfer and Development

Mitigation technology action plans have been developed for GHG mitigation measures identified in Chapter 4. The UNFCCC-supported Technology Needs Assessment process was adopted using multi-criteria analysis and logical problem analysis. The action plan constituted technologies for the energy industries, transport, solid waste, agriculture and FOLU sectors. The proposed technologies are energy efficiency, wind energy (onshore), solar PV, waste to energy, biomass, improved fuel intensity, improved vehicle inspection, hybrid cars, ethanol blend, LFG capture, recycling of paper and textile waste, composting, compost used in bio-farming, crop burning, reduced use of chemical fertilisers (climate-smart agriculture),biogas digesters, fertigation and afforestation/tree planting.

E7.2 Systematic observation and Research

RoM observes systematically several of the Essential Climate Variables of the climate system comprising the atmosphere, oceans and land surface. Six synoptic stations, 23 Automatic Weather Stations (AWS) and some 180 climate stations are operational in Mauritius. Rodrigues has one synoptic station, 3 AWS and 14 rainfall stations. A weather radar is expected to be operational in 2018. Other climate-related observation system includes real-time agrometeorological stations, fixed and mobile ambient air monitoring stations for particulate matter, gaseous pollutants such as sulphur dioxide, oxides of nitrogen, carbon dioxide and carbon monoxide. National Environmental Laboratory (NEL) of the Ministry of Environment, Sustainable Development, and Disaster and Beach Management (MoESDDBM) is equipped, amongst others, with High Volume Sampler for Particulate Matter monitoring, a Portable Gas Analyser.

The Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island which operates 25 stations, and additional stations by Mauritius Meteorological Services (MMS) and Mauritius Oceanography Institute (MOI) which provides an operational ocean service. Measurements of ocean waves, and shore line and coastal erosion are carried out in several of the more exposed places around Mauritius. A storm forecast system in operational at the MMS.

The terrestrial observation system comprises surface and groundwater including river flows at about 100 gauging stations, reservoir storage, and water use. Regions at risk from flooding with a return period of 25, 50 and 100 years and those prone to landslides have been mapped. There is the need to reinforce the existing monitoring system and to put in place a robust Early Warning System. Phenological observations remain sparse and need to be extended.

In order to meet the needs of RoM, a strategy for enhancing the existing network of observations and initiating new sets of observations in support of climate change mitigation and adaptation, and of sustainable development activities need are under consideration.

Considerable efforts are being deployed by the research and tertiary level institutions to introduce climate change in various curricula and undertake research. A few regional initiatives are also encouraging research.

E7.3 Education, Training and Public Awareness

Ministry of Education and Human Resources, Tertiary Education and Scientific Research (MEHRTESR) has taken several initiatives to bring climate change education to learners at early childhood, primary, secondary, and pre-vocational levels. Climate change is mostly taught as a component of *Education for Sustainable Development (ESD)*. To ensure a practical-based education, 24 primary and 26 secondary schools in Mauritius have been equipped with photovoltaic (PV) solar panels, 7 primary and 18 secondary schools have installed rain harvesting systems, while 108 Government primary and 60 secondary schools have established green corners and endemic gardens. The Nine-Year Continuous Basic Education Scheme due to start in 2017 will assist in the process.

Informal education contributes significantly by engaging schools, the public and private sectors civil society and NGOs in climate change-related sensitisation activities. Considerable emphasis is being placed on the training of trainers. MOESDDBM's *Climate Change Information, Education and Communication Strategy and Action Plan 2014 – 2016* aims to raise awareness of 400 000 citizens by 2016 and one million citizens by the year 2020 about climate risks and instils a culture of mitigation and adaptive management. Tools developed for sensitisation include card games, video clips, interactive 3-D model on the impacts of climate change and storm surges on coastal zones. Events such as the Women's Forum 2016 on climate change held in Mauritius and which addressed issues of climate as it relates to health, agriculture and biodiversity, sustainable energy; and, water and sanitation for Africa and SIDS.

E7.4 Capacity Building

A series of capacity building initiatives have been carried out in the context of major projects including on mainstreaming of and adaptation to climate change on various socio-economic sectors, GHG Inventory and pathway calculator 2050 to estimate carbon footprint, weather forecasting and Early Warning System. These trainings were carried out by local and international consultants and were delivered to concerned stakeholders including public, private, NGOs, research institutions and academia.

E7.5 Networking and Information sharing

TNC preparation required a wide range of data and information across disciplines and called for greater collaboration and information sharing among policy and decision makers, public and private sectors, academia, civil society and the public. A few of the data sharing facilities include Statistical Environment Unit, MUELEX web-based, searchable database system, the High Performance Computing (HPC) Server at the University of Mauritius and various Ministries. At the regional level, RoM's involvement in various regional activities such as Indian Ocean Commission's ACCLIMATE project, SADC's Climate Change Programme and World Meteorological Orgainization's Climate Forecast Forum in Eastern and Southern Africa provide considerable opportunities for networking and information sharing at regional level.

The Climate Change Information Centre (CCIC) is gradually building its institutional capacity and a robust network to serve as a Centre of excellence with a platform for knowledge and information sharing. The Centre has identified 44 environmental indicators for reporting purposes. It has collected data on 15 of them and is actively pursuing its efforts to obtain data on the remaining indicators from stakeholders, which include Ministries, public and private sector organisations, academia and NGOs and the public. The Centre may also meet RoM's reporting and other obligations under the Convention.

E8 Constraints and Gaps, and Related Financial, Technical and Capacity Needs

Various constraints and gaps and the related financial, technical and capacity needs were identified particularly pertain to GHG Inventory, Climate Change Scenarios, Vulnerability Assessment & Adaptation, and Mitigation Assessment. Selective gaps and needs applicable to both Mauritius and Rodrigues and, to some extent, other outer islands are given in Table ES7.

Table ES7 Constraints, gaps and related technical and capacity needs in key sectors

SECTOR	KEY AREAS WHERE GAPS AND NEEDS HAVE BEEN IDENTIFIED	PROPOSED MEASURES	POTENTIAL SOURCE OF FINANCIAL/ TECHNICAL SUPPORT
Climate Change Scenarios	• Development of climate change scenarios is quite complex and requires specialized expertise; • Purchase of meteorological data to test and validate climate change models is very costly.	There is a need to develop expertise at national level for concerned institutions for the application of appropriate climate change models and scenarios for determination of climate change impact assessment at sectoral level.	Bilateral, Regional bodies
GHG Inventory	• Lack of disaggregated activity data and Local and country specific Emission	Enhanced CB of scientists and better Lab facilities to conduct studies on	Local training; UNFCCC; Bilateral

	and sink factors for more refined GHG calculation to higher Tiers	determination of local and country specific EF for emission and sinks	
Energy	Insufficient energy auditors and enforcement of regulations under the EE Act	Training of energy auditors and on enforcement; and training of trainers on energy saving and EE	Local training; UNFCCC; Bilateral
Transport	Absence of EE mass transportation systems based on hybrid technologies and cleaner energy	Policy development, institutional CB and technology transfer.	UNFCCC Bilateral
IPPU	Inadequate CB and resources to leapfrog to low global warming potential refrigerants. Data on sectors – metal, minerals	Human and institutional CB for a new generation of appliances and installations (AC/chillers etc.)	Montreal Protocol Bilateral
Forest	Limited data on privately-owned forests, trees along rivers, roadside; on natural forests (type of trees, age distribution class, annual increment)	Refinement of inventory system and capturing data on trees outside forest area and ground truthing on private land. Further training in remote sensing for land use change. Acquisition of high resolution satellite imagery with Near Infrared band for Mauritius for the accurate calculation of carbon sink for the island.	RCMRD; UNFCCC Bilateral
Waste	Insufficient development in integrated waste management including waste to energy and record of waste types and EFs development	Technology transfer for project development and calculation of emissions from wastes; and CB on waste-to-energy technology	Multilateral; ADB; UNDP; Bilateral
Liquid waste	Limited data on emissions at treatment plants and records of population connected; and industries to develop EFs Absence of a real time flow monitoring system for sewers to obtain real time data and take remedial measures upfront. Use of renewable sources of energy has not been explored for the operation of wastewater treatment plants and pumping stations.	Capacity building on development of EFs Secure funding for implementation of projects	UNFCCC
Agriculture	Limited development in integrated pest and disease management; bio-farming; research to develop local EFs; and sustainable land use planning practices; • Lack of trained staff on climate modeling to understand and predict the impact of climate change on the agricultural sector. • Lack of trained staff on techniques for mitigation analysis and scenario building. • Lack of a Systematic Observation framework to study how CC is impacting on the agricultural sector.	Integrated pest and disease management and bio-farming technologies; Ways to introduce revenue-generation mechanisms; other technologies (GIS, agro-meteorological stations) • Integrate CC gaps into current agricultural policies and strategies. • Improve technology transfer and capacity building	Multilateral; FAO; IITA, GCIAR

	• Lack of data pertaining to livestock sector, in particular deer and horses	• Increase funding and investment in CC related adaptation and mitigation technologies.	
Coastal and Tourism	Limited coastal protection works - coastal vegetation; beach nourishment / dune replenishment; coastal wetland protection/ restoration; lagoon management and coral rehabilitation	Coastal protection works - site investigation/source identification; planting of native vegetation; re-establishment of marshes; mangroves/seagrass restoration; coral nursery.	GEF; JICA; AFD; GIZ; Multilateral; Bilateral, REDD+
Water	Limited forecasting and integrated water resources management; limited water use efficiency and water storage capacity ; limited monitoring and data analysis	Development and use of hydrological models; Reduce losses in water distribution system; Promote soil and water conservation techniques; Increase water storage capacity; Modernize data acquisition and management system.	UNDP; USAID; EC; Multilateral; Bilateral
Biodiversity	Limited restoration of native forests and reintroduction of native plants in planted forest; limited expansion and improvement of protected areas and protection of Environmentally Sensitive Areas.	R&D on impacts of CC on native forests; maintenance of replanted forest; removal of invasive alien species. Improving resilience of marine/terrestrial biodiversity to CC.	GEF; REDD+
Fisheries	Limited rehabilitation and expansion of coastal and marine habitat; limited development in sustainable aquaculture; limited improvement in monitoring of coastal areas and absence of a harmonized monitoring methodology.	Promote sustainable aquaculture; coral nursery; seagrass restoration; mangrove propagation; create a centralized knowledge repository; Enhance fishermen sensitization and training programme.	EU, AFD, FAO Bilateral; Multilateral
Health	Insufficient surveillance/monitoring/control of vectors, diseases and environmental hazards; Inadequate health promotion through education/communication/dissemination on preventive strategies; Absence of policies to make projections for hotspots	Policy formulation; Consolidation of data for mapping purposes; implementation of Early Warning System of surveillance to monitor trend of vectors, environmental hazards and climate-sensitive disease and conditions. Create a Unit for vector borne and climate-sensitive diseases	Multilateral; WHO; WB; Bilateral
Infrastructure	Limited use of topographic, hydrology and climate-related data in infrastructure planning (e.g. elevated roads and buildings); and absence of real time warning system for infrastructure failure	CB of institutions on the use of climate related data for infrastructure planning; use of climate resilient materials and techniques in flood prone areas; CB on restoration of landscape integrity and technology deployment	AFD; Bilateral; Multilateral

Gender	Limited expertise to address gender implications of climate change	Capacity Building Programmes of Officers and Gender Focal Points on: • Gender and its implications on Climate Change • Adopting a gender lens while planning, implementing and evaluating projects and programmes	Bilateral

E8.1 Financial needs

E8.1.1 Domestic Public Finance for climate change activities

The domestic public finance for climate change mitigation and adaptation expenditures rose from USD 182.5 M in 2011 to USD 230 M in 2014. The percentage of climate change expenditures is in the range of 7 to 7.9 % of the total government expenditure and is about 2% of the GDP for the period 2011-2014.

E8.1.2 Private sector finance

The private sectors made extensive investment particularly in climate change mitigation in renewable energy including solar and wind energy, cane trash and recycled paper for power production, bio-ethanol industry, small energy plant, landfilled gas to energy and Deep Ocean Water Application (DOWA). Information received so far indicates a total investment of USD 180 M from private sectors from 2014 to 2020.

E8.1.3 GEF, Annex II Parties, multilateral and bilateral contributions

The Ministry of Finance and Economic Development is responsible for coordinating all the funding received and this is eventually reflected in the National Accounting in a spirit of transparency and good governance. Funding was received from many sources including from multilateral (USD 3 035 000) and through bilateral cooperation (USD 34 694 835).

E8.2 Proposed Projects for Financing under INDC

ROM is targeting a 30% reduction in greenhouse gas emissions by 2030. Thirteen projects options have been identified for adaptation and 10 for mitigation. The financial resource requirements are estimated at USD 5.5 billion, with USD 4.0 billion allocated for adaptation and the remaining USD 1.5 billion allocated for mitigation activities during the period 2015 - 2030.

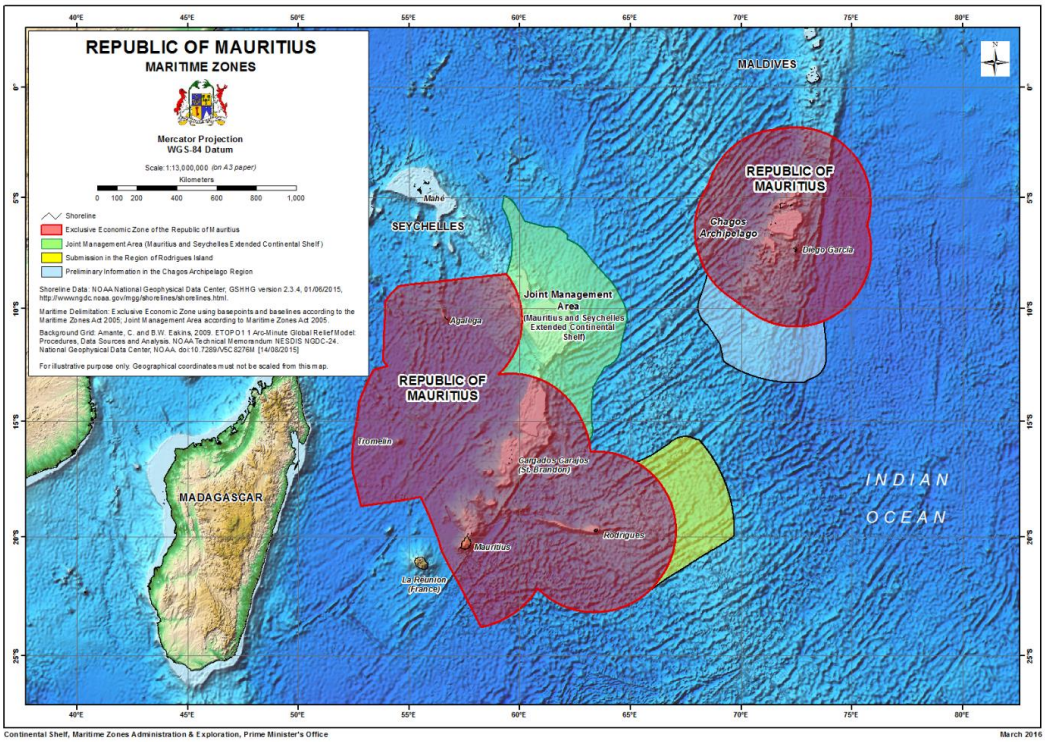
CHAPTER ONE

Chapter 1 NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENTS

NATIONAL CIRCUMSTANCES

1.1 Introduction

The Republic of Mauritius (RoM) is located in the South-West Indian Ocean (SWIO). The State of Mauritius includes Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago, including Diego Garcia and several islets around these islands. Its total area is about 2 040 km² with mainland Mauritius occupying about 1 865 km² and Rodrigues about 108 km². The Republic's ocean territory comprise an Exclusive Economic Zone (EEZ) of about 2.3 million km² as well as an Extended Continental Shelf of 396 000 km² in the region of the Mascarene Plateau which is jointly managed by RoM and the Republic of Seychelles, outside the borders of their respective EEZ (Figure 1.1). RoM has made a submission for an extended continental shelf in the region of Rodrigues. It has also deposited a Preliminary Information to the United Nations for an extended continental shelf in the Chagos Archipelago region.



Source: Prime Minister's Office (2016)

Figure 1.1 Geographical location of Mauritius and Outer Islands with the EEZ (light red); Joint Management Area - Mauritius and Seychelles Extended Continental Shelf (light green); Extended Continental Shelf submission to the UN Commission on the Limits of the Continental Shelf (CLCS) in the region of Rodrigues (yellow); and Preliminary Information to the United Nations for an extended continental shelf in the Chagos Archipelago Region (light blue)

1.2 Climate and Climate variability

Mauritius enjoys a mild tropical maritime climate throughout the year. It has two seasons - a warm humid summer extending from November to April and a relatively cool dry winter from June to September. The months of May and October are commonly known as transitional months.

1.2.1 Temperature

The mean temperature over Mauritius is 24.7°C during summer and 21.0°C during winter. The temperature difference between the two seasons is relatively small and it varies from place to place and is usually larger over coastal areas when compared to the Central Plateau.

1.2.2 Rainfall

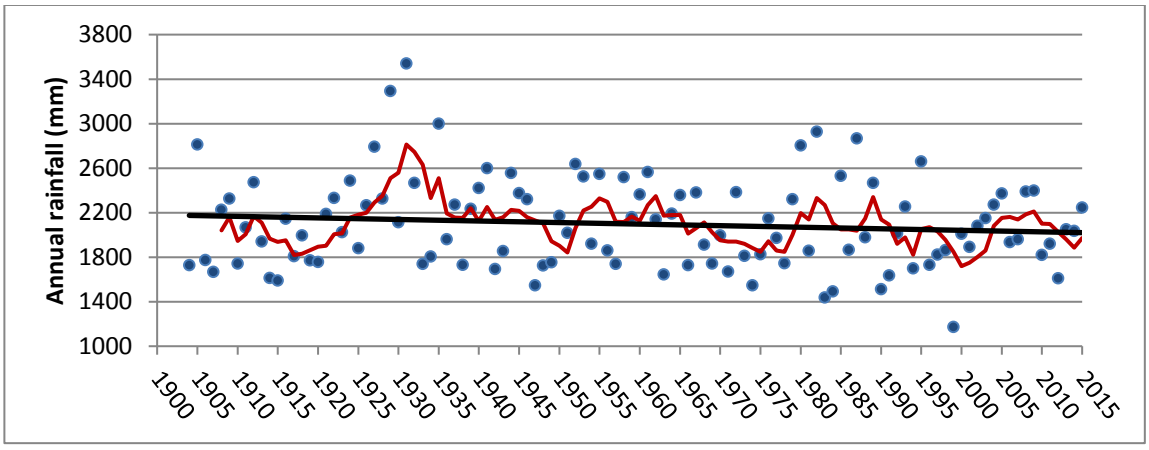
The mean monthly rainfall for the period 1981-2010, as shown in Table 1.1, gives mean monthly, seasonal and annual rainfall for the period 1981-2010 over Mauritius. February is the wettest month and October is the driest.

Table 1.1 Mean monthly and seasonal rainfall in mm over Mauritius (1981-2010)

January	February	March	April	May	June	July	August	September	October	November	December	Summer	Winter	Annual
268	335	264	210	148	110	129	105	100	76	79	175	1 331	668	1 999

Source: Mauritius Meteorological Services

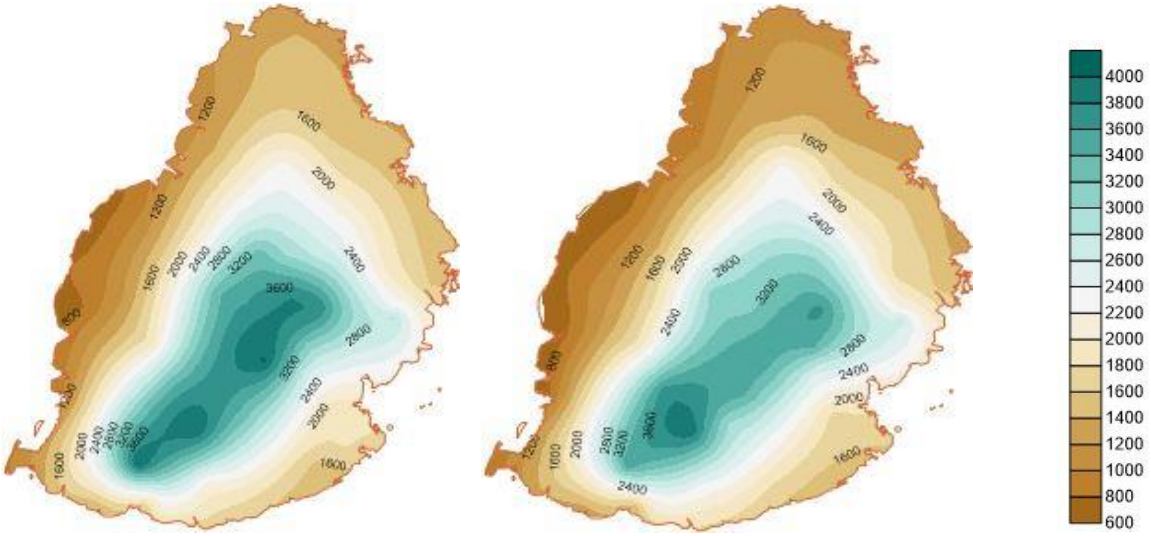
Figure 1.2 shows long-term variations in annual rainfall over Mauritius, the trend and the 5-year moving average (red). The data indicate a steady decreasing trend over the period 1904 to 2015.



Source: Mauritius Meteorological Services

Figure 1.2 Long-term annual rainfall (blue dots), trend (black continuous line), and 5-year moving average (red line) over Mauritius (1904-2015)

Figure 1.3 gives the rainfall distribution over Mauritius over the periods 1951 to 1980 and 1981 to 2010. A comparison of the two periods shows that the Central Plateau, the main recharge zone of the island, has endured a decrease from a maximum of 4 000 mm/year to 3 800 mm/year with more pronounced drying to the North and the West.



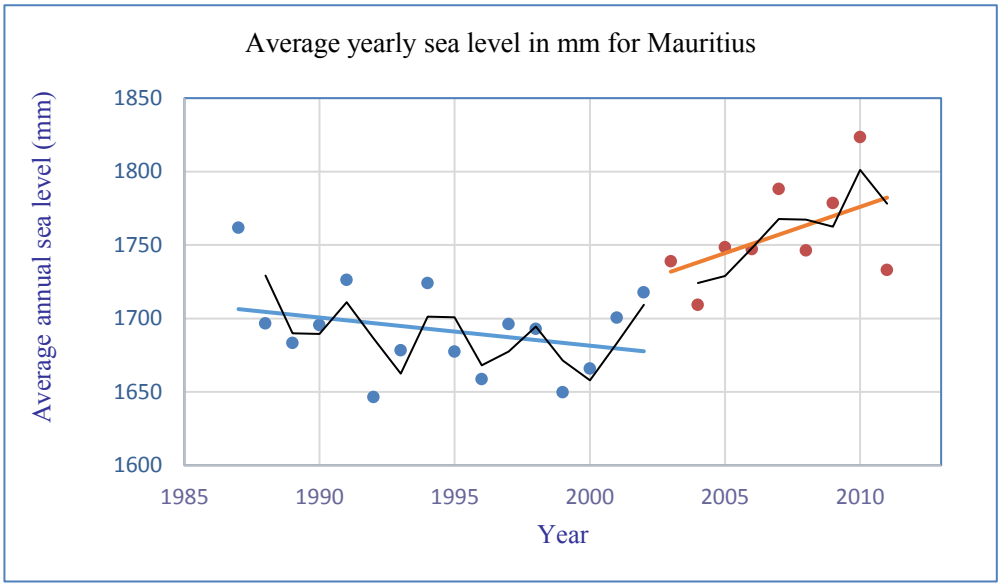
Source: Mauritius Meteorological Services

(a) 1951-1980 (b) 1981-2010 Rainfall scale in mm

Figure 1.3 Long-term annual rainfall distribution in mm over Mauritius for the periods (a) 1951-1980, and (b) 1981-2010

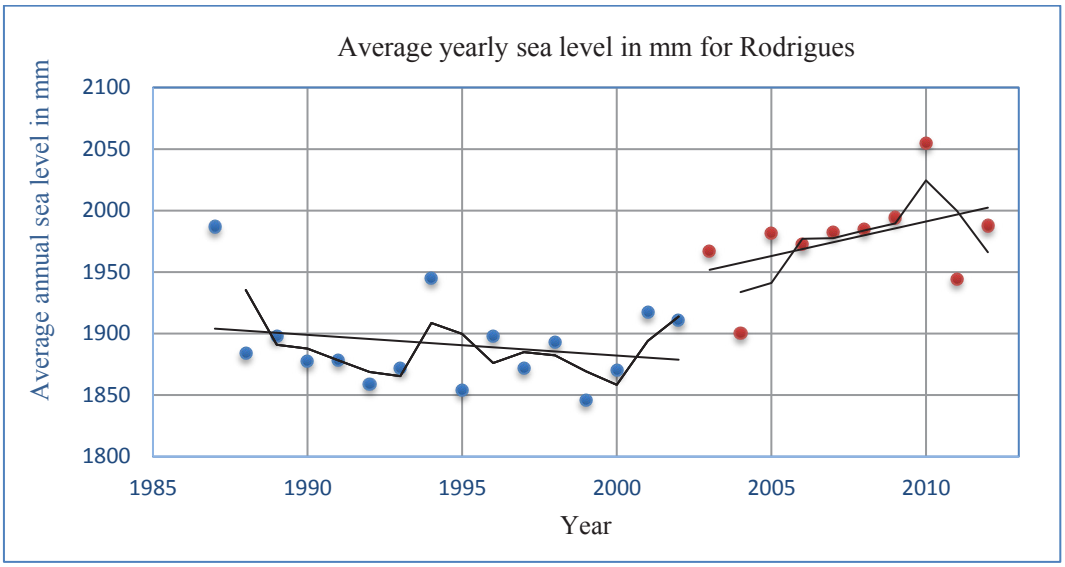
1.2.3 Sea level

Sea level rise has been observed to be accelerating in the last decade at an average rate of 5.6 mm/yr compared to the global value of 3.2 mm/yr. The average yearly sea level for the period (1987 to 2011) along with the trend line and the 2-year moving average for Mauritius are shown in Figure 1.4, and those for Rodrigues in Figure 1.5. The data series are divided into the period when sea level is decreasing (blue) and when it is increasing (red).



Source: Ministry of Environment, Sustainable Development, Disaster and Beach Management (MoESDDBM)

Figure 1.4 Average yearly sea level (in blue) when decreasing and (in red) when increasing, with trend line and 2-year moving average for Mauritius (1987- 2011)



Source: MoESDDBM

Figure 1.5 Average yearly sea level (in blue) when decreasing and (in red) when increasing, with trend line and 2-year moving average for Rodrigues (1987-2012)

1.2.4 Extreme weather events

RoM is located in the cyclone belt of the SWIO. Cyclone season is from November to mid-May. However, tropical cyclones have formed, on some occasions, outside the official cyclone season. Studies conducted by the Mauritius Meteorological Services (MMS) using data for the cyclone seasons 1975-76 to 2014-15 show that the:

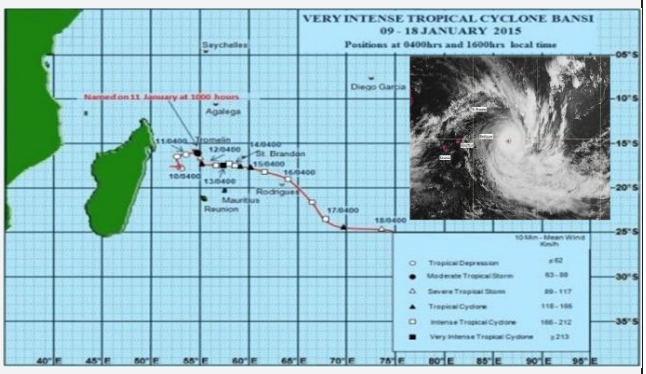
a) mean number of named tropical storms/cyclones in the SWIO has not changed
b) frequency of storms reaching at least tropical cyclone strength has increased
c) rate of intensification of tropical storms has increased, and a higher number of explosive intensification has been observed over the last 15 years
d) no change in latitudinal cyclogenesis has been observed

In April 2016, SWIO experienced one of the strongest known cyclones which reached Category 5 intensity. The very intense cyclone named *Fantala* had a maximum estimated gust of 345 km/h.

Box 1.1 Unusual behaviour of very intense tropical cyclone Bansi (11-18 January 2014)

Very Intense tropical cyclone Bansi

Tropical cyclones usually form in the tropical zone between Diego Garcia and Agalega and move West and then Southward. Bansi first moved Northeastward for a day and then Southeastward. Cyclones generally take a few days to reach the intense stage but Bansi took only 48 hours to reach the highest intensity on the Dvorak scale. On 11January, Bansi intensified from a moderate tropical storm in the morning to a severe tropical storm by the afternoon and a tropical cyclone in the evening. The rapid intensification continued on 12 January, and by late night it reached the very intense tropical cyclone stage (Figure 1.6).



Source: Mauritius Meteorological Service

Figure 1.6 Very intense tropical cyclone Bansi and its trajectory

1.3 Disaster risk reduction and management

Over the last 5 years, a number of flash floods have occurred affecting different localities including Port Louis, Piton, Fond du Sac, Flacq, Curepipe, Quatre Bornes, St Aubin and Mahebourg. The flash flood of 30 March 2013 in Port-Louis caused one of the highest fatalities in recent times when eleven people lost their lives.

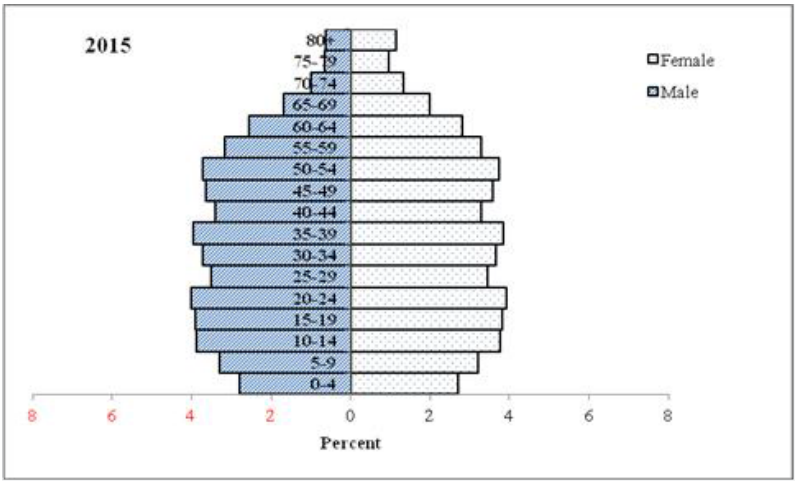
The flood events were one of the factors that led to the creation of the National Disaster Risk Reduction and Management Centre (NDRRMC) which has been administratively operational since October 2013. Its mandate is to establish a strategic and coordinated approach to disaster management for RoM.

The Government has enacted a National Disaster Risk Reduction and Management Act in April 2016. The Act provides a legal framework for the prevention and reduction of the risk of disasters; the mitigation of the adverse impacts of disasters; disaster preparedness; effective response to disasters; and, management of post-disaster activities, including recovery and rehabilitation.

1.4 Population and other vital statistics

The 2011 Census showed a resident population of 1 233 000 (male 608 400 and female 624 600) of which 97% (1.19 million) lived in Mauritius and most of the remaining 3% lived in Rodrigues. As at 31 December 2015, the estimated resident population of RoM was 1 262 862, and was growing at the rate of 0.1% since the end of the year 2014. The population of Rodrigues as at 31 December 2015 was 42 058 (male 20 682 and female 21 376).

Over time, the population age structure of Mauritius depicted by the population pyramid shown in Figure 1.7 has shifted from a wide base to a shrinking base and thickening body indicating an ageing population. This is the result of a decreasing number of births and longer life expectancy.



Source: Statistics Mauritius

Figure 1.7 Population distribution by age (2015)

Statistics indicate that women are less economically active than men. In 2014, the active Mauritian population (aged 16 years and above) stood at 45.3 % for women against 75.2% for men. In 2015, the corresponding figures were 47 % (231 300) for women and 75% for men (353 300).

1.5 Education, including scientific and technical research institutions

The Government provides free education and free transport to students of pre-primary, primary, secondary and tertiary levels, with a view to developing a strong human resource base. At the formal level, there have been several initiatives by the Ministry of Education and Human Resources, Tertiary Education and Scientific Research (MOE&HR,TE&SR) to include climate change education in the curricula at all levels.

1.5.1 Primary

Topics such as global warming, sea level rise, dangers that the planet earth is facing, animals and plants threatened to extinction, sensitisation on tree planting, and the value of renewable energy sources are introduced with formal and informal assessment at upper primary level.

1.5.2 Secondary

At secondary level, climate change is considered as a component of education for sustainable development. Climate change-related topics are addressed in subjects such as physics, chemistry, biology, geography, general paper and marine science. However, a standalone subject dealing with climate change is yet to be introduced.

1.5.3 Tertiary

The University of Mauritius is offering courses in Climate Change Adaptation and Risk Reduction, coastal engineering and other climate change–related subjects at MSc level. Many of the other tertiary institutions offer modules on climate change as part of environmental degree courses.

1.5.4 Informal education

All educational institutions are engaged, at different levels of involvement, in informal education on climate change. Several activities are conducted and these include tree planting within and outside school premises, waste segregation, compost making, rain water harvesting, installation of solar PV on school buildings, and the promotion of campaigns on health risk associated climate change

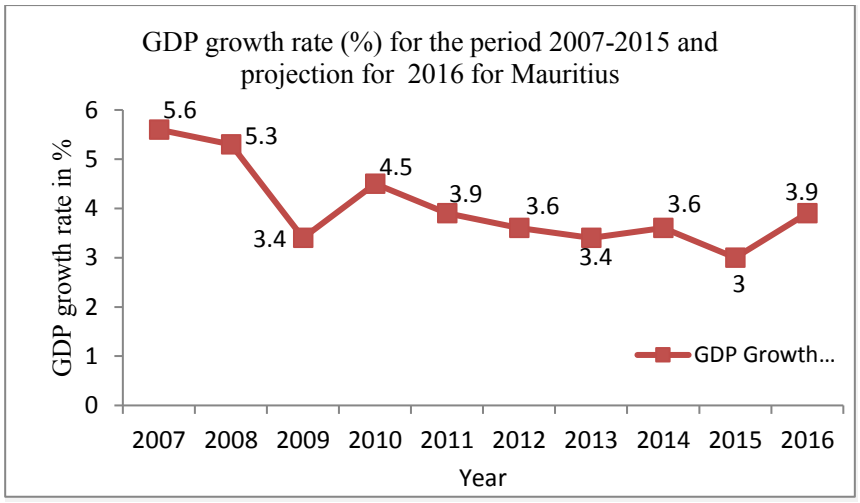
Ministries and institutions usually take advantage of annual celebration of international environment events such the World Environment Day, World Meteorological Day, Earth Day, World Water Day, World Food Day and World Ocean Day to focus some activities on issues related to climate change. In particular, they produce posters, pamphlets and flyers and organise essay and drawing competitions, debates and slams for the benefit of school communities.

1.5.5 Scientific and technical research institutions

The Tertiary Education Commission through a Research Grant Scheme provides funding for research projects of national importance. Several other institutions are involved in climate change-related research. A few of these include the University of Mauritius, the University of Technology, Mauritius, Université des Mascareignes, the Albion Fisheries Research Centre, the Food and Agricultural Research and Extension Institute, and the Mauritius Meteorological Services.

1.6 Economy

Mauritius has recorded sustained economic growth over the period 2012-2014, followed by a growth rate of 3.0% of GDP for 2015, and a target of 3.9% for 2016 (Figure 1.8).



Source: Statistics Mauritius

Figure 1.8 GDP growth rate in % for the period 2007 to 2015 and target for 2016

The main sectors driving growth in 2015 were tourism, financial services, retail trade, and the Information and Communication Technology (ICT)/BPO sector. Selected social and economic indicators for RoM are given in Table 1.2. Sustained growth of the economy has been possible due to several factors such as political stability; stable institutions; an outward market-driven strategy; prudent fiscal, exchange rate, trade, investment and monetary policies; and the careful overall planning, and policy choices.

Table 1.2 Selected social and economic indicators for the Republic of Mauritius (2013 – 2016)

		Period	Unit	2013	2014	2015	2016
Population characteristics and health	Total population	Mid-year	No.	1 258 653	1 260 934	1 262 605	1 263 473
	Life expectancy at birth - male		No. of years	71	71.1	71.2	n.a[1]
	Life expectancy at birth - female		No. of years	77.6	77.8	77.9	n.a
	Population per doctor	Year	No.	616	519	495	n.a
	Population per bed	Year	No.	283	282	281	n.a
Cell phone, energy, rainfall, forest	Mobile cellular telephone subscriptions	as at end of year	Per1 000 persons	1 217.30	1 309.30	1 395.50	n.a
	Total final energy consumption	Year	ktoe	871	892	913	n.a
	Mean annual rainfall	Year	mm	2 126.00	2 094.00	2 377.00	n.a
	Forest land/total land area (%)	Year	%	25.3	25.3	25.2	n.a
Education	Public spending on education as a % of GDP	Year ending June	as at end of June	3.3	3.3	3.8	n.a
	Gross primary enrolment ratio - Total	Year	%	98	97	94	n.a
	Secondary enrolment ratio – Total	Year	%	79	80	80	n.a
	Pupil -teacher ratio - Primary	Year	No.	26	25	25	n.a
	Pupil -teacher ratio - Secondary	Year	No.	15	15	15	n.a
	Tertiary enrolment	Year	No.	23 627	22 793	n.a	n.a

Labour and employment	Labour force (including foreigners) - both sexes	Year	000's	597.5	604	612.9	613.9
	Activity rate Total	Year	%	60	59.9	60.4	60.1
	Unemployment rate - Total	Year	%	8	7.8	7.9	7.7
	Unemployment rate - Male	Year	%	5.3	5.5	5.5	5.4
	Unemployment rate - Female	Year	%	12.2	11.4	11.6	11.2
	Employment by sector						
	% Primary	Year	%	8.4	8.4	8.4	8.4
	% Secondary	Year	%	29.9	29.4	28.9	28.5
	% Tertiary	Year	%	61.7	62.2	62.7	63.1
Tourism	Tourist arrivals	Year	No.	992 503	1 038 334	1 151 252	1 250 000
	Tourist arrivals increase over previous year		%	2.8	4.6	10.9	8.6
	Gross earnings from tourism	Year	MUR M	40 557	44 304	50 191	56 000
	Gross earnings per tourist	Year	MUR.	40 863	42 668	43 597	44 800
Economic indicators (GDP, imports, exports, Investment, inflation)	Gross Domestic Product (GDP) at current market prices	Year	MUR.bn	371	390.7	408.3	436.8
	GDP per capita at current market prices	Year	MUR .000	294.5	309.8	323.3	346
	Growth of GVA (current basic prices) % latest base year	Year	%	3.4	3.6	3	3.9
	Total exports of goods and services (f.o.b.)	Year	MUR. bn	180.3	200.2	200.8	212.2
	Total imports of goods and services (f.o.b.)	Year	MUR bn	229.2	244	241.2	248
	Net export of goods and services	Year	MUR bn	-48.9	-43.8	-40.4	-35.8
	Gross Domestic Savings as % of GDP (market prices)	Year	%	11	10.5	10.4	11.2
	Investment rate	Year	%	20.9	18.9	17.5	17.9
	Rate of inflation	Year	%	3.5	3.2	1.3	n.a
	Interest rates on savings	As at end June	%	2.75 - 3.65	2.40 - 3.40	2.00 - 4.00	n.a

Source: Statistics Mauritius

Note[1]: n.a = information for 2016 was not available at the time of compilation

According to the World Bank's classification, Mauritius has already graduated to an upper middle-income country (MIC) status with a per capita GNI (Gross National Income) of US$ 9 610 in 2015.

Despite these successes, several important challenges remain. Mauritius has been facing increasing inequality in recent years, with the Gini coefficient rising from 0.388 in 2006/2007 to 0.44 in 2014. Environmental pressures are significant, compounded by climate change and the specificity of being a Small Island Developing State (SIDS). Unemployment rate has stagnated at around 8 per cent over the past five years with an increasing proportion unemployed among the skilled youth.

Mauritius is highly dependent on tourism and trade with the Euro Zone. With Brexit, and the devaluation of the GBP so far by around 10%, UK imports in Mauritius will become more competitive while Mauritian exports more expensive. The long-term impact of Brexit on the Mauritian economy would largely depend on the trade agreement

options which the UK might finally adopt. Mauritius needs to accelerate reforms, continue diversifying its economy and re-orienting exports towards emerging markets in order to consolidate growth, create employment opportunities especially for the young unemployed graduates, and further open up the economy to reach the 'High Income Economy' status by 2030. At the same time, Government plans to lend high-level policy support to all aspects of human development, in particular poverty eradication, higher education, sustainable development whilst addressing challenges posed by climate change, governance support and gender development.

1.7 Agriculture

Agriculture occupied 42 % of the land area in 2005 and is dominated by sugar cane cultivation whose contribution to the GDP represented only 3.2 %. Nonetheless, the sector still plays a vital, multi-functional role within the economy in absolute terms, and has significant economic, social and environmental impacts.

1.7.1 Sugar sector

Sugarcane cultivation is undertaken by large commercial farms and nearly 15 600 small farms that contribute around 31% to the total production (MSIRI, 2016). Since 2004, the area under sugarcane harvested has fallen by 27% to 50 694 ha in 2014 (MSS, 2015). Sugar production in 2014 was around 400 000 tonne (t) compared to some 572 000t produced in 2004. The past decade has witnessed a major transformation of the sugar industry into a cluster maximising on the use of its by-products. This transformation was brought about by a drop of 36% in sugar prices following the European Union (EU) Sugar Regime reform whereby the guaranteed preferential access to the EU, as well as the guaranteed minimum price, were revised.

Future strategies aim at contributing to the long-term sustainability of a resilient Mauritian sugarcane industry while capitalising on the multi-faceted potential of the sugarcane plant to deliver a multitude of components, either naturally or industrially with limited impact on the environment. In this regard, a measure that may contribute is fair trade certification for small and medium sugarcane planters (Box 1.2). With increasing emphasis on the use of clean and renewable energy, *bagasse*, a by-product of the milling process, is gaining importance. Currently, co-generation of electricity using bagasse proper is 340 GWh (LMC, 2015), representing 15% of national electricity demand. It is forecast to bring this figure up to 25% by 2025.

1.7.2 Non-sugar sector

Mauritius imports close to 77% of its food requirements. The main items imported include wheat, rice, oil, fresh fruits, meat and milk. Over the last five years, the amount imported has been going up, indicating an increasing dependency on imported food.

Around 8 200 ha of land are devoted to food-crop production that annually aggregate to 110 000t. Agricultural production is undertaken by a relatively large number of small producers and the corporate sector. Some 8 000 small farmers cultivate a range of food crops and a small number of farmers grow fruits and flowers for the export markets.

Box 1.2 Fair trade certification for small and medium sugar cane planters

Trade Certification in Mauritius

The Fair Trade (FT) label is a scheme proposed by the Fair Trade Labelling Organization (FLO), an international NGO based in Bonn, Germany, so as to enable small producers to benefit from fairer and more equitable prices for their products. The buyers of Fairtrade products pay a minimum price and/or a Fairtrade Premium.

The Mauritius Sugar Syndicate (MSS) has launched an initiative to encourage small and medium sugarcane planters to obtain the FT label for the sugar they produce. The label provides accredited cane planters with a Fairtrade Premium currently set at USD 60 or about MUR 2 000 per tonne of sugar sold. This amount may be used to finance socio-economic projects that enhance the living and working conditions of these producers.

Compliance with FT principles also ensures that planters adopt the best agricultural practices and as such promote sustainable development. The Mauritius Sugar Authority is assisting the Cooperative Credit Societies and other small planter entities engaged in sugar cane cultivation to acquire Fair trade accreditation. To date, five Societies have obtained the Fairtrade accreditation.

Source: Ministry of Environment and Sustainable Development of Mauritius (2012)
Figure 1.9 Sugarcane factory

Livestock production is carried out by some 5 000 farmers engaged mainly in cattle, goat, sheep, pig, deer, poultry, and rabbit farming. Local production in 2014 met only 9% of the country's requirements for meat (excluding poultry) and 4% for milk, whilst 100% self-sufficiency was achieved for poultry meat, eggs and venison.

A Strategic Plan 2016-2020 for the Food Crop, Livestock and Forestry has been approved with the overall goal of raising the national food security level in a sustainable manner. The Plan, which is being implemented, focuses on promoting the sustainable management of land, water and other natural resources, and on building capacity to enable farmers to face climate change and move on to '*climate-smart agriculture*' and (good agriculture practices including bio-farming (promotion scheme).

1.8 Land use, Land use change and Forestry (LULUCF)

Over the last two decades, the decreasing profitability of the sugarcane sector is favouring the conversion of cropland to other land uses such as infrastructure and business development. In 2014, the extent of forest cover in Mauritius was 47 103 ha representing about 25% of the total land area. Good quality native forest covers about 2% of the island.

Emphasis on forest management is directed towards increasing or maintaining the existing forest area, resource conservation, watershed protection, forest ecosystem and biodiversity conservation and replacement of exotic species by native species. Non-consumptive use of forest resources are encouraged through leisure, recreational and eco-tourism activities. The strategies and action plans under Implementation adopt a multi-pronged approach for the sustainable management of forest resources based on education and awareness, conservation of biodiversity and increase in the tree cover through national tree planting campaigns and the promotion of urban forestry.

The Government, in collaboration with school and local authorities, private sector, community centres, socio-cultural organisations, and NGOs, has embarked on a "*Tree Planting for Clean Air Campaign*". Under the Campaign, trees have been planted in places such as schools (Figure 1.10), road sides and reserves, towns and villages, residential areas, green spaces and health tracks, islets and mountain flanks. A total of 110 000 trees were planted/distributed during the period 2014/2015.

Credit: MoESDDBM

Figure 1.10 Endemic Garden Project at Sharma Jugdambi SSS

Under the Strategic 2016-2019 Afforestation Programme 2015 – 2019 for carbon sequestration, the Ministry of Agro Industry and Food Security, in collaboration with other institutions, are aiming to plant 500 000 trees (over a period of 5 years) in places such as villages, river and mountain reserves, national parks and the compounds of educational institutions.

1.9 Biodiversity

According to IUCN updated list in 2013, several species in Mauritius are threatened and endemic species are more vulnerable and may become extinct. For example about 81.7 % of endemic flora is threatened by extinction. The native diversity of selected groups in Mauritius is shown in Table 1.3.

Table 1.3 Native diversity of selected groups include the number of extinctions (number in brackets indicate the number of endemic species)

	No. of native species		% species endemic	No. of extinct species		No. of extant species	
Angiosperms	691	(273)	39.5	61	(30)	630	(243)
Mammals	5	(1)	20.0	2	(0)	3	(1)
Land Birds	28	(19)	67.9	16	(12)	12	(7)
Reptiles	17	(16)	94.1	5	(5)	12	(11)
Butterflies	30	(5)	16.7	4	(1)	26	(4)
Snails	125	(81)	64.8	43	(36)	82	(45)

Source: Fifth National Report on Convention on Biodiversity (2015)

The main factors that are responsible for the loss of terrestrial biodiversity include invasive alien species, land conversion and habitat fragmentation, habitat modification for deer ranching and hunting. Various measures including the restoration of degraded island habitats are being taken to protect critically endangered biodiversity. Other actions taken include the eradication or control of undesired exotic species, investment in required infrastructure for the ex-situ propagation and the cultivation of threatened plants, propagation, replanting and re-seeding of endemic plants, and reintroduction of endemic animals from captive-bred populations.

In order to protect marine biodiversity, Marine Protected Areas (MPAs) have been established in strategic sites around Mauritius and Rodrigues. MPAs are protected under the Fisheries and Marine Resources Act 2007 as well as the Marine Protected Areas Regulation 2001. So far RoM maintains 155.2 km^2 of MPAs which amount to 0.01% of its Exclusive Economic Zone. The MPAs around Mauritius encompass six Fishing Reserves and two Marine Parks while those of Rodrigues constitute five Fishing Reserves, four Marine Reserves and the South East Marine Protected Area.

The inventories of two of the Marine Parks in Mauritius revealed the following diversity of the marine biota:

i) *Blue Bay Marine Park*: 108 species of coral, 233 species of fish and 201 species of molluscs
ii) *Balaclava Marine Park*: 118 species of coral, 289 species of fish and 219 species of molluscs

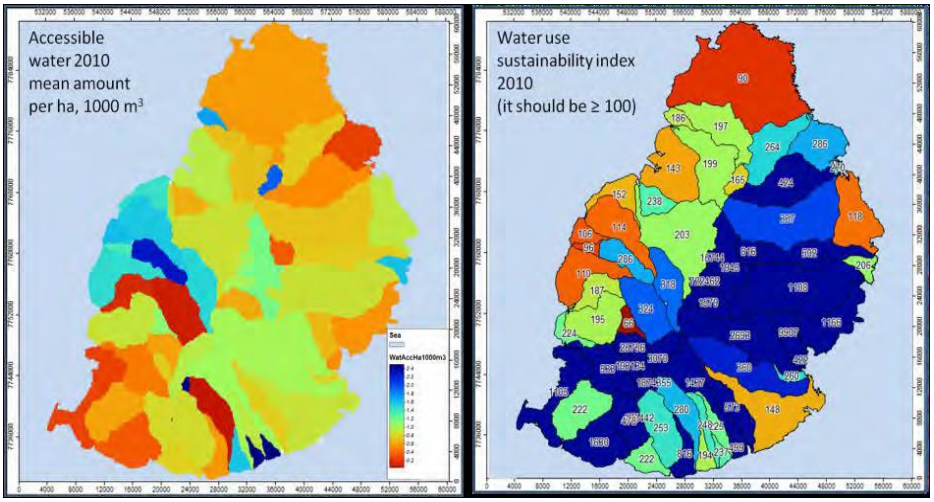
Management Plans for both of the marine parks were prepared under the United Nations Development Programme (UNDP) and Global Environment Facility (GEF) under project "*Partnerships for Marine Protected Areas in Mauritius and Rodrigues*" for the 5-year period 2012/13 to 2016/17.

1.10 Water resources

Mauritius received an annual volume of about 4 435 Mm^3 of rain water in 2015, out of which 660 Mm^3 flows as surface run-off into rivers and groundwater recharge accounts for about 10%, i.e. 445 Mm^3 outflow and 1 330 Mm^3 is lost through evaporation. In 2013, the total estimated water utilization in Mauritius is 888 Mm^3.

In 2010, an experimental ecosystem water account was undertaken for assessing the accessible water from river basins to calculate actual water abstraction in order to draw a stress index related to water consumption. Despite some gaps in data availability, this initial assessment of accessible water highlighted irregular conditions with regard to irrigated sugar cane, in particular in the Northern catchment area (Figure 1.11).

The Northern Aquifer contributes between 50-60% of domestic water supply in the region thus demonstrating its strategic role in water supply equation to ensure water security. However, the aquifer is susceptible to over exploitation, salt water intrusion and pollution risks all these within the overarching impact of climate change. The IWRM project focuses mainly on the protection of the aquifer against pollution risks including sea water intrusion, through a combination of water resources assessment improving management of the aquifer.



Source: Indian Ocean Commission, Experimental Ecosystems Natural Capital Accounts Mauritius case study, June 2014

Figure 1.11 Assessment of water accessibility and areas by river basins under risk of stress

Monitoring climate change parameters has brought to light various trends of importance in assessing future impacts on water resource availability. Of specific interest are trends in temperature increase, which could have a bearing on crop water requirements in irrigated agriculture, and change in rainfall amount.

The Master Plan for the *Development of Water Resources in the Republic of Mauritius* (management of resources) provides a road map to realise the integration and management of water resources up to horizons 2025 and 2050. Improving water security and the regularity of potable water supply for the population is a priority of the Government.

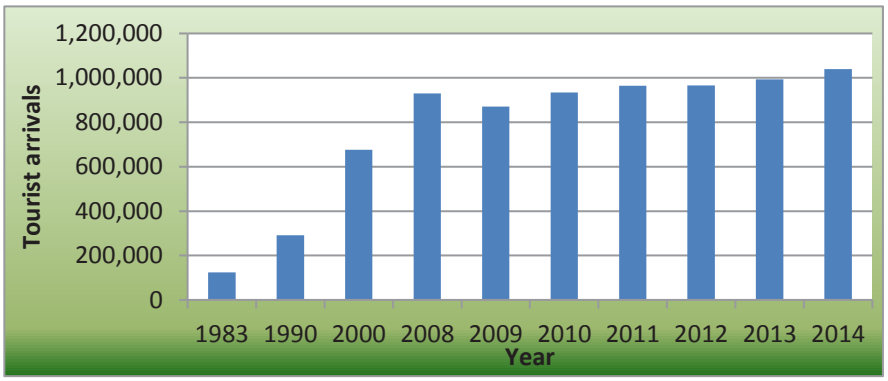
1.11 Coastal management and Tourism

The coastline of mainland Mauritius extends over 322 km and the coastal areas support a number of activities including tourism, recreation, fishery, trade, and industry. The total economic value of the coastal resources has been estimated to be about USD 330 M (ICZM Framework, 2010). The tourism industry is mainly coastal-based and is the fourth pillar of the economy after the Export Processing Zone, Manufacturing Sector, and Agriculture.

The coastal areas of Mauritius are under constant threat. Accentuated beach erosion has shrunk the width of the beaches around certain coastal areas by up to 20m over the last few decades. Significant beach erosion has been observed at Albion, Bel Ombre and Mon Choisy. As a response, various adaptation programmes are being implemented. The minimum setback from high water mark has been increased from 15m to 30m for hotels and residential coastal development. An Integrated Coastal Zone Management Framework has been developed and many coastal activities are controlled through the EIA mechanism.

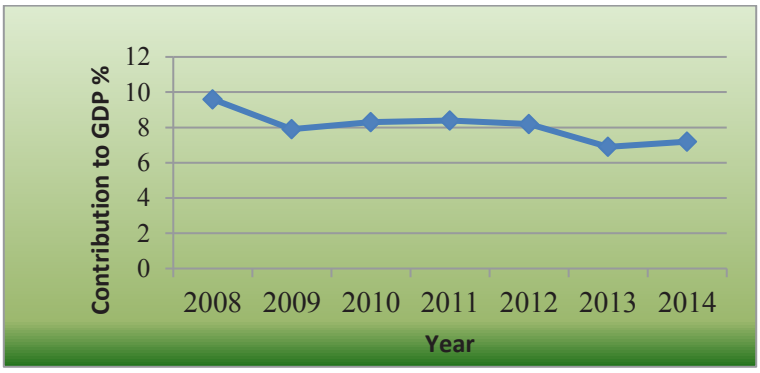
Tourism is envisioned to be a leading and sustainable sector. One of the objectives is to pursue an up-market and selective tourism policy. The emergence of the ocean economy will give a new impetus to cruise tourism with lower CO_2 emissions. In order to increase the number of cruise passengers, in the short-term, to 20 000 and, in the medium-term, to 50 000, Mauritius is investing in the construction of a modern cruise terminal by 2016 with a view to improving facilities provided for embarking and disembarking cruise passengers.

Figure 1.12 shows the growing number of international tourists visiting Mauritius from 1983 to 2014. This steady increase does not match its contribution to GDP (Figure 1.13).



Source Statistics Mauritius

Figure 1.12 Annual tourist arrivals (1983-2014)



Source: Statistics Mauritius

Figure1.13 Annual contribution of the tourism sector to GDP (%) (2008–2014)

In 2015, tourist arrivals in Mauritius reached 1 151 723. Tourism sector brought foreign earnings of MUR 50.2 billion, contributed to 7.5% of GDP, and created around 30 000 direct employment. As at end of June 2016, there were 116 licensed hotels of which 111 were in operation and 5 were temporarily closed due to renovation. The total room capacity of these 111 hotels was 13 092 with 27 523 bed places.

In order to move the tourism sector to a low carbon growth path, the Ministry of Tourism and External Communications has developed a Mauritian Standard as a management system for sustainable tourism which is to be recognized and accredited by the Global Sustainable Tourism Council.

1.12 Fisheries

The fishery sector constitutes four main types namely coastal/artisanal, aquaculture, offshore demersal, and tuna.

So far, the fishing industry has not reported dwindling offshore marine resources owing to climate change-related factors but rather to overfishing of some species. Government acknowledges the urgency of conducting a fish stock assessment to investigate the possible effect climate change and its auxiliary factors on fish stock.

A total of 12 329t of fish products was recorded in 2014. The spike in production is due to one Mauritius-flagged purse seiner which started operation in 2013 and seven in 2014 (Figure 1.14).

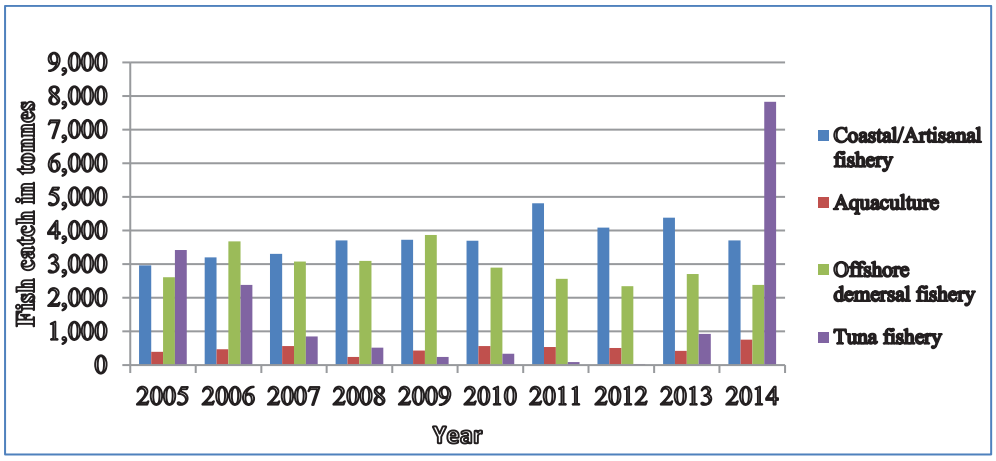


Figure 1.14 Total fish production in wet weight equivalent (tonnes)

The octopus *closed season* initiative started in 2011 in Rodrigues and was first introduced in 2015 in Mauritius. The Rodrigues and Mauritian initiatives yielded positive results in terms of size of octopus caught, and such an activity is now being considered in the forthcoming Fisheries Bill. In order to sustainably increase fish production, an *Aquaculture Master Plan* has been developed with over 20 potential sites identified for aquaculture purposes.

1.13 Energy sector

The objective in the energy sector is to reduce dependency on fossil fuels, encourage the use of renewable sources, and manage demand through energy efficiency measures while ensuring energy security. The Government has set a target for increasing generation from renewable energy sources by at least 35% by 2025 and for maintaining the same level until 2030.

In 2015, around 84% of the total primary energy requirement was met from imported fossil fuel and the remaining from local renewable sources. Energy intensity stood at 7.9 toe /million MUR (Mauritian Rupees) of GDP. The import cost of petroleum products and coal was 23 153 million MUR in 2015, accounting for about 14% of total imports. The peak power demand in 2015 reached 459.9 MW. In 2015, the Independent Power Producers (IPP) produced around 58% of the total electricity generated and Central Electricity Board the remaining 42%. Energy consumption reached 913 ktoe in 2015, as distributed percentage wise in Figure 1.15.

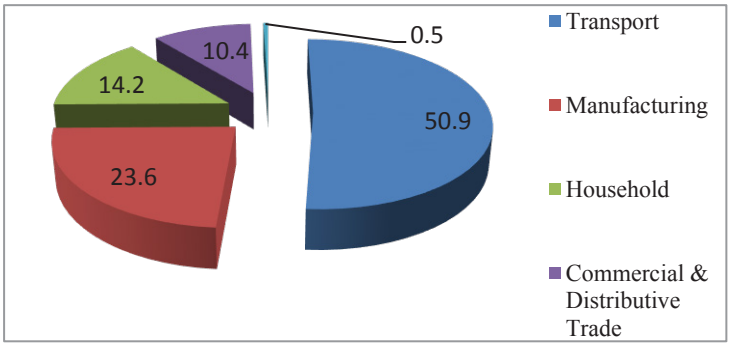


Figure 1.15 Final sectoral energy consumption expressed as a percentage

In 2013, the energy obtained from photovoltaic systems had doubled due to the Small Scale Distributed Generation (SSDG) scheme implemented by the CEB, which allows Small Independent Power Producers (SIPP) to feed excess electricity generated by PV plants installed on their premises to CEB grid. Installation of solar water heaters, mainly subsidised by Government represented an avoided. The avoided electricity and Liquefied Petroleum Gas (LPG) consumptions could not be verified as the CEB has no data with respect to the number of electrical heaters having been replaced.

In 2016, a new wind farm at Plaines des Roches of 9.35 MW became operational. It satisfies the energy needs of approximately 7 700 households.

With a view to up-scale ocean energy in the energy mix, the Mauritius Research Council (MRC) has signed a Collaboration Agreement with the Carnegie Wave Energy Ltd, Australia in 2015. A project on Wave Resource Assessment and Wave – *Integrated Micro grid Design in Mauritius* - is currently being implemented.

1.14 Transport

RoM has a well-developed road network system of 2 275 km of which 99 km are motorways and 1 131 km are main roads. Road transportation is the only mode of land transport in Mauritius. It caters for both the passenger and freight transport needs. The fleet of vehicles which was 319 000 in the year 2006 increased to 443 495 in 2010, and 486 144 in 2015 representing a cumulative growth of 52% over the period 2006 to 2015. The average growth rate was 5.2% per year, that for private vehicles, namely, motor cars and motorcycle was much higher, representing increases of 9.3% and 11.7% respectively. Motorisation rates during the period increased by 38% from 255 to 385 vehicles per thousand people.

Rodrigues had a fleet of 9 332 vehicles as at 2013 and 11 937 in 2015. The fleet increased by 5 569 vehicles during the period 2006 to 2015 representing a cumulative growth of 87.4%. The average growth rate of 8.7% was higher than for Mauritius. This is accounted for mainly by the high number of motorcycles registered in the island as compared other types of vehicles. The forecast investment in roads for the period 2015-2019 amounts to MUR 15 billion. Mauritius does not have any rail-based transport facility but it plans to introduce a mass transit system by 2019.

Air transport facilities connect the islands of the Republic with regular flights on a daily basis. International flights are operated by the national carrier and other major airline companies since Mauritius is an important tourist destination. In 2013, over 10 300 flights were recorded of which 8 100 were international and 2 200 were domestic. Mauritius also has one port from which domestic and international shipping is operated both for cruise, fishing and freight purposes.

1.15 Infrastructure

Some 560 km² of Mauritius are built-up areas. These include roads and reservoirs and about 396 400 residential units, 6 600 industrial buildings, 41 000 commercial buildings and 600 unclassified buildings.

The infrastructure sector in Mauritius is already affected by adverse impact of climate change with the recent occurrences of cracks on roads, collapse of bridges, flooding of culverts, and damages due to landslides.

The Mauritius Container Terminal is particularly vulnerable to the impacts of severe weather systems such as heavy swells, strong winds, gusts and storm surges, which may result in stoppage of operations for several days. For instance, adverse weather conditions in 2013 led to a stoppage of port operations for 21 days resulting in a shortfall

in revenue of about MUR 3.9 billion and in 2014, the suspension for 10 days represented a shortfall in revenue amounting to MUR 1.9 billion.

Recently, during the period from 10 to 13 March 2015, the Mauritius Ports Authority (MPA) had stopped all operations and closed the port for 79 hours due to storm surges so that the safety and integrity of Port infrastructures and ships in the harbour were maintained.

According to the Disaster Risk Reduction (DRR) Strategic Framework and Action Plan (MoESDDBM, 2013), the elements that are at risk due to flooding (due to heavy rain during extreme weather events) and coastal inundation (due to storm surges and sea level rise) in Mauritius and Rodrigues are given in Table 1.4.

Table 1.4 Extent to which some elements are at risk from flood hazard in Mauritius and Rodrigues

Flood hazard	Mauritius	Rodrigues
Agricultural land (km^2)	19-30	0.48-0.6
Built up land (km^2)	5-70	0.38-0.4
Motorway (km)	2.4-3	-
Main roads (km)	18-29	4.17-5.1
Secondary roads (km)	68-109	13.77-16.1

Source: DRR (2013)

The cost of damages to building and infrastructures from flooding in 50 years (by the year 2070) has been estimated to be around USD 2 billion for Mauritius and USD 83 Million for Rodrigues (Table 1.5).

Table 1.5 Extent to which some elements are at risk from coastal inundation in Mauritius and Rodrigues

Coastal Inundation	Mauritius	Rodrigues
Built-up land ($km^{2)}$	12.2	0.56
Expansion areas (km^2)	11.8	-
Primary roads (km)	60	22
Secondary roads (km)	80	23

Source: DRR (2013)

Key infrastructures, namely, schools, health centres, hotels, fire stations, police stations, industrial sites are likely to be affected by the inland flooding, coastal inundation and landslide hazards (DRR Report, 2013). Details regarding the number of these infrastructures that may be adversely affected by flooding, inundation and landslides in Mauritius and Rodrigues are given in Table 1.6 and Table 1.7, respectively.

Table 1.6 Analysis of point elements at risk from flooding, inundation and landslides in Mauritius

Typology of exposed elements (point)	N° of punctual elements at inundation risk	N° of punctual elements at landslide risk	N° of punctual elements at flood risk
Hotel	36	6	8
Industrial site	2	1	2
Medical facilities	9	11	12
Police station	1	5	3
School	11	19	16
Shopping mall	1	1	1

Source: DRR (2013)

Table 1.7 Analysis of point elements at risk of flooding, inundation and in Rodrigues

Typology of exposed elements (point)	N° of punctual elements at inundation risk	N° of punctual elements at landslide risk	N° of punctual elements at flood risk
Hotel	0	1	2
Industrial site	1	1	1
Medical facilities	1	8	1
School	0	4	1

Source: DRR (2013)

1.16 Health and Social services

1.16.1 Health services

RoM has a strong health system from primary to secondary and tertiary health care, which aims to ensure equitable access to health care for the population. In the public sector, primary health care, curative health care services and hi-tech medicine are provided free of user cost to the entire population. The public sector provides services to 85% of the total health care requirements of the population while the private health institutions cater for the remaining 15%.

The total Government expenditure on health for year 2015 was US$ 271.3 million. The per capita public expenditure on health for RoM is around US$ 214.8 or 2.4% of GDP. The estimated private expenditure on health is around MUR 7.90 billion.

After the epidemic of chikungunya in 2005 and 2006, only 10 cases, all imported, have been reported between 2007 and 2014. Mauritius has experienced outbreaks of dengue fever for two consecutive years in 2014 and 2015.Outbreaks or occasional epidemics of vector borne diseases such as chikungunya, dengue, and new emerging influenza-like illnesses including Zika virus fever are major forthcoming challenges. With climate change and its related effects, these can be expected to be more frequent.

1.16.2 Social services

Social assistance in kind and in cash is provided to persons in need. Food allowance at the rate of MUR 165 per person per day for a maximum of 3 days is granted to persons whose foodstuff has been damaged by flood. For example, under this food allowance scheme a total amount of MUR 5 895 450 has been paid to 3 597 heads of households comprising 11 984 family members who were adversely affected by the flood of February 2016 (Ministry of Social Security, National Solidarity and Reform Institutions, 2016).

Emergency shelters are available for sheltering people in distress when natural disasters such as cyclones and floods occur. There are 160 such shelters throughout the country. They are housed in different public buildings owned

either by the Government. With the support of the Adaptation Fund to address climate change issues, a refuge centre will be constructed by June 2017 at the coastal area of Quatre Soeurs to provide shelter to victims of emergency evacuation in the event of a major storm surge. Together with external donors, the Government is funding major coastal rehabilitation works around the island to address beach erosion and improve degraded public beaches caused by the adverse effects of climate change.

1.17 Waste management

The average amount of solid waste generated per capita has increased steadily from 0.7 kg in 2000 to about 1.1 kg in 2015. Prior to the operation of the sanitary landfill, solid waste were disposed in open dump sites. As from 1997, a sanitary landfill is operational at Mare Chicose. The landfill has received about 448 000 t of solid waste in 2015 after their compaction at the five Transfer Stations around the country. The landfill is a fully managed site with leachate collection system and generation of 2.3MW/h of electricity from the landfill gas (Figure 1.16), representing an estimated reduction of 95 433t of CO_2 annually.

Credit: MoESDDBM

Figure 1.16 Mare Chicose Landfill Gas to Energy Project (CDM registered

The landfill is expected to be saturated by 2019. The strategy adopted by Government for solid waste management is to reduce the amount of solid waste being landfilled. About 138 000 t of solid waste have been diverted from the landfill and used for producing compost since its operation in 2011. Some 32 000 compost bins have been distributed freely to promote composting at household level and by small planters. Waste to energy is being considered as a renewable energy option but requires a Waste Management Plan.

Measures favouring re-use and recycling have been initiated for materials such as paper, plastic, metals, used tyres and glass. Regulations were formulated and financial incentives provided to promote the collection of plastic beverage (PET) bottles for export. Since January 2016, only biodegradable and compostable plastic bag are allowed subject to strict conformity to existing standards. Mauritius is implementing an *Industrial Waste Characterisation Project* to assess opportunities for industrial symbiosis. Government has agreed to the proposed establishment of an *Electrical and Electronic Wastes (e-Wastes) Management System* to cater for the approximately 8 000 t of e-waste generated annually.

The Mare Chicose landfill is expected to be saturated by 2019. In its future waste management strategy, Government intends to adopt measures and mechanisms such as waste prevention, reduction, source segregation as well as construction/operation of appropriate infrastructures, including waste management facilities such as Composting Plants and Material Recovery Facilities. The aim is to move from dependence on landfill disposal to resource

conservation and recovery wherein the waste materials are viewed as valuable resources. It is also intended to adopt a new path in which green jobs creation and investment in green sectors are promoted.

Presently some 83 000 households are connected to the public sewer system representing about 26% of the population. With the completion of the ongoing projects by 2020, around 16 000 additional premises will be connected thus bringing the network coverage to 30%. The extension of the wastewater network will continue over the period 2016-2030 to provide proper sanitation facilities and prevent environmental degradation of coastal zones, lagoons and ground water resources, subject to the availability of funding.

As per EIS requirement, about 60 large hotels located along the coastal zone possess their own wastewater treatment plant. Treated wastewater is used for irrigation of golf courses and lawns. The remaining beach hotels and bungalows along the coastline make use of on-site disposal systems consisting of septic tanks followed by absorption systems.

INSTITUTIONAL ARRANGEMENT FOR THE PERIODIC DEVELOPMENT OF NATIONAL COMMUNICATIONS

1.18 Introduction

Since 1 March 2010, a Climate Change Division has been established at MoESDDBM. It is tasked with the coordination of climate change activities and the mainstreaming of climate change into key sectors. MoESDDBM has the mandate to fulfil the reporting requirement of RoM to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (KP) and now the Paris Climate Change Agreement. The Supervising Officer of MoESDDBM is the UNFCCC focal point.

Several Government institutions, private sector, research organisations, academic institutions and NGOs are involved in various climate change activities. The following institutions/committees have been set up fairly recently and they are contributing to climate change adaptation or mitigation activities:

a) The Energy Efficiency Management Office (EEMO) promotes energy efficiency in all sectors of the economy and awareness of the efficient use of energy as a means of reducing carbon emissions and protecting the environment (2011)
b) The Mauritius Renewable Energy Agency (MARENA) aims to promote the use of renewables for electricity generation (2015)
c) The National Disaster Risk Reduction and Management Centre (NDRRMC) will establish a strategic and coordinated approach for disaster risk reduction and management (DRR&M) for RoM (2013) (Box 1.3)
d) Local Disaster Risk Reduction and Management Committee (2014)

Box 1.3 National Disaster Risk Reduction and Management Centre (NDRRMC)

The mandate of NDRRMC

The NDRRMC has the mandate to plan, organise, coordinate and monitor all disaster risk reduction and management activities at all levels. It ensures that Disaster Risk Reduction & Management is in line with international best-practice models, identifies and addresses specific needs of vulnerable groups, and protects against the creation of future risks as a consequence of the possible effects of climate change.

In the event of a major disaster, natural or man-made, the National Emergency Operations Command (NEOC) coordinates with all ministries and agencies that respond to disaster and provides guidance according to existing contingency plans and standard operating procedures.

Source: NDRRMC

In Rodrigues, the Commissioner of Environment is responsible for the planning, coordination and monitoring of the climate change measures. In addition, just as in Mauritius, a Rodrigues Disaster Risk Reduction and Management Centre (RDDRMC) has been set up to plan, coordinate and monitor DRR&M activities and is overseen by a Council. With regards to Agaléga and Cargados Carajos, the Outer Islands Development Corporation (OIDC) carries out DRR&M activities under the guidance of NDRRMC.

1.19 Institutional arrangement under the TNC

The organisational structure under the TNC project is shown in Figure 1.17.

A Project Steering Committee (PSC) under the chair of the Permanent Secretary of MoESDDBM was set up to provide guidance in terms of the process leading to political and stakeholder acceptance of TNC outcomes and to provide overall quality assurance for the final deliverables of the project, namely the TNC and NIR reports.

A Project Technical Committee under the chair of the Director of Environment was set up to provide leadership to the TNC process and to deal principally with all technical aspects of the TNC/NIR and to support the work of the different Technical Working Groups (TWGs).

Five TWGs were established to oversee the implementation of climate change activities in the various key sectors, namely GHG inventory; Mitigation assessment and environmentally sound technologies; Adaptation; Education, Training and Public awareness; and Research and Systematic observation. Four dedicated Working groups were established to focus on National circumstances and Integration of climate change considerations into Sustainable Development Plans and Considerations; Knowledge, Information sharing & networking; Capacity building; and, Constraints and Gaps; and Related financial, technical and capacity needs.

A total of 75 institutions were involved in the TNC process. Some 50 meetings and 7 capacity building workshops were carried out.

As to the future, the experience gained so far is integrated into a schematic representation of a possible structure for a sustained institutional arrangement for the preparation of National Communications, Biennial Update Reports and other similar reports that may be required under the Convention (Figure 1.18)

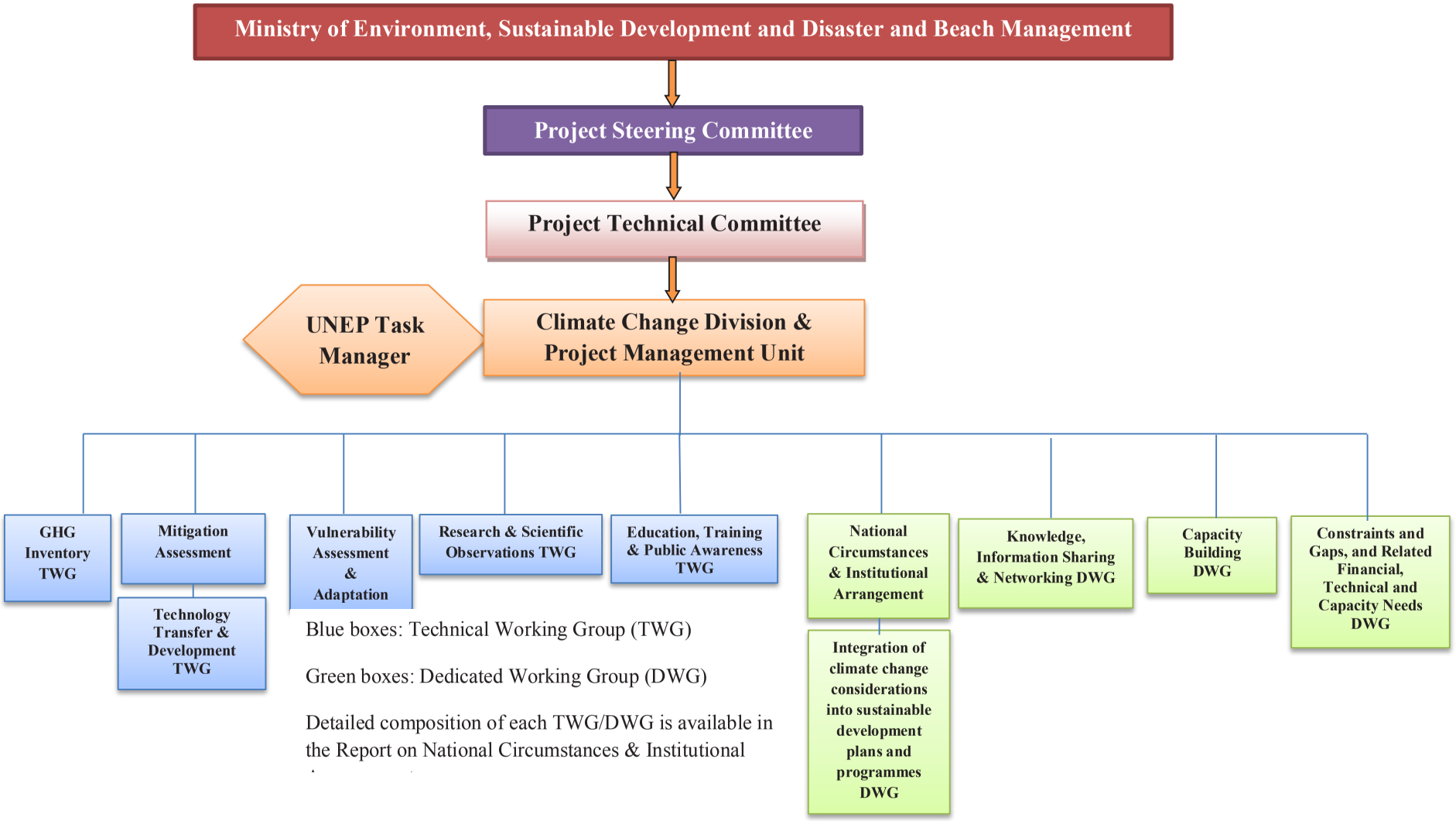
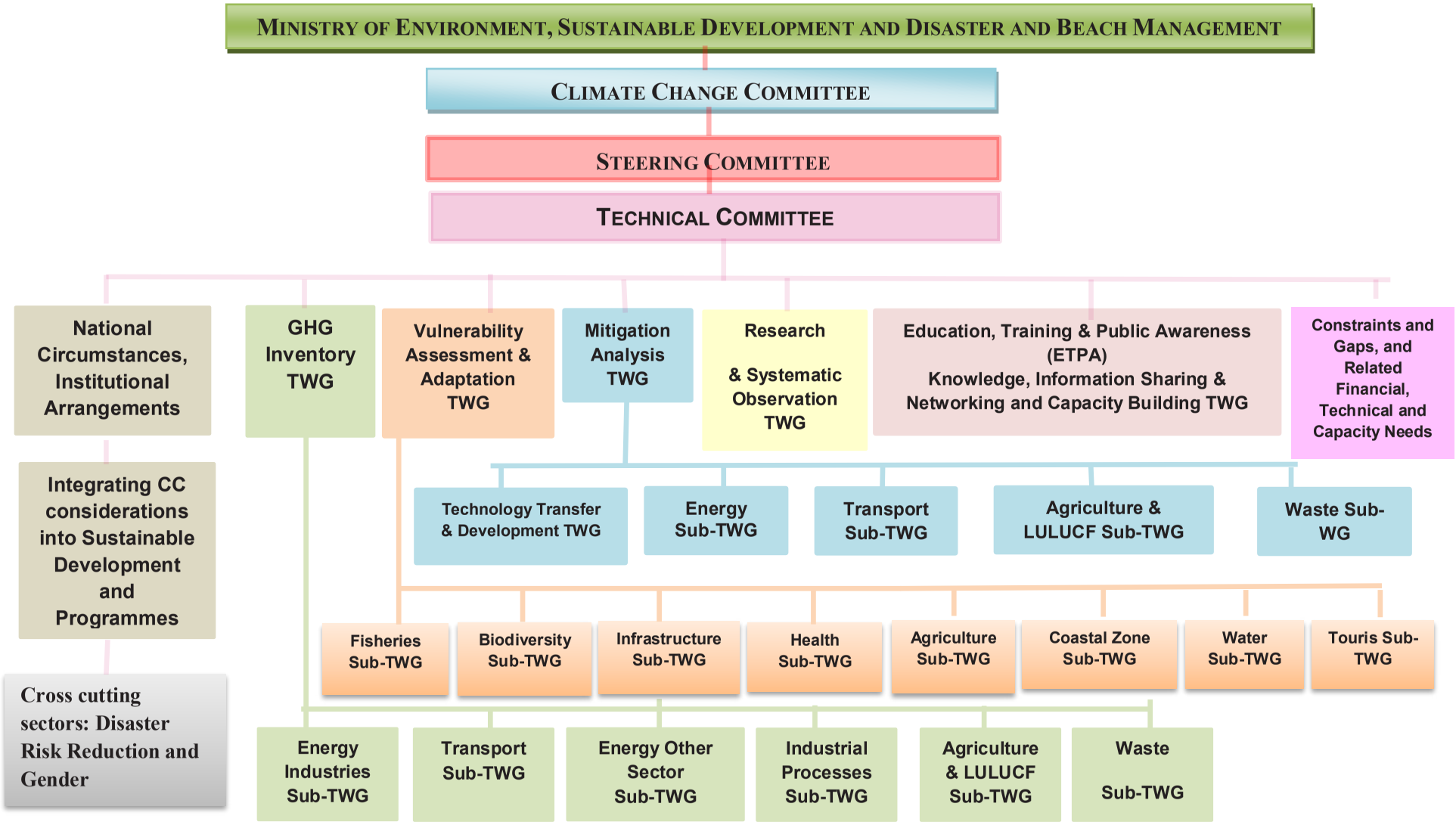


Figure 1.17 Organisational structure under the TNC Project

Figure 1.18 Proposed sustained institutional arrangement for National Communications and Biennial Update Reports



CHAPTER TWO

CHAPTER 2 NATIONAL GREENHOUSE GAS INVENTORY

2.1 Introduction

This chapter presents the Greenhouse Gas (GHG) inventories for RoM for the period 2006 to 2013 and a series as from the year 2000 for the general sectors such as energy, agriculture, Forestry and Land Use (AFOLU), and waste among a few others, for which data were available. It was prepared in line with articles 4 and 12 of UNFCCC and the Guidelines for National Communications of non-Annex I Parties to the UNFCCC.

In line with its obligations under UNFCCC, RoM submitted its Initial National Communication (INC) in April 1999 and the Second National Communication (SNC) in November 2010. GHG inventory was compiled for the year 1995 for INC and for the period 2000 to 2006 for SNC. A stand-alone National Inventory Report (NIR), which was the first NIR compiled for RoM accompanied SNC.

2.2 Overview of the inventory

The national GHG inventory (NGHGI) covers four categories, namely (a) energy (b) Industrial Processes and Product Use (IPPU) (c) Agriculture, Forestry and other Land Use (AFOLU), and (d) waste. It takes into account the following direct gases, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFCs). However, for Rodrigues, only the main sectors of energy (electricity generation and transport), and AFOLU (livestock and forestry) were covered.

The methodology was based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), and GHG emissions and removals were computed by applying the 2006 IPCC inventory software. A combination of the Tier 1 and Tier 2 approaches was used for key sub-sectors, namely waste and AFOLU.

2.3 Brief description of institutional set up

The UNFCCC Focal Point, MoESDDBM through its Climate Change Division coordinated the preparation of TNC including NIR in collaboration with other Ministries and Government institutions, private sector, academia and NGOs (Section 1.19). A Technical Working Group (TWG) was set-up to oversee the preparation of the Chapter on NGHGI and NIR. Six sectoral working groups were constituted for collecting activity data. The organisational structure is described in Figure 1.17 with additional details in Figure 2.1. A dedicated team, comprising members from key institutions, was responsible for data entry into the IPCC 2006 software.

Institutional arrangements for national GHG inventory

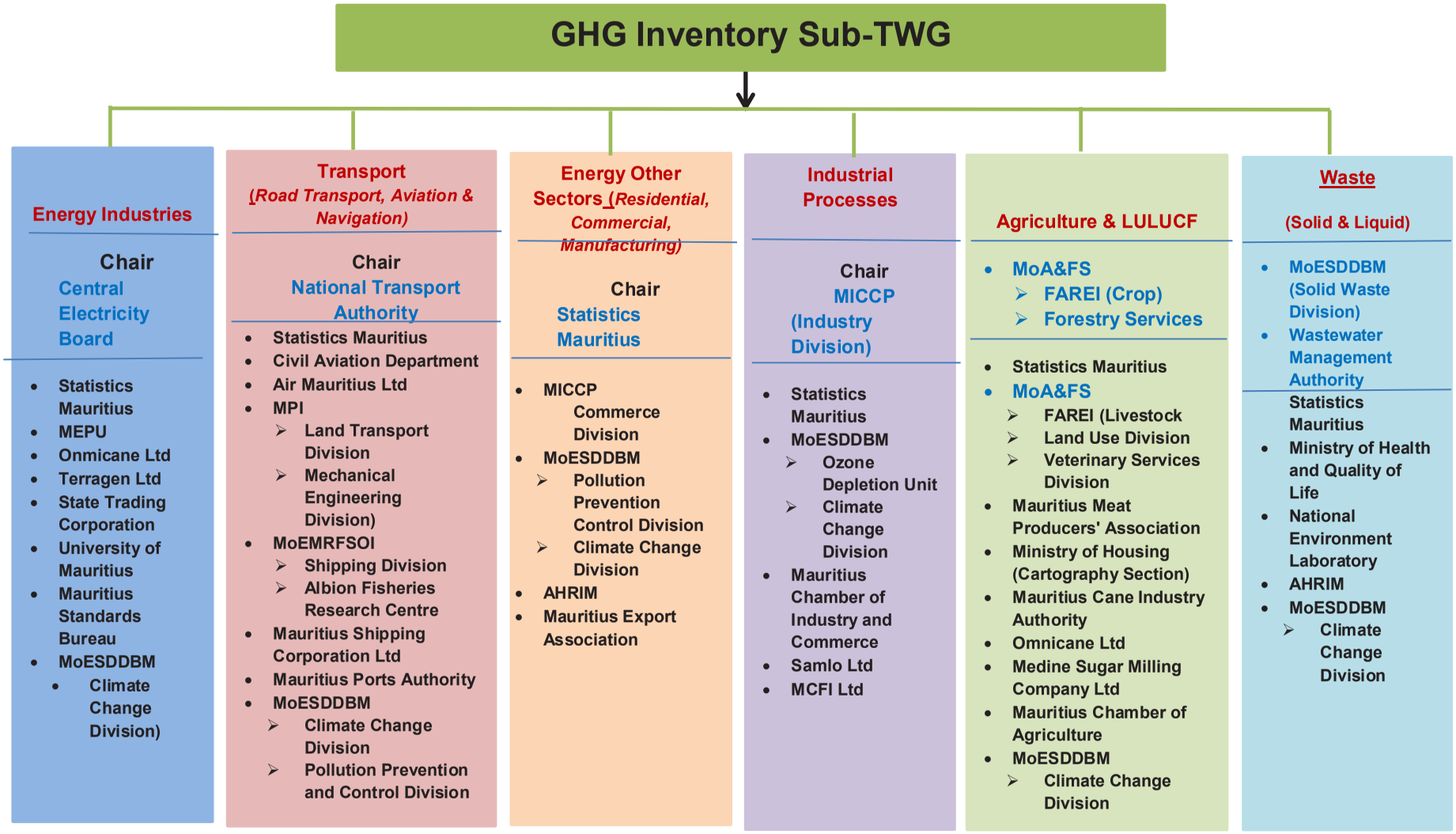


Figure 2.1 Institutions involved in the preparation of NGHGI and NIR

2.4 Data collection

MoESDDBM, the lead for GHG inventory, was responsible for coordinating the activities related to data collection which involved Statistics Mauritius, identification of relevant stakeholders and the organisation of capacity building exercise. The data collection was led by the Team Leader (TL) of each sectoral working group (Figure 2.1), under the guidance of consultants. In the event where data were not available, they were estimated using expert knowledge.

Initial technical and quality evaluation of the data was done by a dedicated team. The database created within the IPCC software was shared among the consultants and the dedicated team members. Activity data, emission and conversion factors were recorded directly into the sectoral and sub-sectoral worksheets of the IPCC software. The institutions involved in data collection, verification and data entry in IPCC software is given in Table 2.1. The wide range of relevant stakeholders from both the public and private sectors involved in the preparation of the NGHGI increased the access to information. Establishment of direct contact with the institutions proved essential in obtaining unpublished data previously collected solely for internal purposes.

Table 2.1 Institutions contributing to the GHG inventory

Institutions	Responsibilities
Forestry Service	Lead institution on forestry for land-use data
Food Agricultural Research and Extension Institute(FAREI)	Data for livestock and population. Crop production data including fruits, flowers, fodder and tea and national consumption of fertilizers. Soil fertility data [33]
Mauritius Cane Industry Authority (MCIA)	Data on sugar cane (plantation, processing and energy production related to sugar cane)
Statistics Mauritius (SM)	Responsible for data and information and facilitate access to timely and high quality statistical data. Contribution to quality control of data. Some energy statistics was also provided.
Fisheries Division	Data on marine transport
Ministry of Housing and Lands (MoHL)	Support for land use data
National Transport Authority (NTA)	Responsible for the transport sector
CEB of the Ministry of Energy and Public Utilities (MoEPU)	Data on electricity generation and distribution and other energy data
Solid Waste Management Division of MoESDDBM	Data on solid waste
Industry Division of the MICCP	Support on the IPPU sector
National Ozone Unit of MoESDDBM	Data on ozone depleting substances substitutes
Private sector (e.g. IPPs)	• Data on energy • Data on deer population • Others

2.5 Brief description of methodology

The NGHGI is structured to match the reporting requirement of UNFCCC and is divided into four main sectors, namely (1) energy, (2) IPPU, (3) AFOLU, and (4) waste (Section 2.2), each of which are further subdivided into sub-categories.. Emissions of direct GHG (CO_2, CH_4, N_2O and HFCs) were not directly measured but were estimated through the application of methodologies used to calculate emissions from data activities/natural phenomena occurring in the different sectors, such as amount of fuel consumed in electricity generation, area of forests by tree species and climate zone.

The estimation of the emissions and removals was computed using the IPCC methodologies where generally the activity data was multiplied by emissions/removal factors. Generally, Tier 1 methodology demands a minimum data set with some provided emission factors (coefficients), often referred to as default values. Tier 2 methods were used

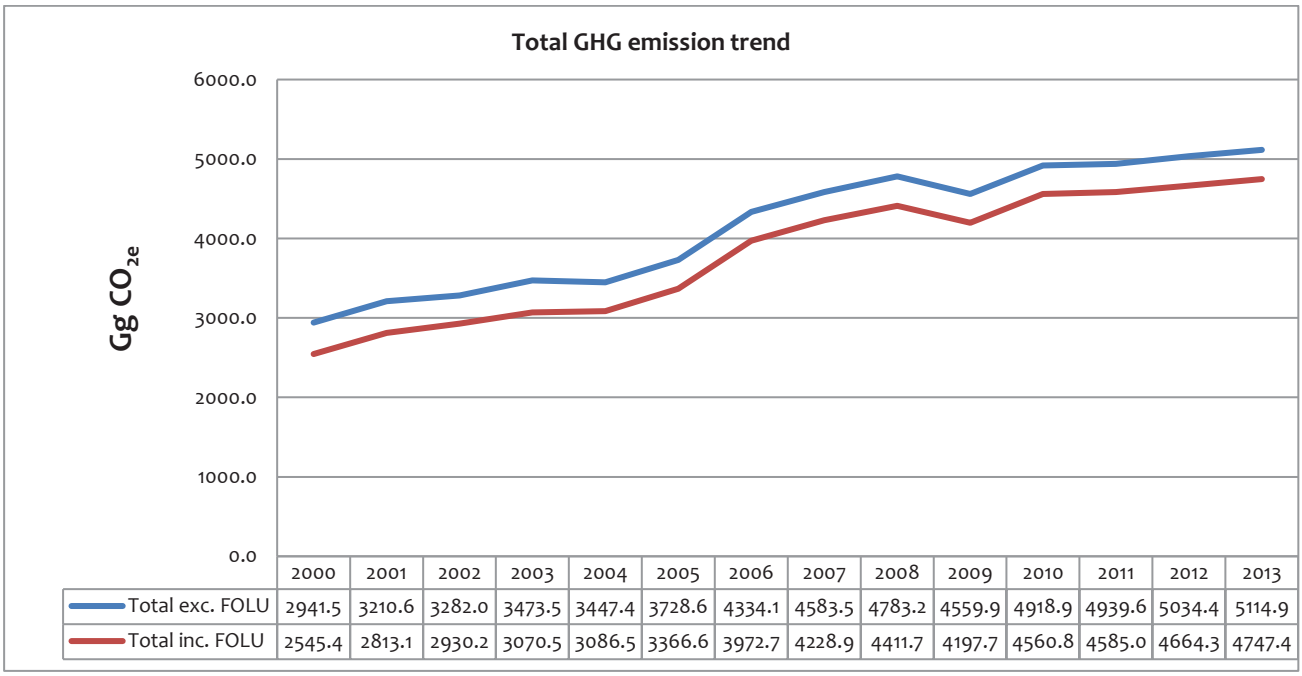
where country specific values were available. A Tier 3 method requires very detailed data at the country specific level and may also involve modelling and continuous and regular measurements. For TNC, some new and additional country-specific activity data were used, such as net calorific values; livestock population enhanced with characterisations by type, region and climate zone; forestry data by climate zone and tree species; solid waste characterisations; and, liquid waste local BOD values. Default emission factors from the IPCC Guidelines were used for many of the categories where country specific values were not available.

The inventory for TNC includes the trend of emissions over the period 2000 to 2013. For the period 2000 - 2006, the emissions from SNC were taken. For FOLU, soils and livestock, the recalculated emissions/removals were used, and for the remaining sectors and sub-sectors the original data were used.

2.6 Summary of aggregated emissions/removals trends

The total aggregated emissions of Mauritius (Figure 2.2, red line) grew at an average rate of 5% per year from 2 545 Gg CO_{2e} (including FOLU – i.e. after taking removals of CO_2) in 2000 to 4 747 Gg CO_{2e} in 2013. For the years 2008 and 2009, the emissions dropped slightly probably due to economic reasons.

While excluding the FOLU sector (i.e. taking only the total emissions), the total aggregated emissions of Mauritius (Figure 2.2, blue line) grew at an average rate of 4.5% per year from 2 941 in 2000 to 5 115 Gg CO_{2e} in 2013. In both cases, the emissions patterns are very similar.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total exc. FOLU	2941.5	3210.6	3282.0	3473.5	3447.4	3728.6	4334.1	4583.5	4783.2	4559.9	4918.9	4939.6	5034.4	5114.9
Total inc. FOLU	2545.4	2813.1	2930.2	3070.5	3086.5	3366.6	3972.7	4228.9	4411.7	4197.7	4560.8	4585.0	4664.3	4747.4

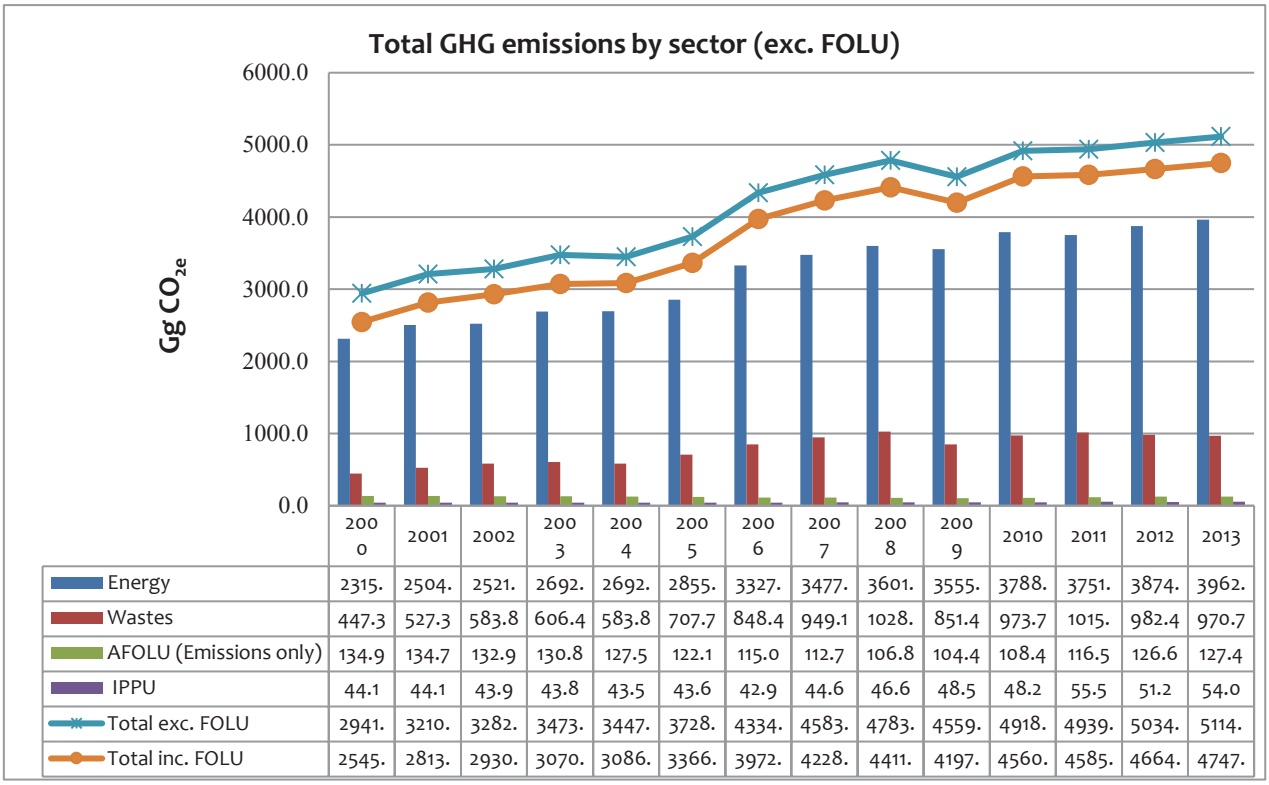
Figure 2.2 Trend of total aggregated GHG emissions ($GgCO_{2e}$) excluding (blue) and including (red) FOLU from 2000 to 2013

Detailed national greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of GHGs are found at Annex 1.

2.6.1 Emission trend by sector

The energy sector is the main source of GHG emissions, contributing 77% of overall GHG emissions (excluding FOLU) in 2013. It is followed by waste sector (19%). The emissions from IPPU (about 1%) are not significant. The CO_2 removal by forestry (a sink of carbon) was around 12% of the total emission including FOLU in 2000 but dropped to about 6% in 2013, probably due to increased emissions. Rodrigues contributed annually to an average of about 32 $GgCO_{2e}$ in these removals. In 2013, the agriculture sector (livestock and fertilisers) contributed about 2.7% of the total emissions.

The general trend characteristics were driven mainly by the energy consumption. The total aggregated CO_2 emissions depend also on GDP growth which fluctuated from a growth of 5.6% in 2007 down to 4.5% in 2010 and to 3.4% in 2013. Figure 2.3 and Figure 2.4 illustrate emission trends sector-wise (bar-line graph), and their shares (pie charts), respectively.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy	2315.	2504.	2521.	2692.	2692.	2855.	3327.	3477.	3601.	3555.	3788.	3751.	3874.	3962.
Wastes	447.3	527.3	583.8	606.4	583.8	707.7	848.4	949.1	1028.	851.4	973.7	1015.	982.4	970.7
AFOLU (Emissions only)	134.9	134.7	132.9	130.8	127.5	122.1	115.0	112.7	106.8	104.4	108.4	116.5	126.6	127.4
IPPU	44.1	44.1	43.9	43.8	43.5	43.6	42.9	44.6	46.6	48.5	48.2	55.5	51.2	54.0
Total exc. FOLU	2941.	3210.	3282.	3473.	3447.	3728.	4334.	4583.	4783.	4559.	4918.	4939.	5034.	5114.
Total inc. FOLU	2545.	2813.	2930.	3070.	3086.	3366.	3972.	4228.	4411.	4197.	4560.	4585.	4664.	4747.

Figure 2.3 GHG emissions and removals in GgCO2e by sector (2000-2013)

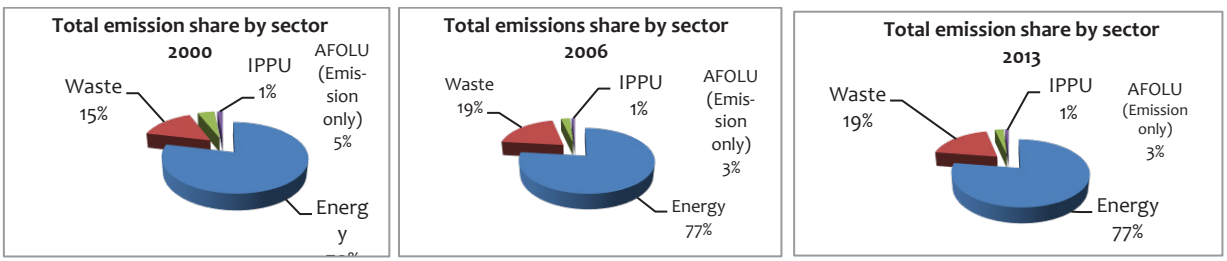
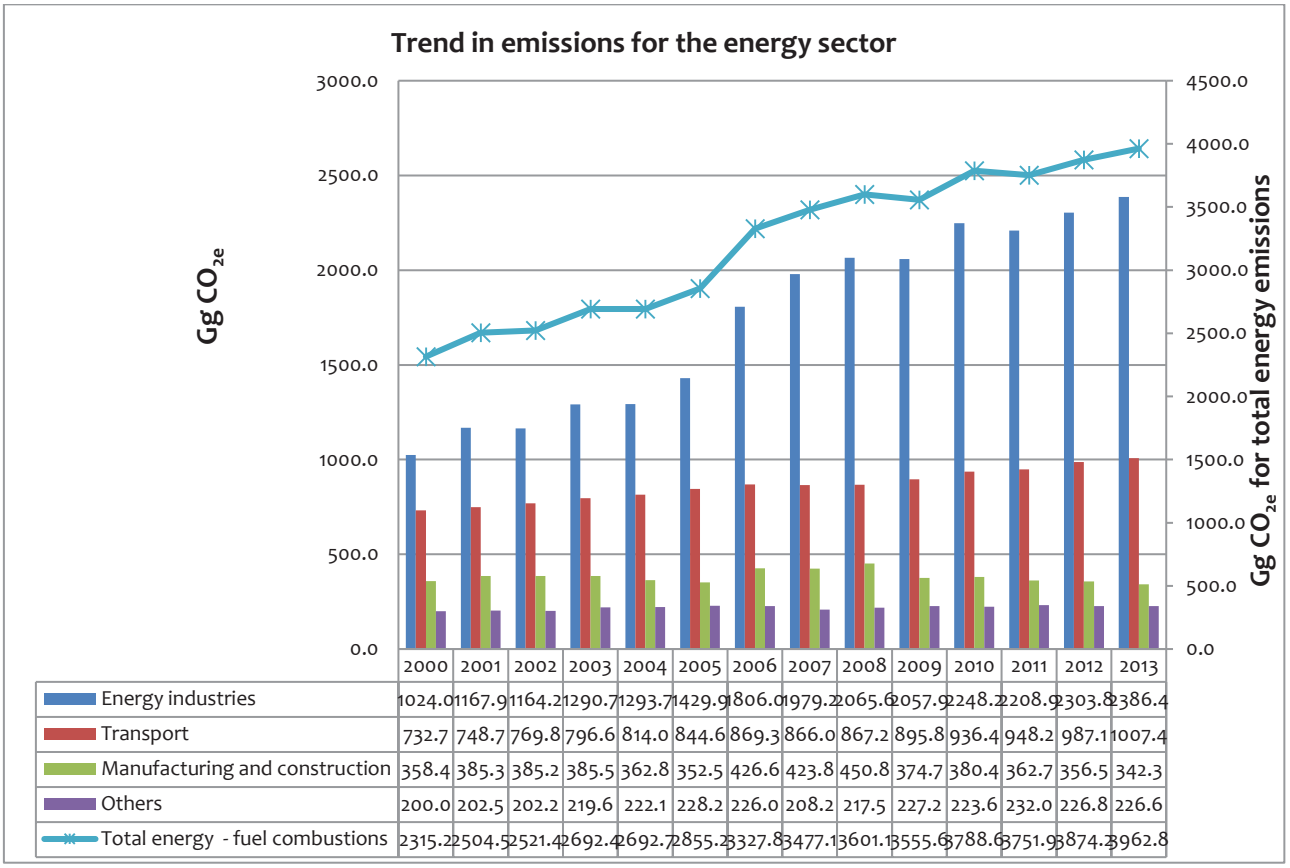


Figure 2.4 Emissions share (%) excluding LULUCF per sector for 2000, 2006 and 2013

2.6.1.1 *Energy sector*

The biggest emitter within the energy sector is the energy industries which in Mauritius is primarily electricity production. The emissions from this sub-sector increased from 1 024 Gg CO_{2e} in 2000 to 1 806 Gg CO_{2e} in 2006, and to 2 386 Gg CO_{2e} in 2013. The average annual growth was 4.3% over the period, with a few occasional slight drops mostly due to economic reasons. This general rising trend can be explained mostly by the change in lifestyle and the increased demand for electricity in households and industries (Figure 2.5 and Figure 2.6). The per capita consumption of electricity sold increased by 63% from 1 158 KWh in 2000 to 1 894 KWh in 2013. The second most important emitter in energy is transport. The emission of this sub-sector increased from 732.7 Gg in 2000 to 1 007.4 Gg in 2013. The emission from transport increased less than that compared to energy industries.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy industries	1024.0	1167.9	1164.2	1290.7	1293.7	1429.9	1806.0	1979.2	2065.6	2057.9	2248.2	2208.9	2303.8	2386.4
Transport	732.7	748.7	769.8	796.6	814.0	844.6	869.3	866.0	867.2	895.8	936.4	948.2	987.1	1007.4
Manufacturing and construction	358.4	385.3	385.2	385.5	362.8	352.5	426.6	423.8	450.8	374.7	380.4	362.7	356.5	342.3
Others	200.0	202.5	202.2	219.6	222.1	228.2	226.0	208.2	217.5	227.2	223.6	232.0	226.8	226.6
Total energy - fuel combustions	2315.2	2504.5	2521.4	2692.4	2692.7	2855.2	3327.8	3477.1	3601.1	3555.6	3788.6	3751.9	3874.2	3962.8

Figure 2.5 Trends of emissions for the energy sector

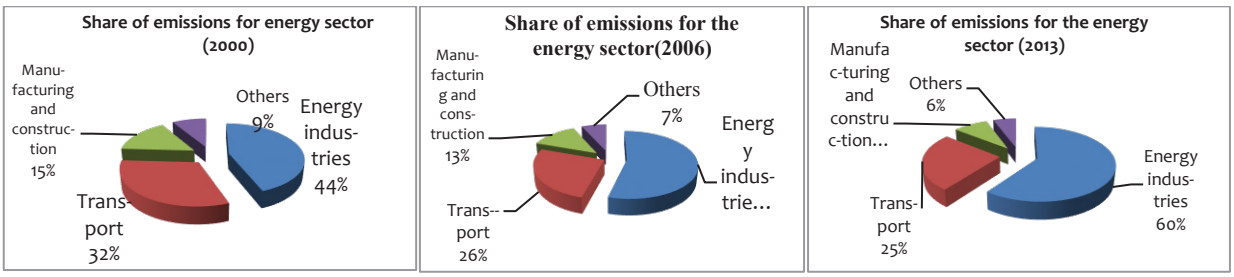
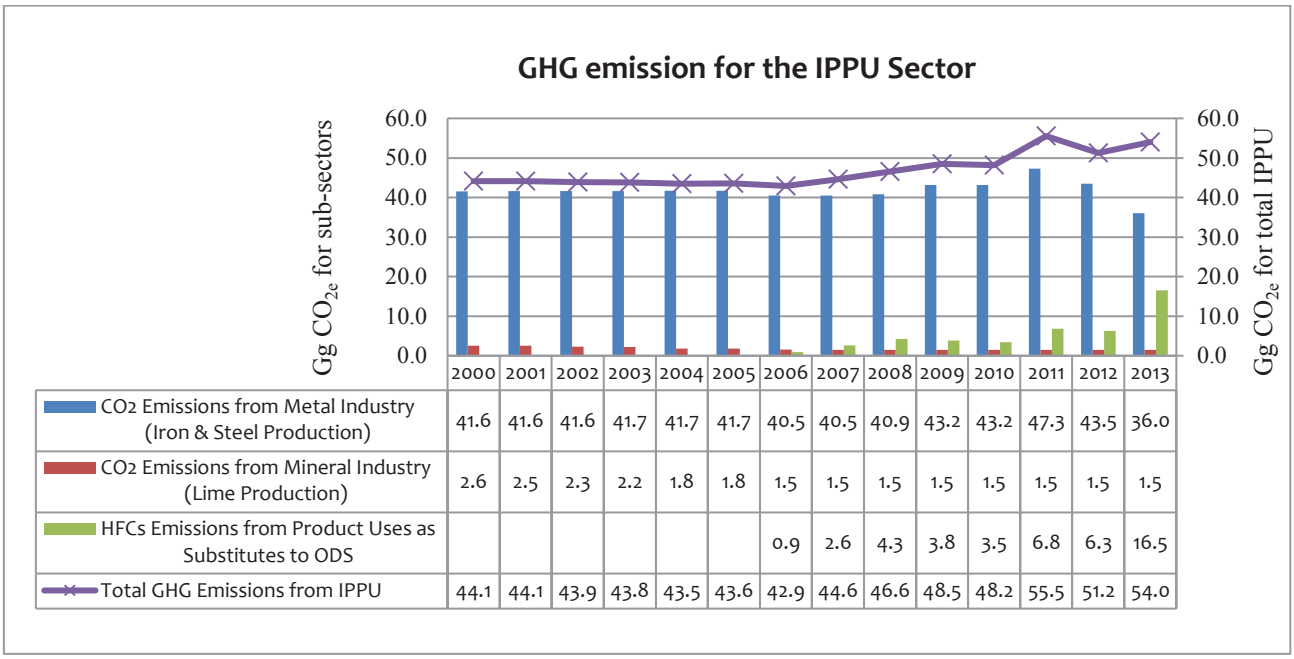


Figure 2.6 Share of emissions for the energy sector for the years 2000, 2006 and 2013

2.6.1.2 IPPU sector

This sector was the least important one in terms of the magnitude of emissions in Mauritius. Very few sub-categories in this sector emitted GHGs. The total for this sector was 54 Gg CO_{2e} in 2013, as shown in Figure 2.7. The metal industry (construction of iron bars from scrap metals) shared the highest level of emissions for this sector (67% in 2013), but with a slight drop as from 2011, probably due to decreased demand. Hydro-fluorocarbons (HFCs) showed rising emissions likely due to increased use of the gases in air conditioning and refrigeration.

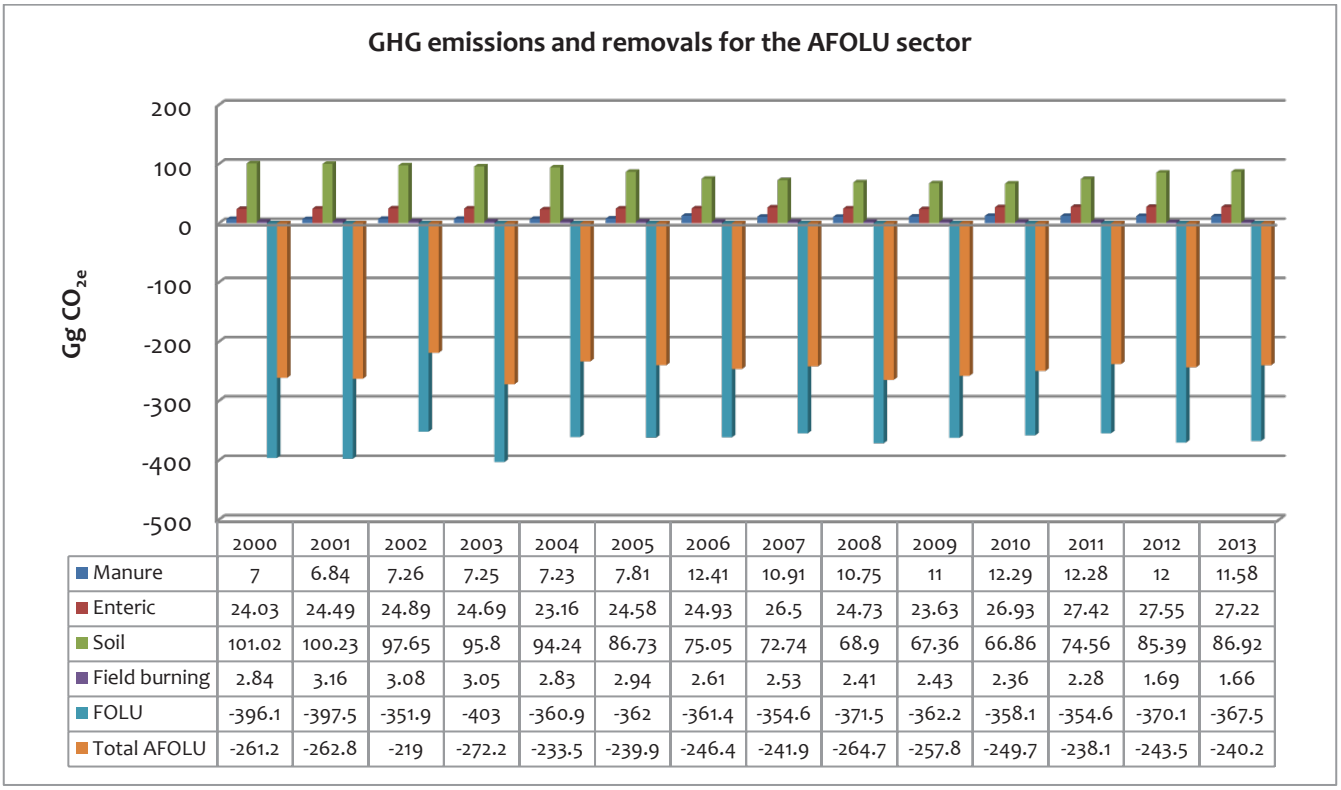


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO2 Emissions from Metal Industry (Iron & Steel Production)	41.6	41.6	41.6	41.7	41.7	41.7	40.5	40.5	40.9	43.2	43.2	47.3	43.5	36.0
CO2 Emissions from Mineral Industry (Lime Production)	2.6	2.5	2.3	2.2	1.8	1.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
HFCs Emissions from Product Uses as Substitutes to ODS							0.9	2.6	4.3	3.8	3.5	6.8	6.3	16.5
Total GHG Emissions from IPPU	44.1	44.1	43.9	43.8	43.5	43.6	42.9	44.6	46.6	48.5	48.2	55.5	51.2	54.0

Figure 2.7 Trend in emissions from the IPPU sector (2000 to 2013)

2.6.1.3 AFOLU sector

This sector (Figure 2.8) is particularly important as a carbon sink where the forests and a few other land areas sequestered, on an average, about 370 Gg of carbon yearly to which Rodrigues contributed some 32 Gg. The emissions occurred most importantly from the soils as the use of fertilisers were very common, especially in the sugarcane cultivation, from where on an average 83 Gg CO_{2e} were emitted yearly, primarily as N_2O. Livestock, with enteric fermentation and manure management contributed to the emission of CH_4, of which almost half came from Rodrigues which has important livestock population.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Manure	7	6.84	7.26	7.25	7.23	7.81	12.41	10.91	10.75	11	12.29	12.28	12	11.58
Enteric	24.03	24.49	24.89	24.69	23.16	24.58	24.93	26.5	24.73	23.63	26.93	27.42	27.55	27.22
Soil	101.02	100.23	97.65	95.8	94.24	86.73	75.05	72.74	68.9	67.36	66.86	74.56	85.39	86.92
Field burning	2.84	3.16	3.08	3.05	2.83	2.94	2.61	2.53	2.41	2.43	2.36	2.28	1.69	1.66
FOLU	-396.1	-397.5	-351.9	-403	-360.9	-362	-361.4	-354.6	-371.5	-362.2	-358.1	-354.6	-370.1	-367.5
Total AFOLU	-261.2	-262.8	-219	-272.2	-233.5	-239.9	-246.4	-241.9	-264.7	-257.8	-249.7	-238.1	-243.5	-240.2

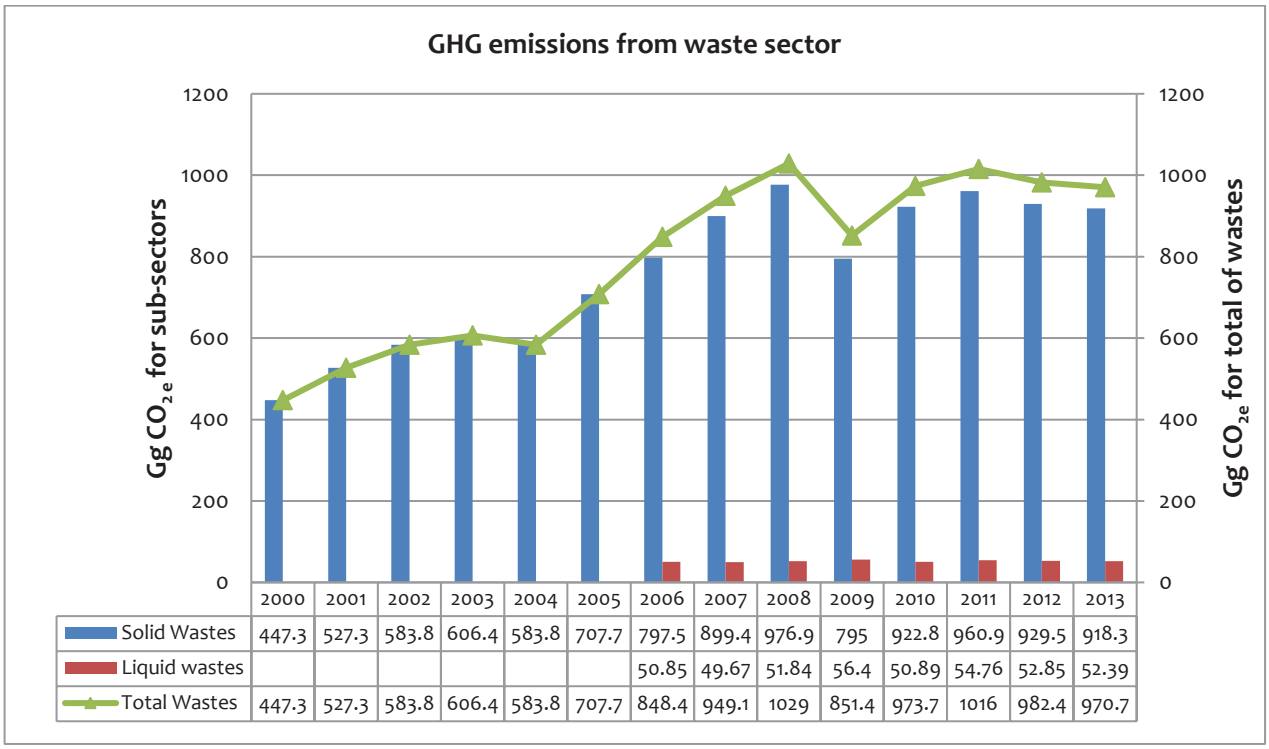
Note: Data for Rodrigues are included for FOLU. For the period 2000-2005, the data has been taken from SNC.

Figure 2.8 GHG emissions from AFOLU sector

2.6.1.4 Waste sector

The waste sector comprises both the solid and liquid waste emissions (Figure 2.9). The main GHG was CH_4. Solid waste emission (918 Gg CO_{2e} in 2013) share was higher due to the increased amount of waste generated and landfilled. Besides, 5.4% of the liquid waste was given primarily aerobic treatment and hence there were less emission. The emission from solid waste dropped in 2009. This may be due to factors such as changes in economic activities, production and consumption.

The total emission trend for wastewater varied from 56.8 Gg CO_{2e} in 2006 to 61.0 Gg CO_{2e} in 2013, corresponding to an increase of 7.2%.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Solid Wastes	447.3	527.3	583.8	606.4	583.8	707.7	797.5	899.4	976.9	795	922.8	960.9	929.5	918.3
Liquid wastes							50.85	49.67	51.84	56.4	50.89	54.76	52.85	52.39
Total Wastes	447.3	527.3	583.8	606.4	583.8	707.7	848.4	949.1	1029	851.4	973.7	1016	982.4	970.7

Note: For the liquid waste, the data for years 2000 to 2005 needs some refinements and not included here

Figure 2.9 GHG emissions from waste sector

2.6.2. Summary of GHG emission trends per gas

The dominant GHG was CO_2 which shared 79% of total emissions in 2000 and which decreased to 76% in 2006 and then rose slightly to 77% in 2013 (Figure.2.10). The second most important GHG was CH_4 which had increased its share from 17% in 2000 to 20% in 2013. The share of N_20 varied between 3 and 4%. The contribution of HFCs was minor with 0.02% in 2006 but increased to 0.3% in 2013 (Figure 2.10).

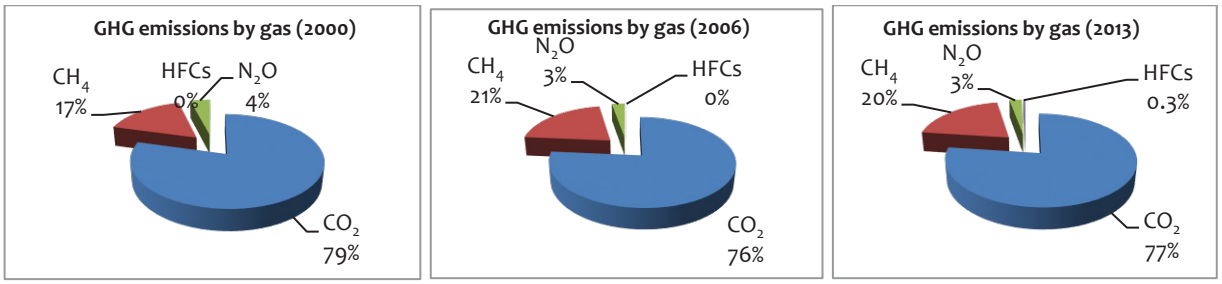


Figure 2.10 Total emission trend and share per gas for the years 2000, 2006, and 2013

2.6.2.1 Carbon dioxide

From 2000 to 2013, the emission trend curve of CO_2 is given in Figure 2.11. It shows an average increase of 4.2% per year. This was mostly due to the energy consumption pattern which followed a similar trend.

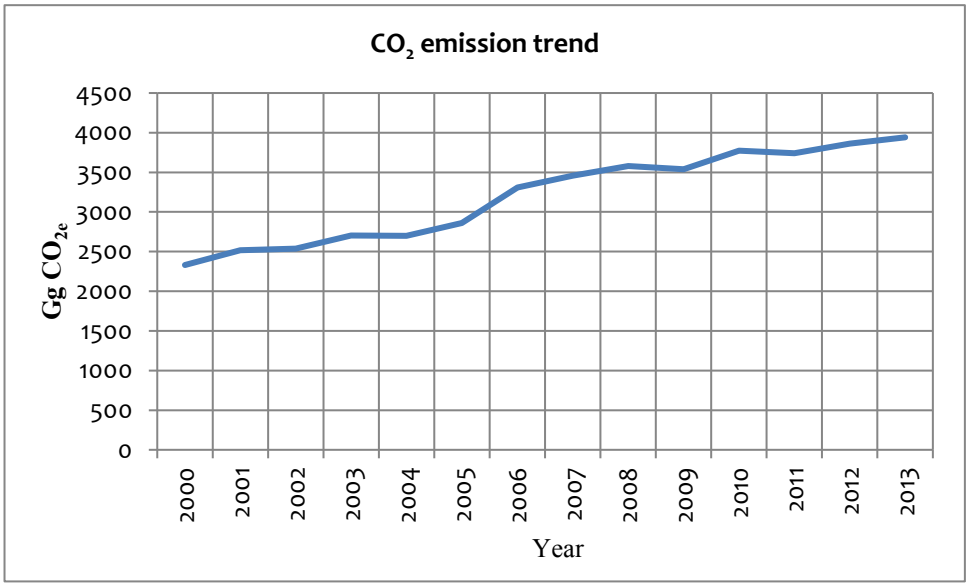


Figure 2.11 Trend of total CO_2 emissions from 2000 to 2013

2.6.2.2 Methane

From 2000 to 2005 (Figure 2.12), the trend of methane emission was characterized by an increase of 9.3%. A drop was noted from 2008 to 2009 probably due to economic reasons. Thereafter, the emissions increased slightly at an average rate of 4.6% per year to reach 1 025 Gg CO_{2e} in 2013.

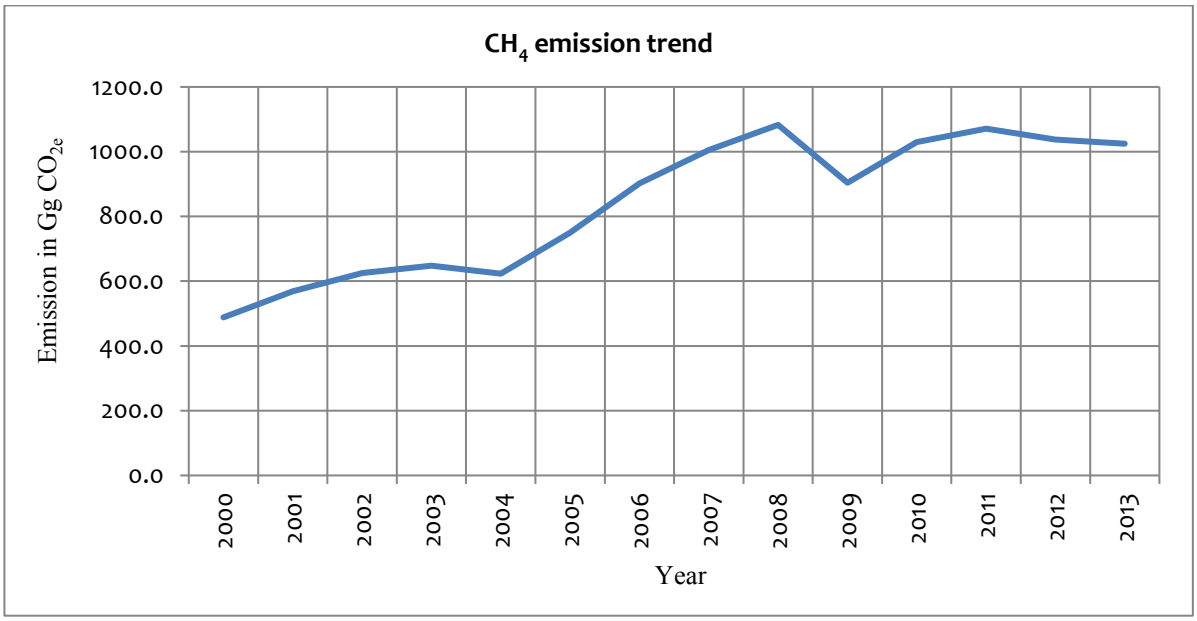


Figure 2.12 Trend of total CH_4 emissions from 2000 to 2013

2.6.2.3 *Nitrous oxide*

From 2006 to 2009 (Figure 2.13), nitrous oxide dropped from 120 to 110 Gg CO_{2e} due to the termination of nitric acid production which was used in the manufacture of fertilisers. The trend from 2010 to 2012 was again upward before reaching 130 Gg CO_{2e} in 2013, probably due to rise in emissions from sectors such as agriculture and waste.

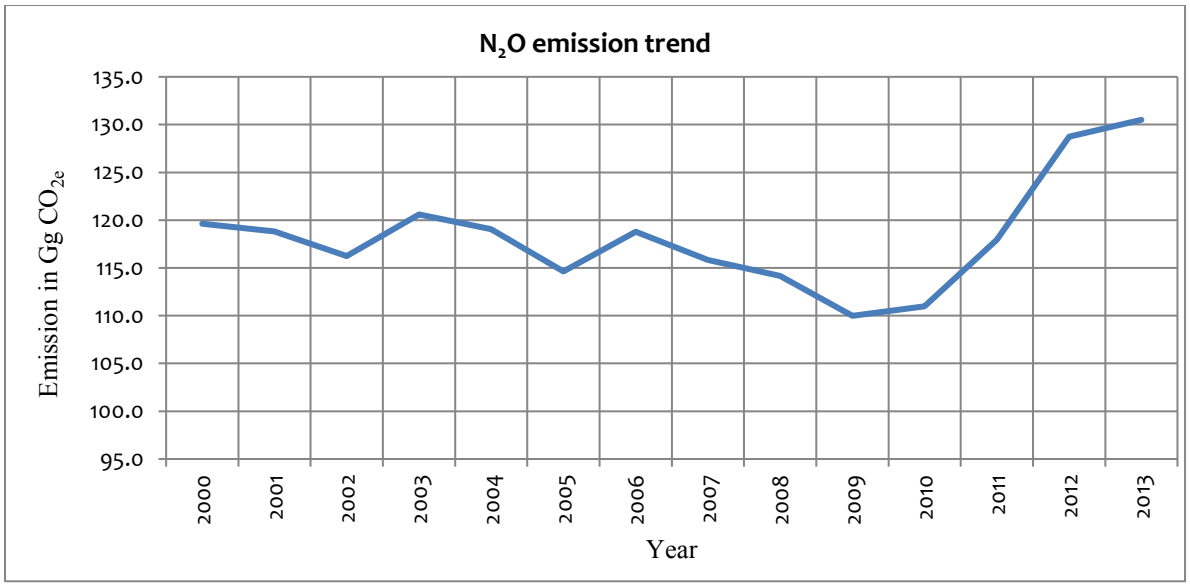


Figure 2.13 Trend of total N_2O emissions from 2000 to 2013

2.6.2.4 *Hydrofluorocarbons (HFCs)*

HFCs showed an increasing trend, especially in the recent years due to the demand for alternatives to ozone depleting substances (ODS). From 2006 the emissions increased from 0.9 to 6.3 Gg CO_{2e} in 2011 before peaking to 16.3 Gg CO_{2e} in 2013, probably due to increased demand of these gases for air conditioning and refrigeration.

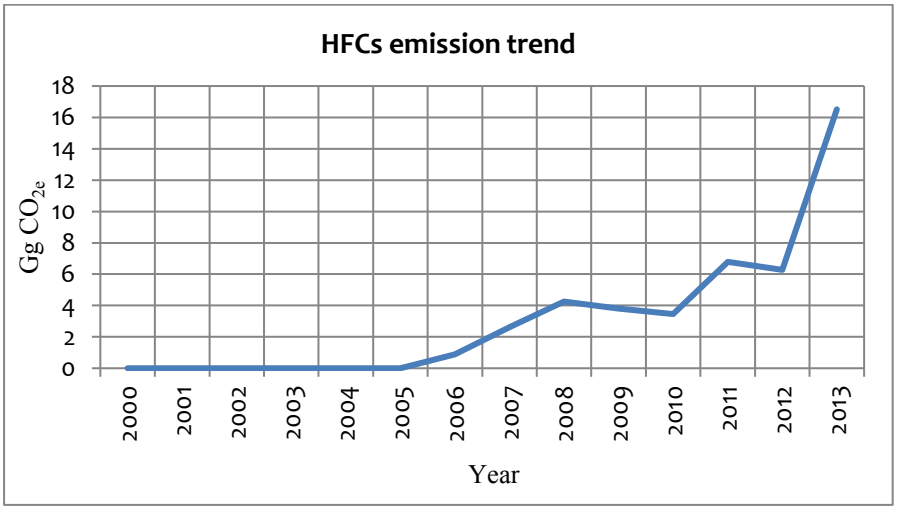


Figure 2.14 Trend of total HFCs emissions from 2006 to 2013

2.7 Key category analysis

A Key Category Analysis (KCA) was carried out to determine the sectors or sub-sectors and the GHGs that were important in the inventory and that needed greater focus for accurate calculations. 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 GHGs in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term *key category* is used, it includes both source and sink categories (IPCC 2006).

The assessment for the period 2006-2013 resulted in the following gases (CO_2 and CH_4) and sectors as key sources/sinks of GHGs:

a) CO_2 emissions from
    i) energy industries - solid fuels
    ii) road transportation
    iii) energy industries - liquid fuels
    iv) Forest land
    v) civil aviation
    vi) manufacturing industries and construction - liquid fuels
    vii) other sectors - liquid fuels
b) CH_4 emissions from solid waste disposal

This assessment is a listing of all those categories that cumulatively account for up to 95% of the total inventory when summed up in descending order of magnitude. The key category assessment with-LULUCF (including carbon sinks – mainly forests) includes values relating to estimated carbon removals in the LULUCF sector, taking into consideration the quantified values without taking into account the sign (removals are normally considered as being equivalent to negative emissions). The key category assessment without-LULUCF assessment excludes estimates of removals from the LULUCF sector.

The individual contributions of these categories to the national emission/removals vary between 3% and 26% of the total national emission/removals. Therefore, any GHG mitigation option on these categories would be significant for Mauritius.

2.8 Quality Assurance and Quality Control procedures (QA/QC)

The 2006 IPCC Guidelines recommends that quality control be exercised by comparing emission results using alternative approaches, comparing results and investigating anomalies. It also recommends that control may include review of emission factors, verification of activity data to ascertain source of data, reliability, and distinction in use where applicable, and to ensure avoidance of double counting.

All the data used in TNC were reviewed during peer review meetings with stakeholders. Moreover, the QC procedures were implemented by the inventory team through routine and consistent checks to identify errors and omissions. All calculations made during the exercise were done as per IPCC Guidelines. The approved standardised procedures for emission calculations, measurements and documentations were applied. The inventory process was carried out under the close supervision of the local and international consultants to ensure compliance with the IPCC Guidelines.

2.9 General uncertainty assessment

As defined in the 2006 IPCC Guidelines, uncertainty is the lack of knowledge of the true value of a variable. Uncertainties are associated with accuracy, precision and variability. The uncertainty depends on the analyst's state of knowledge, which in turn depends on the quality and quantity of applicable data as well as knowledge of underlying processes and inference methods. Uncertainties were found to be generally below 10% for most sectors/sub-sectors.

Care was taken to reduce uncertainties, for instance by collecting more country specific data, especially the activity data; improving on previous national communications, filling data gaps; involving further the stakeholders, and by conducting several training events with the assistance of the local consultant and the international consultants. Therefore, the understanding of the categories and the processes leading to emission and removal have much improved and helped to discover and correct problems of incompleteness.

However, due to time constraints , it was recommended that during the upcoming development of the Biannual Update Report (BUR), the methodology already identified would be improved taking into account both the development of national emission factors and use of data from the emissions monitoring systems.

2.10 General assessment of the completeness

A complete inventory refers to an inventory which includes estimates for all relevant sources and sinks and gases, and that covers all the applicable geographic areas of the country. As far as possible, the national inventory strives to include the most complete picture of emissions and removals from all known sources and sinks within the whole territory. Assessments of completeness for each sector have been conducted under the sector-specific description section of NIR.

2.11 Planned improvements

National GHG inventory requires continuing need for improving its quality. GHG inventory reporting requires detailed activity data collection and estimation of country-specific emission factors.

2.11.1 Planned improvement on the methodology

The level of inventory reporting depends on the data quality and methodology employed and is indicated as Tier 1, 2 or 3 as per the IPCC Guidelines for National Greenhouse Gas Inventories (2006). Despite the comprehensive initiation of activities under the TNC project, there is considerable scope for improvement. The inventory estimation has to be made at more disaggregated level, preferably at Tier 2 or 3 levels for the key sources.

Finer sub-sectoral level estimates of activity data and emission factors (EF) have to be developed. Similar and consistent formats have to be adopted for data reporting and ensuring consistency in generating activity data by organizations.

In future GHG inventory, it is proposed that academia and research institutions be more actively involved in the preparation and reporting of GHG inventory in order to fine tune the proper use of GHG methodology. They could undertake the following actions:

i) verify the proper use of the methodology
ii) conduct uncertainty assessment of emission factors
iii) carry out overall check of inventory
iv) undertake overall quality assurance as per IPCC Guidelines

The detailed planned improvements on data collection, research and emission factors with regard to the priority action, responsibility and expected time frame are detailed in National Inventory Report.

2.11.2 Planned improvement on capacity building and information sharing

Despite the knowledge acquired during the preparation of the TNC, there are still need for more capacity and empowerment of staff and institutions. The duration of training could be at least be two continuous weeks including theoretical training and practical exercise and could cover, amongst others,:

i) data collection
ii) methodology development, including for deriving EFs

iii) use of software, including IPCC, GIS and others
iv) report writing

Concerning the information sharing it is recommended to:

i) create national registry/website/database or clearinghouse for the GHG inventory with tools etc.
ii) open website for gathering public and private reviews

2.11.3 Strategies for long-term improvement in the National Inventory System

RoM has an obligation to submit BUR as well as NC on a regular basis. It is vital that the process be strengthened and a system is developed and maintained in a robust manner to ensure that it functions on a continuous basis to meet RoM's reporting requirements. There is a need to strengthen the existing institutional arrangements or establish new ones to ensure that national capacity is available to yield more technically robust reports and meet the frequency of submissions.

The Third National Communication (TNC) was prepared as a project by the Climate Change Division under the Directorate of Environment of the Ministry of Environment, Sustainable Development, and Disaster and Beach Management.

The Climate Change Division embarked on the preparation of TNC and is also formulating a Low Carbon Development Strategy and Nationally Appropriate Mitigation Actions (NAMAs) for Mauritius. However, under the Division there is no permanent staff having attribution to follow day to day activities related to GHGs inventory.

According to Article 4 of UNFCCC, Parties are committed to communicate regularly the following information:

i) Anthropogenic emissions and removals
ii) Established measures and related policies to mitigate climate change
iii) Established measures and related policies to adapt to climate change impacts
iv) Existing and planned research and systematic observation
v) Existing and planned programmes of education, training and public awareness

To meet these requirements and ensure the timely availability of future GHG inventories, while making continued general improvement of national communication reports, it is recommended to empower further the Climate Change Division.

CHAPTER THREE-A

CHAPTER 3A VULNERABILITY ASSESSMENT AND ADAPTATION (MAURITIUS)

3.1 Introduction

Climate records over the period 1951-2014 show a significant warming trend of about 1.2°C and a decreasing trend in rainfall amount of about 8%. With climate change these trends are projected to continue along with sea-level rise ranging between 52 cm and 98 cm by the end of the century if no mitigating action is taken (IPCC, 2013). In addition, the risk from natural disasters arising from extreme events such as cyclones, flood and droughts are expected to increase. Already, according to the World Risk Report 2015, Mauritius is ranked as the 13th country with the highest disaster risk and 7th on the list of countries most exposed to natural hazards (UNU-EHS, 2015).

The vulnerability of RoM is projected to increase with these phenomena impacting adversely on its socio-economic and environmental sectors. The assessment of the vulnerability is made on the basis of climate trend projections of the regional climate model COSMO-CLM, developed under the Disaster Risk Reduction Strategic Framework and Action Plan 2013 (DRR, 2013). Temperature is expected to increase, with a range (depending on the seasons and scenarios) between 1°C and 2˚C for the period 2061-2070, with respect to the period 1996-2005. This range of warming potential is utilised in the assessment of vulnerability throughout the chapter.

On the basis of the above climate change-related projections, challenges for seven key sectors namely agriculture, coastal resources and tourism, water resources, marine and terrestrial biodiversity, fisheries, human health and infrastructure are presented. In addition, adaptation strategies for each sector are elaborated. The strategies have three main objectives:

i) avoid and reduce damage from climate change
ii) build capacity to understand, analyse and pre-empt, in a timely manner, any future climate change impacts
iii) integrate and mainstream climate change adaptation into RoM's core development policies, strategies and plans that would turn challenges into new opportunities.

These strategies could be integrated in order to constitute a unique national strategy, making use of cross-sectoral synergies. The integrated approach within each sector is used to identify the intervention options, the required investments, and the policy-induced avoided costs and added benefits.

3.2 Sectoral vulnerabilities and adaptation

3.2.1 Agriculture

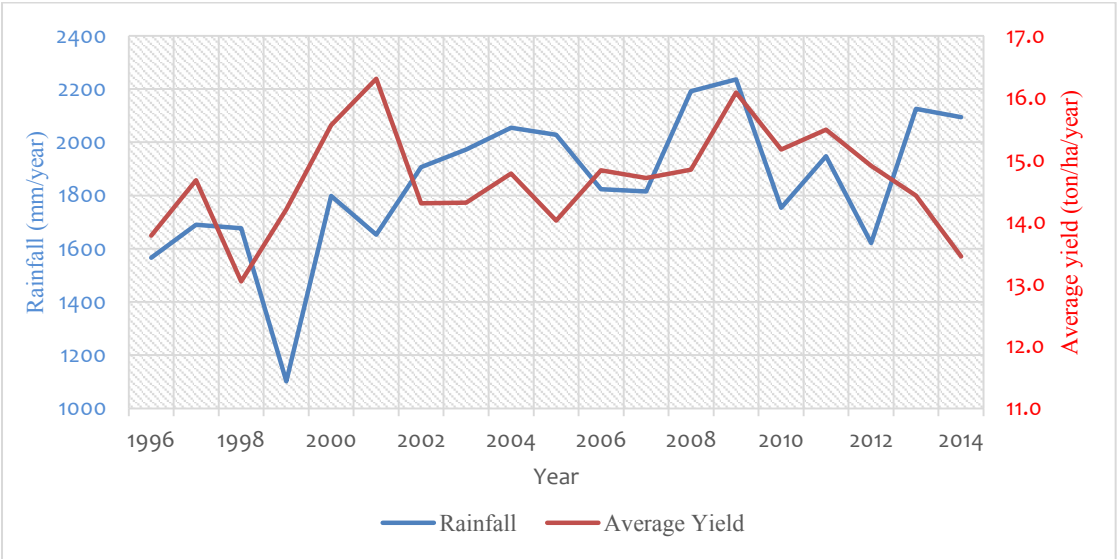
3.2.1.1 Climate change vulnerabilities

Mauritius has 980 km^2 of agricultural land or 48.3% of total land surface (FAO, 2013). The agricultural sector uses about 68% of the total water withdrawn. RoM is aiming to improve food security (UNEP, 2014) but the expansion of the agricultural sector is constrained by increased climate variability and loss of key ecosystem services (Table 3.1).

Table 3.1 Climate change-related impacts on agriculture

Climate variability and climate change impacts	Observed impacts on agriculture
Temperature rise of 0.74 to 1.1°C in the period 1998-2008 relative to 1951-1960	Affects soil moisture and leads to a shift in agricultural zones; and causes heat stress, which lowers crop productivity and increases mortality in poultry and incidence of agricultural pests and crop diseases. (Ministry of Environment and Sustainable Development, 2012)
Increase in rainfall variability and drought periods, with an 8% decline in rainfall in the last 60 years, comparing 1998-2008 to1951-1960	Leads to soil erosion, with higher risks of flooding and crop damage, and an overall decline in yields
Increase in climate extremes	Damages crops and farm buildings, causing loss of animals, and increase in the leaching of plant nutrients and fertilizers to groundwater (GoM, 2012)
Sea level rise	Leads to the salinisation of water used for irrigation in coastal zones, and causes coastal flooding and loss of agricultural land around the coast

The vulnerability of the agriculture sector is expected to increase in the coming decades. A continuation of the current trends that is reduced rainfall and an increase in evapotranspiration due to warming may lead to a decline in agricultural production by as much as 15-25% in the medium- and longer term (Figure 3.1) (Ministry of Environment and Sustainable Development, 2012). Higher temperatures and lower temperature amplitude will lead to increased vulnerability of vegetables and other crops (e.g. due to a change in phenology and reduced flowering intensity), with reduction in yield and productivity (GoM, 2012). This is the case with tomatoes. The monthly yield, which is estimated as a weighted average for several crops in the Eastern region, may possibly decline by 8.2% in the short-run and 13.3% in the long-run with a 1°C temperature increase and 10% precipitation decrease (GoM, 2012).



Source: Statistics Mauritius

Figure 3.1 Annual rainfall (in blue) and average annual agricultural yield (in red) (1996-2014)

3.2.1.2 Adaptation policies

In order to address the challenges posed by climate change impacts, make progress towards achieving competitiveness in the agricultural sector and meet national targets in food security, GoM, in collaboration with other relevant entities, will actively support the transition to sustainable agriculture (Table 3.2).

Table 3.2 Strategies in support of transition to sustainable agriculture

Strategy	Means of implementation and expected results
Improve resource efficiency, specifically in relation to the use of land, fertilizers and pesticides	The aim is to reduce vulnerability to climate change by increasing land productivity with sustainable practices. This will also lead to reduced volatility in production, and ensure stable revenues and access to domestic and foreign markets for sustainable (e.g. Fair Trade (Box 1.2) and organic products
Estimate the economic value of natural capital	This may be achieved by increasing the knowledge and use of sustainable land use practices and promoting the use of ecosystem services, and in this way address ecological scarcity and reduce the loss of ecosystem services that are costly to replace
Support the strengthening of the capacity of institutions	The institutions need to train their human resources as well as those of the local communities. This will ensure the prompt and proper uptake and use of technologies and agriculture practices, leveraging both public and private investments. It will also ensure increased resilience of the agriculture sector in the provision of food (e.g. strategic crops), and in lowering the burden of imports
Stimulate research and technology development	The objective may be attained by the identification, development and breeding of crop varieties capable of adapting to climate change, and bringing technologies to farmers to increase their resilience to climate change. To this end, effective communication for the transfer and dissemination of information on climate change could be arranged

The implementation of VAA strategies (Table 3.3) is expected to reduce vulnerability to climate change, increase yields, maintain employment, and reduce both the loss of natural capital (e.g. through decrease in soil erosion) and the carbon footprint of the sector by reducing sources and increasing sinks.

Table 3.3 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the agriculture sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	**To create new opportunities**
Agriculture	i) Food insecurity ii) Vulnerability to climate change (iii) Increased dependence on food imports (iv)Resurgence of livestock and poultry disease	Reduce vulnerability to climate change	**A1**[1]**.** Water supply and conservation support	**AN1**[2]**.** Preventing, preparing for, and responding to agricultural invaders, pests and diseases
		Enhance food security	**A2.** Sustainable land use planning practices	**AN2.** Promote working landscapes with ecosystem services to improve agro-biodiversity
		Foster sustainable agricultural development	**A3.** Building and sustaining institutional support	**AN3.** Research, innovation and technology development and communication
		Reduce vulnerability of livestock and poultry farms to incidence of pest and diseases	Reinforcing capacity building and logistic facilities of Veterinary services for disease surveillance	Looking forward for a contingency plan for livestock sector: Preventing, preparing for, and responding promptly to pests and diseases in order to reduce economic losses

			Sensitizing farmers on importance of adopting biosecurity measures on farm	

Note[1]: A1 etc. refer to proposed strategies to address current problems
Note[2]:AN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the a*griculture* sector are given in Annex 2.

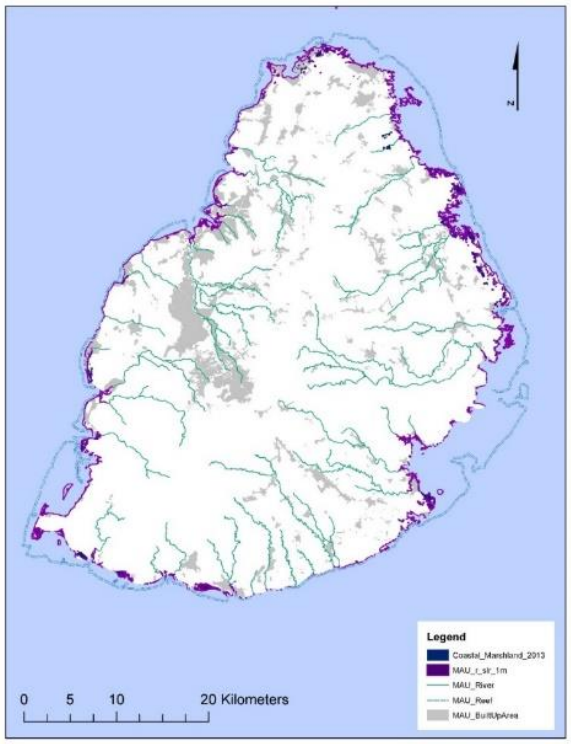
3.2.2. Coastal areas and tourism

3.2.2.1 Climate change vulnerabilities

Mauritius has 322 km of coastline and 243 km^2 of lagoon area enclosed by 150 km of fringing reef that surrounds part of the island. About 20% of the population resides in coastal areas. The revenue generated directly from activities in the coastal zone was equivalent to 36% of GDP in 2011 – out of which 99% was represented by tourism. This sector is considered to be a highly climate-sensitive economic sector (Ministry of Environment and Sustainable Development, 2012).

The various climate change-related impacts *observed* in the coastal areas and in the tourism sector in Mauritius are:

i) increasing costs for various tourism operations (e.g. supply of quality water, heating-cooling costs, irrigation needs, pest management interventions, evacuations and temporary closures) (Tourism Council, 2015)
ii) beach erosion and the deterioration of reef quality (Ministry of Environment and Sustainable Development, 2012). Based on University of Hawaii Sea Level Centre data for the main island of Mauritius, the sea level rise for the period 1987 to 2011is given in Figure 1.4. It shows a marked rise of 5.6 mm/year for the period 2000 to 2012. Figure 3.2 shows the different parts of Mauritius that are likely to be affected by a sea level rise of 1 m (DRR Report, 2013).
iii) spreading of infectious diseases, wildfires, algal blooms, insects or water-borne pests and disease vectors (Tourism Council, 2015).



Source: Source: DRR (2013)

Figure 3.2 Areas on the coast of Mauritius likely to be affected by 1 m rise in sea level

The most relevant direct *future impacts* of climate change include:

i) reduction in tourist arrivals, due to an increase in mean annual temperature along with an increase in temperature extremes (Tourism Council, 2015; GoM, 2012);

ii) accelerated beach erosion due to sea-level rise between 52 and 98 cm by 2100 if no mitigating action is taken (IPCC, 2013).

In the context of the National Climate Change Adaptation Policy Framework (NCCAPF) it was estimated that the cumulative 50-year value of beach tourism (US$ 45.5 billion, assuming no increase in tourist numbers from 2010, to be conservative) the revenue loss per year might range from US$ 2 million in 2011 to US$ 100 million/year in 2060 (in 2010 terms), assuming a constant rate of beach erosion (GoM, 2012).

3.2.2.2 Adaptation policies

In order to address sea level rise, coral reef decline, and temperature increases, and resulting impacts on coastal erosion, lagoon quality, tourism arrivals and local leisure activities, GoM, in collaboration with other relevant entities, may implement suitable adaptation policies (Table 3.4).

Table 3.4 Adaptation policies aimed at reducing the vulnerabilities of coastal areas and tourism sector

Action proposed	Means of implementation and expected results
Reduce the vulnerability of coastal areas to climate change by considering social, economic and	This may be done through prevention (e.g. setbacks and relocation), implementing non-structural (e.g. shore and beach management) and structural interventions (e.g. hard shoreline protection structures like groynes,

environmental impacts of climate change	artificial headlands, detached breakwaters and shoreline armouring) aimed at improving environmental as well as economic resilience
Ensuring coastal protection	This can be achieved by respecting buffer zones for wetlands and by encouraging coral farming and the growth of coral reefs. These activities are expected to create synergies, for instance within the tourism sector
Incentivise resource efficiency for the tourism sector to mitigate costs, while promoting eco-tourism	With growing expected climate change impacts, operational costs in the tourist sector are expected to increase. Improving resource efficiency may allow the mitigation of cost increases for tourism establishments. An improvement in efficiency, resulting in the use of natural resources, will complement interventions on coastal areas, by valuing native vegetation
Revive practices utilised in the past	The practices could include limiting access to beaches (as a form of conservation) to allow for natural restoration, and control developments in the proximity of beaches. A location-based approach as mentioned in Section 7.2.3.1 could be envisaged.

The implementation of the VAA strategies (Table 3.5) is expected to reduce vulnerability to climate change on coastal areas and, as a consequence, reduce potential economic damage to infrastructure and the operational costs of the tourism sector. This may be achieved while increasing the desirability of Mauritius as a tourist destination, through a more sustainable management of coastal areas including coral reefs and beaches, which would increase the competitiveness of the sector (Box 3.1) and hence generate employment and income for the local population.

Box 3.1 Sustainable management of coastal resources

Sustainable building and management at Long Beach Golf and Spa Resort

The renovation of Long Beach Golf and Spa Resort at Belle Mare, a new 255 room complex, was viewed as an opportunity to build a hotel that could use sustainable design and construction principles as well as incorporate sustainability principles. With its 6 000 energy-efficient light bulbs, compact fluorescent light bulbs and spots or LED lighting, the saving in electricity usage is equivalent to the annual consumption of 500 households. The roofs are covered with plants, pebbles and special materials to reduce the impact of sun exposure. The heat produced by the air conditioning system is captured and then used to heat water. The oil in the kitchen is recycled for reuse as fuel in vehicles. Ozone is used for laundry, which means that lower washing temperatures can be used.

A Building Management System (BMS) maintains the temperature of the rooms wisely. Photovoltaic panels produce electricity while rainwater is collected for irrigation and toilets. Waste water is also recycled to irrigate the gardens of the hotel. The Hotel is expected to produce 150m³ of green waste daily, some from the 59-acre site and some compostable waste from the kitchens, which is converted into fertiliser for the gardens.

Source: Ministry of Environment and Sustainable Development of Mauritius (2012). *Sustainable Consumption and Production: Best Practices in Mauritius*. UNEP

Figure 3.3 Long Beach Golf and Spa Resort

Table 3.5 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the coastal area and tourism sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	**To create new opportunities**
Coastal areas and tourism	i) Loss of revenues in the tourism sector ii) Vulnerability to climate change coastal erosion, and infrastructure damage	Reduce vulnerability to climate change	**T1[1].** Restoration of coastal vegetation	**TN1[2].** Promoting beach nourishment and dune replenishment
		Ensure coastal protection	**T2.** Coastal wetland protection and restoration	**TN2.** Encouraging coral nursery and growth of coral reefs
		Foster competitiveness in the tourism sector	**T3.** Increase resource efficiency	**TN3.** Incentivise eco-tourism, with the valorisation of natural capital

Note[1]: T1 etc. refer to proposed strategies to address current problems
Note[2]:TN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *coastal area and tourism* sector are given in Annex 3.

3.2.3 Water resources

3.2.3.1 Climate change vulnerabilities

The protection, sustainability, and enhancement of freshwater quality and availability constitute a fundamental prerequisite for long-term socio-economic development. However, the sustainable use of the country's water resources is threatened due to the combined effects of increased demand, climate change impacts such as reduced precipitation and increasing evapotranspiration, contamination and other factors (UNEP, 2014). Already in 2010 water availability was equivalent to 965m^3/person, which is below the threshold for classifying a as water-scarce (GoM, 2012).

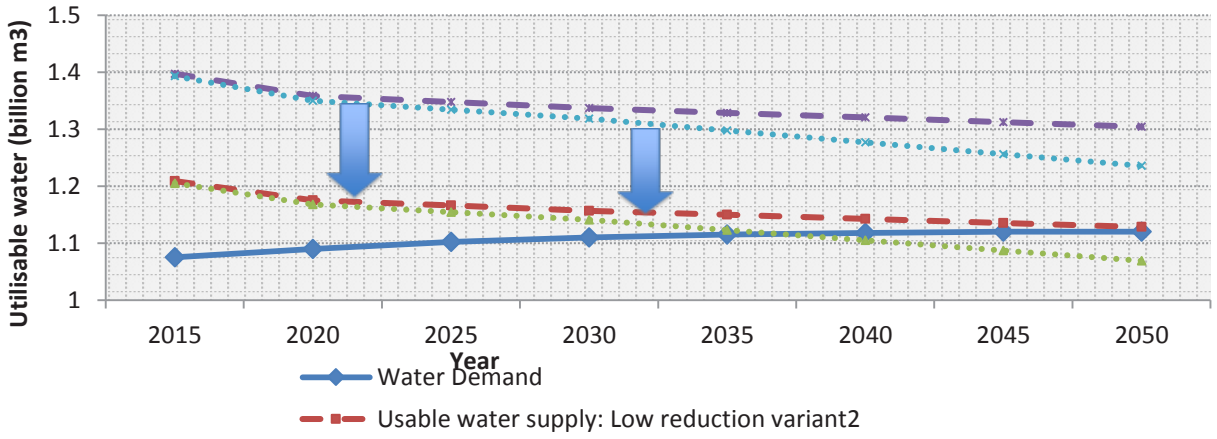
The various climate change-related impacts *observed* in the water sector in Mauritius (GoM, 2012) are:

i) a decreasing trend in annual precipitation of about 8% when comparing 1951-1960 and 1998-2008 figures

ii) an increase in rainfall variability with heavy rainfall events on the rise

iii) the duration of the transitional dry months between winter and summer is becoming longer. This shift in the onset of summer rain translates into increasing pressure on the water sector to enhance storage capacity in order to cater for longer periods of dry spells and to meet equally growing demands of the agricultural, tourism, industrial and residential sectors the Central Plateau, with the largest catchments in the common recharge zones, has seen a significant decrease in water level which is reflected in changes in ground water and river-flow regimes.

Projections indicate that the utilisable water resources may decrease by up to 13% by 2050, if no action is taken to restore catchment areas (Figure 3.4). This trend in the reduction of surface and groundwater recharge may be explained by a reduction in the longer term trend in precipitation (GoM, 2013). Analysis carried out in the context of the Mauritius Environment Outlook 2011 shows that the total water demand is projected to reach 1 200 million m^3 per year by 2040 based solely on changes in population dynamics. This demand, which does not take into account water demand from other growing sectors of the economy, is in excess of projected supplies and close to the present utilisable renewable potential of 1 233 million m^3 per year (GoM, 2012).



Source: Government of Mauritius (2012)

Figure 3.4: Water demand and usable water supply under two different climate change scenarios

3.2.3.2 Adaptation policies

In order to address the challenges posed by water scarcity and progress towards reaching national development goals, GoM, in collaboration with other relevant entities, will implement relevant policies (Table 3.6).

Table 3.6 Adaptation policies aimed at reducing vulnerabilities in the water sector

Action proposed	Means of implementation and expected results
Reduce vulnerability to climate change	The objective may be achieved by fully developing the potential for integrated water resources management in order to maximize preparedness against extreme events (before and after their occurrence), and reduce the impacts of climate change (e.g. salt water intrusion). Interventions may include the development of hydrological models, modernisation of data acquisition and management, and regular maintenance of catchment areas that includes weeding and forest maintenance, thereby improving ecosystem health and reducing soil erosion, as well as improving the combined use of . surface r and ground water
Ensure water availability	The objective may be attained by intervening on both demand and supply. including the rationalisation of water rights. Interventions in the short-term include the introduction of incentives for increasing water efficiency. This could be coupled with activities aimed at enhancing and sustaining ecosystems, increasing usable water supply and ensuring natural filtration. These activities would lead to synergies with biodiversity and tourism sectors
Foster water efficient economic activities	This activity may lead to the growth of new sectors (in addition to improving the efficiency of water use in existing ones) through the monitoring of data to better identify areas where the potential for expansion exists. Location optimisation may be coupled with the expansion of independent water storage capacity to increase the resilience of economic activities

The implementation of VAA strategies (Table 3.7) is expected to reduce water scarcity, by increasing supply and improving efficiency of use. In so doing, the water sector will turn from being a potential constraint to development to an enabler of inclusive growth, through interventions that value natural capital and favour the adoption of new technologies.

Table 3.7 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the water resources sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	**To create new opportunities**
Water	i) Degradation of ecosystems and water quality ii) Growing demand and constrained supply (water scarcity) iii) Increased vulnerability to climate change	Reduce vulnerability to climate change	**W1.** Fully develop the potential of integrated water resources management	
		Ensure water availability and water quality	**W2[1].** Increase water use efficiency	**WN2[2].** Enhance and sustain ecosystems
		Foster water efficient economic activities	**W3.** Expand water storage	**WN3.** Preserve, upgrade and increase water monitoring and data analysis

Note[1]: W2 etc. refer to proposed strategies to address current problems
Note[2]:WN2 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the w*ater resources* sector are given in Annex 4.

3.2.4 Biodiversity

3.2.4.1 Climate change vulnerabilities

The flora and fauna of Mauritius has a relatively high level of diversity and endemism as a result of the island's location, age, isolation and varied topography. Mauritius has 691 flowering plant species of which 273 are single island endemics and another 150 are Mascarene endemics (Baider et al., 2010). About 9% of endemic plants are extinct and nearly 200 of the surviving plants are red-listed according to the International Union for the Conservation of Nature (IUCN) (Strahm. 1993). The island supported 28 land birds, 17 reptiles and 3 fruit bats besides insectivorous bats, snails and insects. A suite of these species are globally, regionally or locally extinct, resulting in an impoverished but yet globally important endemic animal assemblage that includes for example, nine endemic land birds (Box 3.2), 11 endemic reptiles, one fruit bat, the insectivorous bats and much fewer insects and snails.

Box 3.2 An endemic bird of Mauritius

Mauritius kestrel (*Falco punctatus)*

Mauritius Kestrel (*Falco punctatus*) which is endemic to Mauritius was once considered the most endangered bird in the world, with numbers down to six birds in 1974. The most severe decline was in the 1950s and 1960s due to indiscriminate DDT use and invasive species like cats, mongooses and crab-eating macaques which killed the kestrels and their eggs. However, the bird was rescued from the brink of extinction through intensive conservation efforts and it has now increased to 300 individuals, and is one of the great success stories in species recovery programmes. The Mauritius kestrel feeds primarily on lizards, large insects and small birds.

Credit (photo): Jacques de Speville
Source: Mauritius Wild Life Fund

The importance of biodiversity has been recognised for at least two centuries, but more so since the 1970s. This culminated in major efforts to avert extinctions of plants, birds and reptiles, and to restore their habitats. Besides their importance in sustaining biodiversity, forests play a key role in providing ecosystem services such as carbon sequestration, water regulation, flood control and soil protection. Ecosystems restoration represents one of the most effective mitigation and adaptation measures against the impacts of climate change.

The various climate change-related impacts *observed* in the biodiversity sector in Mauritius are:

(i) change in rainfall pattern on the East coast of Mauritius over a 40-year period may have affected the breeding success and productivity of Mauritius kestrels (*Falco punctatus)* (Senapathi, 2009)

(ii) Increasing frequency of storms of tropical cyclone strength or higher may have affected the hatchability and chick survival of Round Island petrels (*Pterodroma arminjoniana)* (Tatayah, 2006; Nicoll et al., 2016)

(iii) El Nino Southern Oscillation, likely affecting the proportion of Round Island petrel chicks fledging and recruited into the breeding population (Tatayah 2006; Nicoll et al., 2016)

(iv) endemic birds feed on flower buds, flowers, fruits and young leaves of native food plant species (Rane, 2005). Changes in local climate coupled with habitat loss and degraded habitats and the scarcity of natural foods in the Mauritian native forests are strongly suspected to influence the biological cycles of native fauna and flora and to have led to the decline in the endemic birds of Mauritius (Cheke & Hume, 2008). Further adverse impacts of the projected climatic change may lead to additional decline in native fauna and flora.

The most relevant direct *future impacts* of climate change on biodiversity include:

i) temperature rise that may lead to greater proliferation of invasive alien species at the expense of native species, although some endemic plants may have enough resilience to be able to cope with climate change

ii) more severe droughts that may lead to loss of native forests and cause increasing stress to animals

iii) increasing susceptibility of forests to wild fires causing degradation to ecosystems

iv) reduction in pollinator abundance and distribution due to climatic stresses may lead to disrupted pollination systems, hence reduced native plant viability

v) decrease in pollinator activity due to shifts in plant phenology

vi) high intensity rainfall that may lead to soil erosion and soil acidity, affecting endemic plants

vii) sea level rise that may cause loss of shoreline, and adversely affect coastal vegetation, turtle nesting, and wader visitation on low lying islets.

3.2.4.2 Adaptation policies

In order to address the challenges posed by the loss of biodiversity and degradation of ecosystems and reduced ecosystems services, and progress towards conserving and increasing biodiversity, GoM, in collaboration with other relevant entities, including NGOs involved in conservation activities, will adopt suitable adaptation policies (Table 3.8).

Table 3.8 Adaptation policies related to reduction of vulnerabilities of terrestrial biodiversity sector

Action proposed	Means of implementation and expected results
Significantly increase the restoration of native forests, or recreate native forests	Such activities will conserve biodiversity and improve ecosystems services such as regulation of water supply, soil conservation and air quality
Increase ex-situ conservation of plants	Undertaking such actions may serve as a safety measure against extinction, and provide plants for reintroduction into native forests
Increase native animal reintroduction and in-situ management	This activity may reduce risks of decline or extinction of animals and reinstate plant-animal interaction
Expand and improve protected areas	The purpose is to promote the creation of a functional corridor ecosystem
Promote the creation of local capacity	This could be carried out by undertaking research on the effects of climate change on biodiversity, and on the impacts of measures to address these effects
Conduct ecosystems valuation	This objective may be achieved by promoting the importance of biodiversity and mainstreaming of biodiversity

The implementation of VAA strategies (Table 3.9) is expected to reduce vulnerability of biodiversity to climate change, improve ecosystems services, support eco-tourism and provide forests for the enjoyment of the population and visitors.

Table 3.9 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the terrestrial biodiversity sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
Terrestrial biodiversity	i) Continuous decline in quality of habitats due to invasive alien species ii) Decline in native forest acreage due to development pressure iii) Ecosystems services increasingly compromised iv) Poor policy and enforcement of conservation laws v) Growing impacts of climate change	Exploit synergies (water, soil, leisure, inland tourism, biodiversity protection)	**B1[1].** Catchment areas: eradication of invasive species	**BN1[2].** Reintroduction of native plants in planted forests
		Maintain terrestrial biodiversity	**B2.** Restoration of native forests	**BN2.** Expansion and improvement of protected areas
		Resilience to climate change (e.g. cyclones)	**B3.** Enforce ESAs policies	**BN3.** R&D on impacts of climate change and benefits of native forests

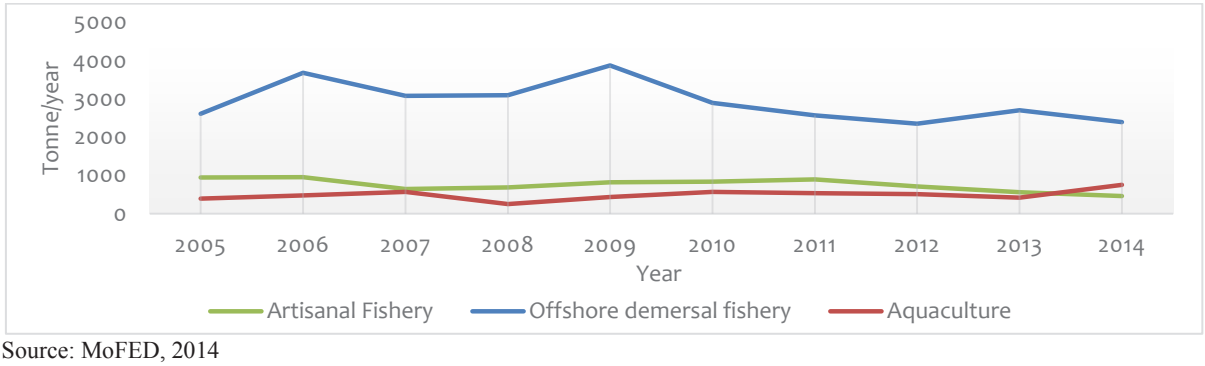
Note[1]: B1 etc. refer to proposed strategies to address current problems
Note[2]:BN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the b*iodiversity* sector are given in Annex 5.

3.2.5 Fisheries

3.2.5.1 Climate change vulnerabilities

There are four main types of fisheries in Mauritius, namely: *coastal/artisanal, aquaculture, offshore demersal, and tuna*. In 2014, total fish production was 12 329t, representing a decrease of around 13% over the previous year (14 222t). As shown in Figure 3.5, coastal/artisanal catch was 1 649t in 2014 compared to 1 749t in 2013, representing a decrease of 6%. Other catch (aquaculture, offshore demersal, and tuna) decreased by 13% from 9 838t in 2013 to 8 625t in 2014 (MoOEFSOI, 2016). The fisheries sector in Mauritius employs an estimated 5 000 people with around 2 038 registered fishers in 2014 and the total domestic production in the sector is valued at MUR 1000 million (ASCLME 2012).



Source: MoFED, 2014

Figure 3.5 Fish catch by type of activity except for tuna (2005-2014)

The main critical ecosystems include mangroves, seagrass beds and coral reefs. In Mauritius there are 159 species of scleractinian corals, two species of mangroves covering 145 ha (MoESD, 2009), 1 656 species and 290 families of marine species, some 340 species of fish out of which 42 are of economic importance, over 400 species of seaweeds (Bolton *et al.* 2012), and nine species of seagrass. Existing stresses on fisheries include fishing pressure, decreasing habitats and pollution including those arising from ballast water. These stresses are likely to be exacerbated by climate change which may cause local shifts in production, altered growth rates, and stock migration.

Box 3.3 Mangrove propagation around the coast–A public, private, NGO and local community partnership

Public-private-NGO-local community partnership in mangrove propagation

In 1980, the area under mangrove forest was only 45 ha following gradual removal to accommodate settlement and agriculture. A *Mangrove Propagation Programme* was implemented by the national authorities from 1995 to 2008 and the area increased to more than 145 ha. Non-State actors were encouraged to continue implementing the Programme in several coastal regions that were then still undergoing degradation. A few NGOs participated in the Programme.

In February 2008, the Association pour le Développement Durable (ADD), a non-profit environmental NGO, planted one hectare of mangrove at Le Morne, involving the local community (Figure 3.6) within the framework of the EU-funded Decentralized Cooperation Programme. Training and advice on mangrove planting and maintenance was provided by the Albion Fisheries Research Centre (AFRC).

In February 2011, the MCB Forward Foundation, established by a private bank, in the context of its Corporate Social Responsibility, provided some funding to ADD to extend the Le Morne mangrove by another four hectares and a further 3ha at Case Noyale in 2013 and 2014, respectively. In all ADD has planted about 100 000 seedlings (10ha) around Mauritius coasts.

The area under mangrove plantation now stands at 181 ha. Other mangrove projects are planned (Annex to Chapter 11/Mangroves)

Source:Association pour le Dévelopment Durable (2015)

Figure 3.6 Villagers planting mangrove propagules at Le Morne

The fisheries sector is indirectly influenced by climate change. Observed dynamics include variations in meteorological parameters (e.g. water temperature and ocean acidification) that affect ecosystem, which eventually disturb fisheries dynamics. This is relevant because Mauritius has a lagoon area of around 243 km^2 with two Marine Parks and six Fishing Reserves, known to be highly diverse and very productive. These areas remain relatively shallow, making ecosystem health vulnerable to climate change.

The increased sea surface temperature (SST) are mostly responsible for coral bleaching that reduce coral biodiversity and fish species, with only resilient species surviving. Mass coral bleaching were observed in 1998, 2003, 2004, 2009 and 2015 and are projected to occur more frequently. Algal blooms due to high SST and nutrient rich seepage into lagoons are known to be the cause of mass mortality of corals and fish. More frequent and intense rainfall is expected to cause increased sedimentation of the lagoons thus smothering the corals. Mangroves will be impacted by climatic change as well, leading to a reduction in fish reproduction and fish stocks. MoESDDRM, in collaboration with NGOs, is actively involved in the propagation of mangrove around Mauritius and Rodrigues

(Box 3.3) Overall, the assessment of climate change impacts on fisheries remains complex due to the simultaneous presence of anthropogenic and other non-climate-related stresses. Both of these factors affect habitat and the exploitation of the resource. As fisheries contribute to GDP, the socio-economic implications of climate change on fisheries are expected to be significant in Mauritius.

3.5.2.2 Adaptation policies

In order to address the challenges within the fisheries sector and progress towards reaching national development goals, GoM, in collaboration with other relevant entities is committed to adopt policies aimed at reducing the vulnerability of the sector (Table 3.10).

Table 3.10 Adaptation policies related to the reduction of vulnerabilities of fisheries sector

Action proposed	Means of implementation and expected results
Improve the health of marine ecosystem	The improvement could be achieved by (a) strengthening governance and the enforcing existing legislation regarding marine protected areas, and (b) expanding the protected areas to places which are sensitive and vulnerable to climate change. The rehabilitation and expansion of sensitive coastal habitats such as corals, seagrass and mangroves could be also undertaken
Adopt and promote sustainable fishing practices	This could be carried out through the provision of incentives to promote entrepreneurship for sustainable aquaculture and by encouraging and enabling fishers to fish outside lagoons
Improve the capacity of institutions and fishers in understanding and managing the marine ecosystem	This could be achieved through the sensitisation of fishers over the effects and impacts of climate change over the resources and through an improved and harmonised monitoring of the marine environment

The implementation of the VAA strategies (Table 3.11) is expected to reduce the loss of marine habitat and thus improve landings and the competitiveness of the fisheries sector and, in so doing, improve livelihoods in the coastal areas.

Table 3.11 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the fisheries and marine biodiversity sectors

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
Fisheries and marine biodiversity	i) Loss of marine habitat ii) Reduced landings and competitiveness of the sector iii) Disruption of livelihoods in coastal areas	Improve the health of marine ecosystem	**F1.** Expand protected areas and improve governance and enforcement	**FN1.** Rehabilitation and expansion of coastal and marine habitats
		Adopt sustainable fishing practices	**F2.** Incentivise aquaculture	**FN2.** Incentivize fishing outside of the lagoons
		Improve capacity of institutions and fishers	**F3.** Sensitisation of fishers	**FN3.** Improve the monitoring of coastal areas and harmonise monitoring methodology

Note[1]: F1 etc. refer to proposed strategies to address current problems
Note[2]: FN1 etc. refer to strategies for creating new opportunities while addressing the current problems

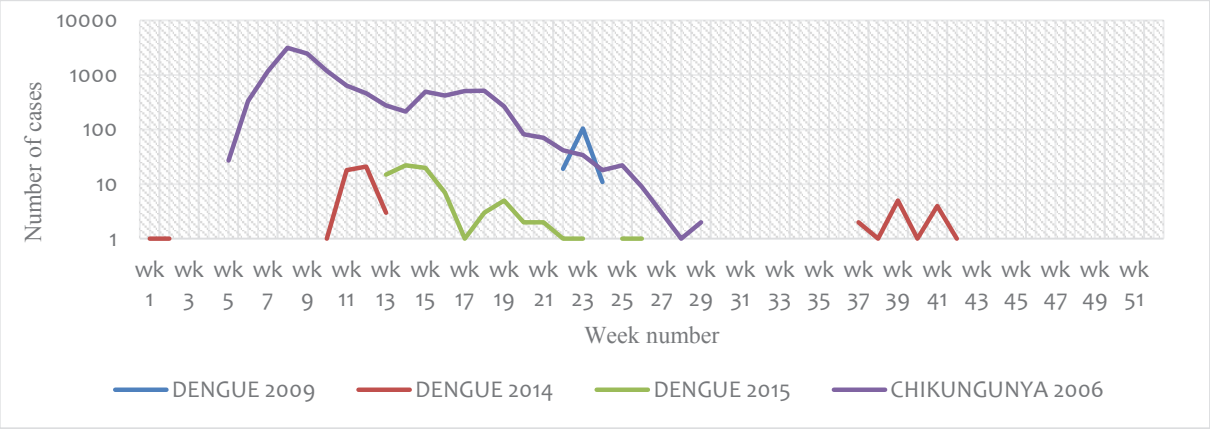
An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *fisheries* sector are given in Annex 6.

3.2.6 Human health

3.2.6.1 Climate change vulnerabilities

The end-determinant of the extent of health impacts of climate change on development is the interplay of geography, political governance, health infrastructure and socio-demographic profiles. Since these factors vary over time and space, different regions of the world will be differently impacted by the health consequences of climate change. As Mauritius does not have a landmass for re-locating vulnerable population, it may be disproportionately impacted.

Globally, a number of health conditions have been linked to climatic risk factors such as heat waves leading to stroke; rise in diarrheal diseases and vector-borne diseases like malaria and dengue; food insecurity; water insecurity, and malnutrition (WHO, 2015). Mauritius is prone to both local and imported cases of dengue and chikungunya viral fevers. Circumstantial information links the rise in temperature in Mauritius to increase in vector-borne diseases. For example, an increase in vector-borne diseases was observed for the first time in 2006 with an epidemic of some 9 000 cases of chikungunya fevers. This was followed by epidemics of dengue observed for the first time in 2009 recording some 300 cases island-wide with successive outbreaks in the years 2011, 2014 and 2015 (Figure 3.7). These outbreaks coincided with the gradual increase in temperature from 1950 to 2005 as observed by the Mauritius Meteorological Services (Ministry of Health health statistics report for 2015). These circumstantial evidence taken against the globally-projected dengue rise (Fock, 1995) argues for climate change as a possible cause of vector-borne diseases in Mauritius.



Source: Ministry of Health and Quality of Life

Figure 3.7 Occurrence of epidemics of vector-borne diseases

Additional circumstantial evidence is obtained from observations on climate-sensitive diseases that include the annual occurrence of episodes of conjunctivitis and gastroenteritis in the summer months and annual cases of respiratory diseases in the winter months. For example for the period 2010 to 2015, an average of 35 000 cases of gastroenteritis and some 600 000 cases of respiratory diseases were registered annually. Additionally, for the same period of observation, some 2 500 cases of mental illness were also noted. These observations highlight the high prevalence of climate sensitive diseases that may be amplified by climate change.

Climate change may increase the vulnerability of the health sector in the coming decades leading to higher disease burden with associated health cost and impaired socio-economic development. Climate change may lead to an increase in communicable diseases and may exacerbate the effects of the already high prevalence of non-communicable diseases that is affecting some 80% of the population. Climate change may lead to an increase of communicable diseases and exacerbate the effects of the already high prevalence of non-communicable diseases. The net effect may be an increase in the rate of cardiovascular diseases, strokes and renal diseases thus creating a situation of double burden of communicable and non-communicable diseases, including injuries and worsening of nutrition and food security. The health sector will bear spill-over effects from other sectors, for which preventive action is needed.

3.2.6.2 Adaptation policies

In order to address the challenges posed by the health impacts of climate change and concomitantly attain the Sustainable Development Goals by 2035, GoM, in collaboration with other relevant entities, may adopt a three-pronged approach (Table 3.12).

Table 3.12 Adaptation policies related to reduction of vulnerabilities of coastal areas and tourism sector

Action proposed	Means of implementation and expected results
(i) Strengthen climate-resilient health systems	This is essential for enhanced preparedness to cope with the anticipated surge in burdens from climate-sensitive diseases such as vector-borne diseases, respiratory and diarrheal diseases; diseases and injuries associated with extreme events; worsening of food security and nutrition, and mental health disorder including post-traumatic stress. Anticipated strategies will include expansion and strengthening of new public health infrastructure, development of public policy as well as institutional and professional capacity development

(ii) Strengthen preventive measures to avert disease burden attributable to climate change	This objective may be achieved through enhanced surveillance in the form of early warning system for the monitoring, surveillance and management of health events. A series of actions could include (a) contingency planning, (b) identification of vulnerable exposed communities for monitoring, forecasting and predicting possible adverse health effects, and (c) the adoption of healthy life-style and nutrition habits by promoting health promotion strategies
(iii) Target response for triggering effective and timely response	In order to reduce the incidence of morbidity and mortality from disease burden associated with climatic changes, action could include (a) dedication of trained health care workers (b) procurement of essential medicines, emergency supplies kits, and (c) expansion of possible range of currently available vaccines.

The implementation of the VAA strategies (Table 3.13) is expected to reduce vulnerability to climate change, and decrease morbidity and mortality. The avoided cost of these strategies includes reduced health expenditure and private insurance premium or out of pocket expenses for the vulnerable. The resulting added co-benefits include increase in life expectancy and a healthy population. These benefits amy catalyse economic growth and social stability.

Table 3.13 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the health sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
Health	i) Increase in climate-sensitive-vector-borne and epidemic-prone diseases ii) Extreme events and related health impacts (e.g. respiratory and epidemic diseases) iii) Disaster-induced injuries and diseases iv) Worsening of nutrition and food security and safety	Strengthen climate-resilient health system for preparedness	**H1.** Strengthen infrastructure to monitor and control diseases and manage patients	**HN1.** Formulate climate-sensitive public health policy
		Strengthen preventive measures to avert disease burden attributable to climate change	**H2.** Surveillance of diseases, monitoring of vector density and abnormal levels of climate-sensitive environmental hazards	**HN2.** Health promotion for education, risk communication and dissemination of information on preventive strategies
		Targeted response for triggering timely response to reduce incidence of disease, morbidity and mortality	**H3.** Train and dedicate staff for managing increase in disease burden attributable to climate change	**HN3.**Stock piling of medicine and essential medical supplies

Note[1]: H1 etc. refer to proposed strategies to address current problems
Note[2]:HN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *human health* sector are given in Annex 7.

3.2.7 Infrastructure

3.2.7.1 Climate change vulnerabilities

Mauritius has 560 km² (30%) of built-up areas that include roads and reservoirs. The main components are given in Table 3.14.

Table 3.14 Main components of the infrastructure sector

Component of infrastructure	Description
Land transport	Road transport relies on a road network aggregating 2 100 km out of which 49% are main roads, 29% are secondary roads, 4% are motorways and the remaining 18% are unclassified roads
Electricity supply	The total supply reached 3 000 GWh in 2014, out of which around 80% was generated from non-renewable sources (fossil fuel). Electricity is transmitted almost exclusively by overhead cables
Water resources	Water resources are harnessed through 11 reservoirs aggregating a storage capacity of 91 Mm³ and are used for power generation (275 Mm³/year); for domestic, industrial and tourism consumption (250 Mm³/year); and, for agriculture (375 Mm³/year)
Building infrastructure	The building infrastructure includes 396 400 residential units, 6 600 industrial buildings, 41 000 commercial buildings and 600 unclassified buildings

The various climate change-related impacts *observed* on these infrastructural assets are given in Table 3.15.

Table 3.15 Observed impacts of climate change on infrastructure

Effects of climate change	Observed impacts on infrastructure
Temperature rise at a rate of approximately 0.20^0C per decade	This may lead to accelerated softening and deterioration of bituminous pavement, formation of surface and thermal cracks in concrete, increased corrosion of steel, soil shrinkage, more evaporation from reservoirs and lakes and higher demand for domestic water and power, resulting from extended use of air conditioning
Increase in rainfall intensities coupled with a decline in total annual rainfall volume	This element often leads to soil erosion, landslides and flood. Soil erosion in turn leads to scouring of foundations and collapse of embankments, and landslides cause the destruction of buildings and road infrastructure. Floods inundate properties, buildings and water treatment plants, causing damage to infrastructure and fixtures, and the degradation of water quality, leading to serious health hazards. A decline in the total annual volume of rainfall may also leads to decreased water supply for domestic use, power generation, and irrigation
Storms or intense cyclones	Such storms cause damage to roads, buildings and power transmission masts
Sea level rise coupled with storm surges	These parameters often cause flooding of coastal roads and their temporary closure, erosion and washing away of coastal structures and salt water intrusion into the coastal water supply aquifer

The climate-related impacts observed so far are likely to persist, and worsen, when considering future temperature increase and rainfall variability.

3.2.7.2 Adaptation policies

In order to address the challenges posed by climate change impacts on the infrastructure sector, GoM, in collaboration with other stakeholders (investors, sponsors, private equities, funding agencies), may actively enforce adaptation policies with a view to incorporating successful, energy efficient and sustainable design parameters into the design of buildings and infrastructure (Table 3.16).

Table 3.16 Adaptation policies and strategies relating to structural measures

Structures	Adaptation measures and strategies
Coastal infrastructure	The adaptation measures include wave breakers at sea and flood wall on the coastline to protect vulnerable on-land infrastructure, raising existing wharfs to lessen inundation by sea surges and building elevated roads or relocating coastal roads more inland (Box 3.4)
Transport infrastructure	The set of structural measures include increasing the carrying capacity of existing road-side drains to cope with more intense floods, re-dimensioning new drains, raising existing bridges and culverts to cope with higher flood level, increasing the drainage base layer under roadways to counter increased pore pressure due to rise in water table, reinforcing the wearing surface of roadways by the use of fabric reinforcement to cope with increased stress due to temperature rise, and re-designing of road furniture items such as direction and safety signage and road-marking
Buildings	The measures include protection of existing buildings by replacing cladding, flooring and linings with water resistant materials and constructing levees or floodwalls around them, incorporating energy efficient materials and components into the construction of new buildings, constructing ground floors at higher levels, encouraging natural ventilation and air conditioning optimisation through the use of reflective roofing paints or green roofs, and high performance glazing to reduce the rate of heat transfer into building structures

Box 3.4 Coastal adaptation measures to protect vulnerable coastal infrastructure

Soft and hard engineering measures to adapt to climate change

White sandy beaches are the main assets for the tourism industry, one of the main economic pillars of RoM. Accelerated sea level rise and more intense tropical cyclones and sea swells are increasingly causing deterioration of beaches and damage to coastal roads and other infrastructures. A soft measure has been used to rehabilitate a degraded beach Figure 3.8 (left) and, a hard measure has been applied to protect a coastal road Figure 3.8 (right).

Source: MoESDDBM

Figure 3.8 (left) Beach nourishment at La Preneuse and (right) Rock revetment for shoreline protection at Baie-du-Cap

Other structural measures may include sedimentation basins and filter drains to settle transported silt and exclude pollutants, on-site flood attenuation/retardation basins to depress the peak of flood, energy dissipators to reduce

flow velocity on hilly terrain and prevent erosion, river training to enhance flow velocity on flat terrain, and prevent backflow of water into properties. Some non-structural measures envisaged by GoM are given in Table 3.17.

Table 3.17 Adaptation policies and strategies relating to non-structural measures

Non-structural measures	Adaptation measures and policies
Management schemes on how to transport storm water	The storm water would be transported from residential areas as quickly and safely as possible, so flooding is controlled
A manual on procedures with hands-on advice on planning methods and management techniques for Government officials	Reduce the amount of runoff by increasing porous zones and reducing paved areas
	Develop integrated storm water and storm retardation management schemes such as treatment systems to remove suspended solids and phosphorus from storm water, prevent sedimentation of streams and establish an erosion control plan
	Increase public awareness on the need to maintain drains free of dumped waste and waterways free of unauthorised construction
	Restrict urbanisation to areas physically capable of a specific type of land development so as not to cause soil erosion or sedimentation or unjustified inconvenience, harm or health hazards to inhabitants
	Efficient operation and maintenance of energy systems
	Re-vegetation to increase ground cover and infiltration
Reviewing of design standards	Include higher factors of safety to account for climate change impacts such as wind loading, flood return periods and probable maximum floods
Research and development of innovative, eco-friendly and technically and economically sound building materials	Make better use of renewable energy, and promote energy efficiency

The implementation of VAA (Table 3.18) strategies is expected to reduce vulnerability to climate change by protecting existing infrastructures and incorporating more stringent materials and design criteria to new infrastructures, thereby protecting the population and the environment alike.

Table 3.18 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the infrastructure sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
Infrastructure	(i) Frequency of floods and landslides ii)Increased expenditure for maintenance (iii) Economic competitiveness and social well-	Increase infrastructure resilience	**IS1.** Upgrade drains, assure frequent maintenance	**ISN1.** Use of climate resilient materials and techniques (e.g. water-draining road pavement)
		Implement integrated landscape planning	**IS2.** Improve landscape management (slow water time of travel)	**ISN2.** Collection and use of topographic, hydrological and climate-related data in infrastructure planning (e.g. elevated roads and

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
	being			buildings)
		Improve awareness and capacity	**IS3.** Implement real time warning system for infrastructure failure	**ISN3.** Improvement of institutional capacity

Note[1]: IS1 etc. refer to proposed strategies to address current problems
Note[2]: ISN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *infrastructure* sector are given in Annex 8.

3.3 Cross-sectoral considerations

Climate change is expected to impact, directly and indirectly, on various social, economic and environmental sectors. As a result, achieving national development goals would remain more challenging, if adaptation measures across all sectors are not properly addressed. If coherent action is taken by coordinating efforts across sectors, synergies can be found that will not only mitigate expected negative impacts, but will turn them into new opportunities. Some of the measures were highlighted in sectoral sections 3.2.1 to 3.2.7. Cross-sectoral considerations (Table 3.19) are now taken into account to identify and highlight entry points for interventions that will lead to increase efficiency of budget allocation and policy implementation.

The strategies that more markedly contribute to the overall development include capacity building and awareness-raising, along with improved data collection and analysis. In addition, ecosystem restoration (terrestrial and marine) was identified as an ideal intervention in six of the seven sectors analysed. The main benefits identified when considering cross-sectoral dynamics include a reduction in public spending (with several instances in which avoided costs emerge) along with an increase of public revenues (e.g. tax revenues, through increased economic activity); employment creation (across all sectors and interventions); improved well-being (with better health and a reduction of injuries and diseases); and an amelioration of leisure opportunities (both for the local population and for tourists). The following paragraphs highlight in more details some of the more outstanding opportunities emerging from cross-sectoral linkages.

(i) *Agriculture*

The adoption of bio-, smart and ecological agriculture practices, in addition to the adoption of IPDM techniques, reduces the runoff of chemical fertilizers and pesticides, leading to an improvement of water quality and coastal habitat, and also to a better food quality and health. Further, policies implemented in other sectors can have a positive impact on the agricultural sector. These include the development of climate-resilient infrastructure; and, awareness-raising activities that can increase the demand for organic products, and lead to the creation of a new domestic market as well as to the development of export opportunities.

(ii) *Coastal areas and tourism*

The restoration of wetlands is critical for fisheries and for the protection of infrastructure from storms and sea level rise. The replenishment of dunes prevents the salinization of rivers, and the development of eco-tourism fosters investments in biodiversity conservation. Policies implemented in other sectors can have a positive impact on coastal sector and tourism, and may include the integrated management of fisheries. Such an approach may improve the health of coastal ecosystems, and enhance investments in resource efficiency (through R&D and infrastructure) and lead to a reduction in ecological footprint of coastal resorts.

(iii) *Water*

The protection and restoration of water catchment areas can have positive impacts both on agriculture because of a reduction in costs associated with water pumping, and on biodiversity because of the value that freshwater ecosystems have on biodiversity conservation. Reducing sedimentation may decrease the costs associated with infrastructure maintenance and coastal erosion which, in turn, negatively impact coastal areas and tourism. Activities aimed at increasing awareness on water consumption can lead to a reduction in costs for households and the tourism sector. On the other hand, desalination has to be carefully assessed due to the potential consequences on coastal areas and lagoons. Further, policies implemented in other sectors can have a positive impact on the water sector. For example, the adoption of smart agriculture practices can reduce the amount of water needed for irrigation and reduce chemical contamination of underground aquifers by leaching.

(iv) *Biodiversity*

The eradication of invasive species in catchment areas has positive impacts on freshwater quantity and quality; the expansion of protected areas is expected to positively affect tourism; and, R&D on the benefits of native species for climate resilience has the potential to support bio-farming and agro-forestry. Policies implemented in other sectors can have a positive impact on the biodiversity sector and may include the reduction of fertilisers and pesticides that negatively impact species diversity, and the adoption of integrated land use planning (with a reduction of land conversion).

(v) *Fisheries*

The rehabilitation and expansion of coastal and marine habitats support biodiversity conservation, and hence improved leisure activities and tourism. The improvement of governance for protected areas incentivises eco-tourism, and the improvement in the monitoring of coastal areas can reduce climate-related impacts on infrastructure. Policies that have cross-sectoral advantages include the integrated management of coastal ecosystems that benefit fish stocks, tourism and other leisure activities. Another area of intervention that benefits the fishery sector is the management of terrestrial biodiversity, as well as the utilisation of sustainable agriculture practices, averting the increasing challenges being faced for coastal livelihoods.

(vi) *Health*

The upgrading of the health system for the monitoring of climate-sensitive disease surveillance and food security would benefit households and the tourism sector, in addition to the private sector (through higher labour productivity). Policies implemented in other sectors can have a positive impact on the health sector. These may include better water and land use management and may avoid the growth of carriers of vector-borne diseases.

(vii) *Infrastructure*

The use of climate-resilient materials and techniques can decrease the health risks associated with natural hazards. The restoration of landscape integrity can benefit biodiversity; and, the upgrade of drains can improve water quality.

A better management of water (e.g. restoration of water catchment areas) can reduce flood and damage to infrastructure, and the restoration of marine habitat can reduce coastal vulnerability.

Table 3.19 Policy interventions and their inclusion in sectoral strategies

	Sustainable land use planning	Ecosystem restoration	Resource efficiency	Integrated water management	Climate resilient infrastructure	Eco-tourism	Institutional capacity and support	Awareness raising	R&D and data analysis
Agriculture	√	√		√			√	√	√
Coastal areas and tourism	√	√	√	√	√	√		√	√
Water		√	√	√				√	√
Biodiversity	√	√				√		√	√
Fisheries	√	√					√	√	√
Health					√		√	√	√
Infrastructure		√		√	√	√	√	√	√

CHAPTER THREE-B

CHAPTER 3B VULNERABILITY ASSESSMENT AND ADAPTATION (RODRIGUES)

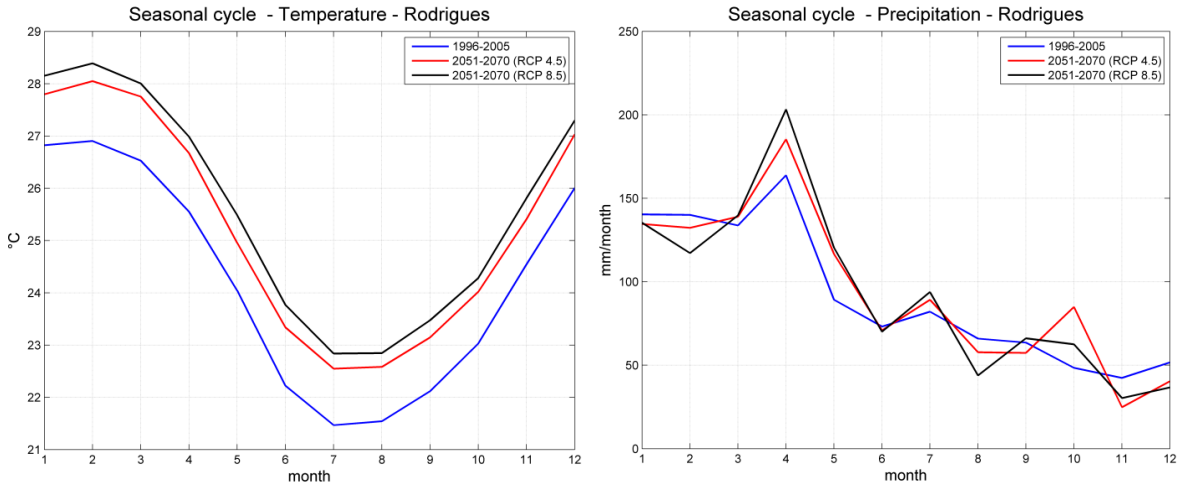
3.4 Introduction

Rodrigues, as part of RoM, occupies an area of 108 km² and is the smallest and probably the oldest of the Mascarene Islands. Just like Mauritius and the other outer islands, the impacts of climate change are noticeable. These include the increasing frequency of droughts, the growing variability of other extreme climatic events, including severe cyclones and flooding, and rising sea level.

3.5 Climate trends to the year 2070

Changes in Rodrigues are evident when reviewing historical data on temperature, precipitation and sea level rise. Over the period 1961 to 2014, the mean maximum temperature has increased by 0.023^{0}C and the mean minimum temperature by 0.016^{0}C. Rainfall records show a downward trend when compared to the data of the 1960's. Sea level rise has been accelerating and the rate as from 2003 is 5.1 mm/year with adverse effects on coastal resources. Port Mathurin may be at risk of being inundated with serious consequences for some 1800 coastal dwellers (GoM, 2015) and the infrastructure.

Climate change projections for the period 2051-2070 show an increase in temperatures of 0.9^{0}C to 1.4^{0}C and of 1.3^{0}C to 1.6^{0}C for two climate scenarios, relative to the period 1996-2005 (Figure 3.9, left). Concerning rainfall, the interpretation of the model projections is quite complex as no clear long-term-trend could be identified. However, wide variations emerge across seasons, with a projected decrease in rainfall over the summer months and a likely increase over the transition months of May and October (Figure 3.9, right).



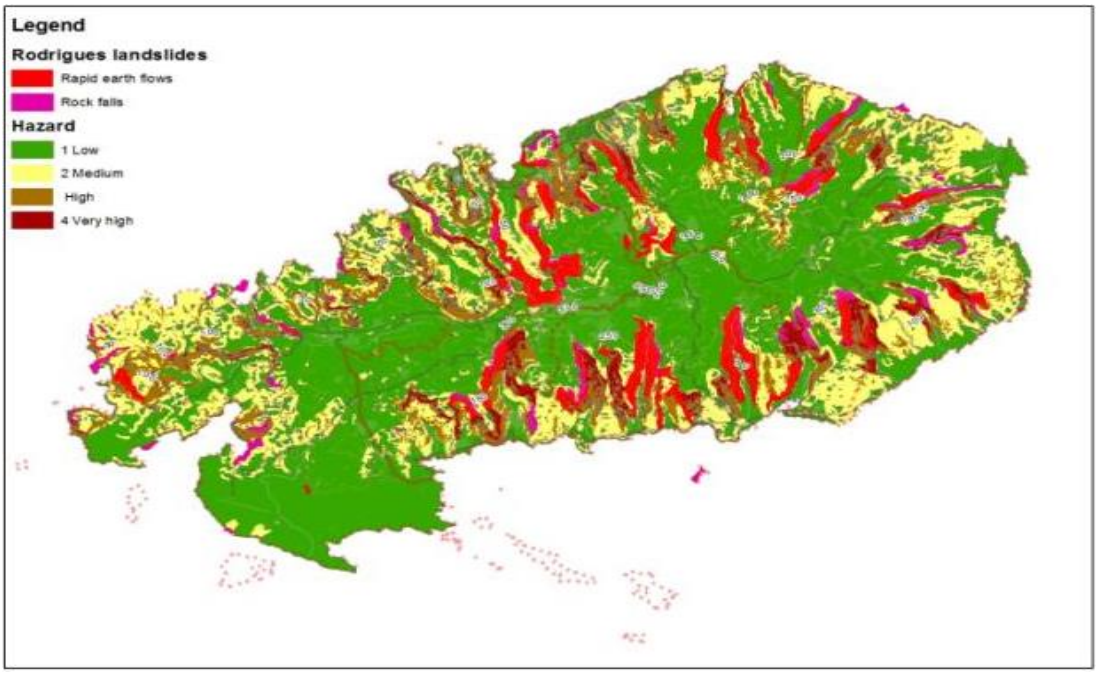
Source: DRR (2013)

Figure 3.9 Seasonal cycle of temperature (left) and precipitation (right) for Rodrigues, comparing observations with projections for the period 2051 to 2070, for two climate scenarios

3.5.1 Vulnerability

Several elements of vulnerability to climate change have been observed in Rodrigues, including increased frequency of landslides, floods and inundations. The estimation of landslides presented in the DRR report for Rodrigues was

obtained by applying digital terrain models to geological, soil map and land use data (GoM, 2013). This study found that the observed increase in frequency of extreme weather events has led to floods, soil erosion and landslides. Soil erosion in turn leads to scouring of foundations and collapse of embankments, and landslides cause destruction to buildings and road infrastructure. Figure 3.10 shows a map of Rodrigues indicating the locations most at risk from landslides. Table 3.20 shows the distribution of agricultural land, built up areas and roads across four levels of exposure to climate-related hazards, namely 1 as low, 2 as medium, 3 as high and 4 as very high, specifically relating to landslides (Figure 3.10).



Source: DRR (2013)

Figure 3.10 Rodrigues hazard map and landslides distribution

Table 3.20 Risk classes for different land use categories (Landslide risk)

	Hazard level			
Land use	**4** (very high) (%)	**3** (high) (%)	**2** (medium) (%)	**1** (low) (%)
Agricultural fields	1	6	12	80
Built up area	1	6	9	85
Main road	0	4	7	89

Red: very high risk; Orange: high risk; Yellow: medium risk; Light green: low risk; Green: very low risk
Source: DRR (2013)

The DRR report has applied the standard hydrologic and hydraulic study methods to determine areas that are likely to be affected by flood and inundation (GoM, 2013). Figure 3.11 presents the flood hazard map of Rodrigues, whereas Table 3.21 presents risk classes arising from flood risk for different land use categories.

Source: DRR (2013)

Figure 3.11 Flood hazard map of Rodrigues

Table 3.21 Risk classes for different land use categories (Flood Risk)

Landuse	RP[1] 25 (%)	RP 50 (%)	RP 100 (%)	RP 500 (%)
Built up area	8.4	8.8	9.0	9.4
Agricutural fields	6.0	6.5	6.5	7.1
Main road	5.0	5.5	10.0	10.7

Red: very high risk; Orange: high risk; Yellow: medium risk; Light green: low risk; Green: very low risk
Note [1]: Demanded level of protection in terms of Return Period, measured in years.
Source: DRR (2013)

Table 3.22 and Table 3.23 present, respectively, the value of exposed elements and of potential damage arising from flood and inundation in Rodrigues (GoM, 2013)

Table 3.22 Value (MUR million) of exposed elements to flood and inundation in Rodrigues

Value of exposed elements in million MUR	Period in years			
	Rp[1] 25	Rp 50	Rp 100	Rp 500
Flood	902	955	985	1000
Inundation	531	658	935	1.207

Note[1]**:** Demanded level of protection in terms of Return Period, measured in years.
Source: DRR (2013)

Table 3.23 Value of potential damage from flood and inundation (MUR million)

Potential damage to buildings and infrastructure in MUR million	Period in years			
	Rp[1] 25	Rp 50	Rp 100	Rp 500
Flood	98	105	108	130
Inundation	80	99	144	181

Note[1]: Demanded level of protection in terms of Return Period, measured in years.
Source: DRR (2013)

3.5.2 Chapter overview

Part B of the chapter aims at presenting the current and upcoming challenges in seven priority sectors in Rodrigues. It further elaborates on sectoral adaptation strategies and integrates them into a unique strategy for Rodrigues, making use of cross-sectoral synergies. As for Mauritius, the three main strategic objectives for Rodrigues are to:

i) avoid and reduce damage from climate change
ii) build capacity to understand, analyse and pre-empt, in a timely manner, any future climate change impacts
iii) integrate and mainstream climate change adaptation measures into core development policies, strategies and plans of RoM to create new opportunities in Rodrigues.

There are several areas of overlap across sectors, indicating the potential both to achieve considerable budget savings, and to reach effectively several sectoral goals across sectors simultaneously. It is important that in Rodrigues, which is characterized by heavily interconnected social, economic and environmental drivers of change, adaptation strategies are designed and implemented accordingly, to improve well-being effectively.

An integrated approach is used where the intervention options, which turn challenges into opportunities, are identified along with required investments, policy-induced avoided costs and added benefits.

3.6 Sectoral vulnerabilities and adaptation

3.6.1 Agriculture

3.6.1.1 Climate change vulnerabilities

Agriculture is the mainstay of the economy in Rodrigues, not only in terms of income generation, but also in terms of full-time and, especially, part-time employment. Traditional farming systems produce the basic food commodities. However, adverse climatic conditions and water stress have severely constrained agricultural development (Table 3.24).

Table 3.24 Climatic conditions that constrain agricultural development

Observed change in climatic conditions	Consequences
Rainy season has become shorter	Rainfall patterns are becoming more erratic
Tropical cyclones are becoming less frequent	There is less available water. Cyclones contribute to more than 60% of annual rainfall
Acute shortage of water for irrigation, and the trend is worsening	Several incidences of crop damage from irrigation using coastal boreholes have been recorded, due to salt-water intrusion
Rainfall is now drastically low	There is the need to revisit known adaptive measures
Both summer and winter rainfall patterns have changed, with the onset of the rainy season occurring earlier than in the past	Hence farmers find it more appropriate and profitable to start planting rain-fed beans and onions in February/March instead of April/May as they used to. The flowering of fruit trees is also occurring earlier than in the past

Soil erosion has become a major problem and soil fertility has been considerably reduced. Fodder is available only on high ground and has almost disappeared from the coastal region. Consequently, livestock has suffered from the change in climate patterns.

3.6.1.2 Adaptation policies

In order to address the challenges posed by climate change impacts and reach national targets of food security and competitiveness in the agriculture sector, RoM through the Rodrigues Regional Assembly, and in collaboration with other relevant entities, could actively support the transition to sustainable agriculture in Rodrigues (Table 3.25).

Table 3.25 Strategies in support of transition to sustainable agriculture

Strategy	Means of implementation and expected results
Reduce vulnerability to climate change	This objective may be achieved by improving water conservation and increasing the efficiency of irrigation. The dissemination of micro-irrigation systems can increase the capillarity of water supply and limit water loss by reducing the distance that water has to travel in the irrigation system. Expanding rainwater harvesting to be reused on-site, rather than allowing it to run off, can decrease the need for pumping water from the aquifer. Technologies for rainwater harvesting include wells, shafts, and boreholes.
Develop plans for sustainable land use planning	The plans will help to find a balance among competing uses. Fertile land in rural areas becomes scarcer due to population growth, pollution, erosion, and the effects of climate change. On the remaining land, local users compete to achieve food security. This includes designing laws for zoning, enforcing the abidance to these laws, and investing in education to avoid land encroachment.
Prevent and respond to agricultural invaders, pests, and diseases	This aim may be achieved by developing policy for import, maintaining local production, and implementing integrated pest and disease management. This can be realised through integrated pest management (IPM), which aims at integrating appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified, and reduce or minimize risks to human health and the environment.
Promote bio-production both for the internal market and for exports.	This goal entails providing technical and financial assistance to local farmers for maintaining traditional production, and increasing reliance on traditional fertilisers and pesticides. Besides, a certification scheme for organic products can facilitate exports to foreign markets, and promote internal consumption if consumers become more aware of the positive externalities of organic products

The development challenges for Rodrigues in agriculture are similar to those of Mauritius except that it is far less dependent on food imports. Otherwise, the goals and the VAA strategies to address current problems and create new opportunities are very similar. These are given in Table 3.3.

An integrated approach that identifies the intervention options, which turn challenges into opportunities, and the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the agriculture sector, are given in Annex 9.

3.6.2 Coastal areas and tourism

3.6.2.1 Climate change vulnerabilities

Unlike Mauritius, the main economic resource on the coasts of Rodrigues is fisheries combined with some tourism activities. However, the number of fish and octopus caught during the past few years is on the decline. This decrease is attributed to the loss of marine biodiversity, unsustainable fishing practices, and beach erosion that is causing

sedimentation in the sea. The main cause of beach erosion in Rodrigues is the continuous sand movement pattern that exists along the beaches, and the presence of hard infrastructure placed on the sea. Sand extraction practices also exist in the Rodrigues lagoon at Banc Catherine. It is estimated that about 25 000 t of sand are removed annually. Though control measures at sand landing station have been strengthened, to this date there is no study that assesses the sand stock required to ensure sustainable exploitation. Furthermore, higher sea surface temperature and sea level rise are foreseen to worsen beach erosion and the problems faced by the fisheries sector in the decades to come.

Coral bleaching has been a recurrent problem in Rodrigues. The coral reefs of Rodrigues were some of the few reef areas in the Indian Ocean to escape the mass coral-bleaching event of 1997-1998. The 2016 El-Nino event is believed to have brought massive coral bleaching as per visual inspection made. Unusually warm sea conditions had resulted in coral bleaching, particularly at sites in the North and West of Rodrigues. Surveys showed occurrences of severe bleaching leading to the mortality of up to 75% of corals at some sites. If widespread coral mortality does not decrease in the near future, this may result in a decline in fish population, loss of the protective function of the reef, and a possible increase in toxic dinoflagellates. The North and West of the island are particularly vulnerable. These areas would benefit from immediate protection in order to allow the corals to recover, and further management measures could be taken to protect the beach from further damage. Furthermore, some islets such as Ile Coco are vulnerable to sea level rise. Considering a sea level rise at 5 mm/yr, as predicted by a few studies, the loss of sandy beaches may be of the order of 5 m every decade, threatening these islets.

3.6.2.2 Adaptation policies

In order to address sea level rise and temperature increase, and the resulting impacts on coastal erosion in Rodrigues, RoM through the Rodrigues Regional Assembly, and in collaboration with other relevant entities, could undertake to:

i) *Preserve natural landscapes through the establishment of natural parks for eco-tourism*. This action may not only protect valuable ecological resources and biological diversity but could also foster high-value and low-impact tourism, which ensures more revenues than mass tourism
ii) *Plant mangroves to decrease infrastructure damage arising from climate change vulnerability*. Mangroves not only act as nurseries for fish and control aspects of water chemistry in coastal zones, they also serve as a critical buffer against storm waves and other extreme weather events

The implementation of the VAA strategies (Table 3.26) is expected to reduce vulnerability to climate change on coastal areas and, consequently, reduce potential economic damage to infrastructure and the operational costs of the fishery sector.

Table 3.26 VAA strategies for addressing current problems and transforming development challenges into new opportunities for achieving the development goals in the coastal area and tourism sector

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
Coastal areas and tourism	i) Preservation of natural landscape ii) Vulnerability to climate change (coastal erosion and infrastructure	Reduce vulnerability to climate change	**T1**[1]**.** Restoration of coastal vegetation	**TN1**[2]**.** Promoting the creation of natural parks
		Ensure coastal protection	**T2.** Protection and restoration of ESA	**TN2.** Encouraging coral nursery and growth of coral reefs
		Planning for sustainable tourism	**T3.** Promote best practices (water, energy, etc.)	**TN3.** Incentivise eco-tourism, with the valorisation of natural capital

Sector	Development challenges	Goals	VAA strategies	
			To address current problems	To create new opportunities
	damage)			

Note[1]: T1 etc. refer to proposed strategies to address current problems
Note[2]:TN1 etc. refer to strategies for creating new opportunities while addressing the current problems

An integrated approach that identifies the intervention options, which may turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs, and the added benefits in the *coastal area and tourism* sector are given in Annex 10.

3.6.3 Water resources

3.6.3.1 Climate change vulnerabilities

Rodrigues is a water scarce island. The main sources of water are rainfall, especially during the heavy rain season, and coastal boreholes. Most of the annual precipitation occurs in the summer months from December to April. Long-term mean annual rainfall is 1 104 mm, with mean rainfall totalling 724 mm (65%) in summer and the remaining 380 mm in winter. Sixteen boreholes provide around 60 to 70% of the water supply in the island. Traditionally, rain harvesting at household level has been a common practice to address the issue of water shortage. Nowadays, desalination is considered as a valuable option (Figure 3.12) in spite of its high cost. Three plants are now in operation. They supply about 1 250m³ of water per day to the main water network. The establishment of additional desalination plants are being envisaged. However, the high-energy consumption of desalination plants may inevitably lead to an increase in GHG emissions. Moreover, the need to mitigate environmental impacts of the desalination process has to be considered. The process generates a very concentrated and continuous stream of brine. In fact, the management of the plant has to do not only with the generation of potable water, but also with the disposal of the salt extracted.

Credit: MoESDDBM
Figure 3.12 Desalination Plant at Anse aux Anglais

3.6.3.2 Adaptation policies

In order to address the challenges posed by water scarcity and progress towards reaching national development goals in Rodrigues, RoM through the Rodrigues Regional Assembly, and in collaboration with other relevant entities, may undertake to:

i) *Increase water use and production efficiency*. Water use efficiency can be increased by improving infrastructures, increasing consumers' awareness, and reducing the need for irrigation in agriculture. On the other hand, water production can be made more sustainable by reducing the environmental impact of desalination
ii) *Promote integrated flood management*. The process promotes the coordinated management and development of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

iii) *Generate data and improve the reliability of their analysis*. Data processing aids in the understanding of the spatial and temporal patterns in water quality, taking into consideration the natural processes and characteristics of a water body.It allows the impact of human activities to be understood and the consequences of management action to be predicted.

In the water sector, the development challenges, goals and the VAA strategies to address current problems and create new opportunities are very similar to those proposed for Mauritius. In particular, the implementation of the VAA strategies (Table 3.7) in Rodrigues is expected to reduce water scarcity, by increasing supply and improving efficiency of use. In so doing, the water sector will turn from a potential constraint to an enabler of inclusive growth, through interventions that value natural capital and favour the adoption of new technologies.

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *water resources* sector are given in Annex 11.

3.6.4 Biodiversity

3.6.4.1 Climate change vulnerabilities

Rodrigues is most likely the oldest of the Mascarene Islands. This has allowed a very high density of endemic taxa per unit area. Rodrigues has 150 native flowering plants, of which 47 are single island endemics, and 72 are Mascarene endemics (Baider et al., 2010). A list of endemic species unique to Rodrigues is given in Box 3.5.

Box 3.5. Endemic species unique to Rodrigues

Species endemic to Rodrigues		**Nature and status of the species**
Species	**Number**	
Bat	2	Endemic to the Mascarenes, of which one is locally extinct
Bird	30	Of these 16 were endemic to Rodrigues or the Mascarenes. Only two endemic Rodrigues species survive
Tortoise	2	All are extinct
Non-chelonian reptiles	7	Six of those were endemic but all six are extinct
Insects and snails	An unsuspected number was known	Most of them are extinct or highly threatened.

Rodrigues has undergone a marked destruction of its native forests (Carl Jones, in Cheke and Hume, 2008) since the island's colonisation in the early 18th century. Forest clearance for agriculture and the advent of forest fires, hunting, mammalian predators and invasive plants has had a heavy toll on the biodiversity of Rodrigues, making it one of the most degraded islands in the world. Of the 36 to 38 taxa of endemic flowering plants, nearly all are threatened (Strahm, 1989). The main threats to forest biodiversity are past forest clearance and unsustainable agricultural practices (Figure 3.13) that lead to habitat fragmentation, soil erosion, and water scarcity. Invasive alien species are rampant both in cultivated and forested areas. However, there are a few and degraded native forest patches which are being restored, namely those. at Grande Montagne, Anse Quitor, and in some of the valleys and on some islets including Ile Cocos and Ile aux Sables. The most relevant direct impacts of climate change expected in the future are similar to those for Mauritius, and the main ones are given in Table 3.27.

Credit:MoESDDBM

Figure 3.13 Forest cover in the region of La Ferme

Table 3.27 Projected direct impacts of climate change

Impacts of climate change	Projected impacts on biodiversity and the environment
Temperature rise	Greater proliferation of invasive alien species (e.g. *Lantana camara*) at the expense of native species, although some endemic plants may have enough resilience to be able to cope with climate change
More severe droughts	Loss of native forests and increasing stress to animals
Increasing susceptibility of forests to wild fires	Degradation of ecosystems, especially as invasive species that are fire-prone (e.g. *Heteropogon contortus*) may expand
Reduction in pollinator abundance and distribution due to climatic stresses	Disrupted pollination systems could lead to reduced native plant viability
Decreased pollinator activity	This may be due to shifts in plant phenology
High intensity rainfall	Soil erosion and soil acidity may affect endemic plants
Sea level rise	Loss of shoreline may affect coastal vegetation, turtle nesting, and wader visitation on low lying islets such as Ile Cocos and Ile aux Sables

3.6.4.2 Adaptation policies

The policies related to adaption to climate change for Rodrigues are similar to those for Mauritius. As a result, in order to address the challenges posed by loss of biodiversity and degradation of ecosystems and reduced ecosystems services, and progress towards achieving biodiversity goals, RoM through the Rodrigues Regional Assembly, and in collaboration with other relevant entities, including conservation NGOs, could undertake to:

i) Increase significantly the restoration of native forests, or recreate native forests, in order to conserve biodiversity and improve ecosystems services such as regulation of water supply, soil conservation and air quality. This is already a policy decision in Rodrigues, with the Forestry Service creating new forests with native species solely. The Mauritian Wildlife Foundation and the Forestry Service are also restoring large areas of the nature reserves of Rodrigues

ii) Increase ex-situ conservation of plants as a safety measure against extinction, and provide plants for reintroduction into native forests

iii) Address the issue of domestic and stray cattle grazing in forests that accelerate soil erosion and the spread of invasive species
iv) Improve habitats for native animals to use and recolonise forested patches, and reduce risks of decline or extinction of animals, and reinstate plant-animal interaction
v) Expand and improve protected areas to promote the creation of a functional corridor ecosystem, and explore a ridge to reef connection
vi) Promote the creation of local capacity to undertake research on the effects of climate change on biodiversity, and on the impacts of measures taken to address these effects
vii) Conduct ecosystems valuation to promote the importance and mainstreaming of biodiversity

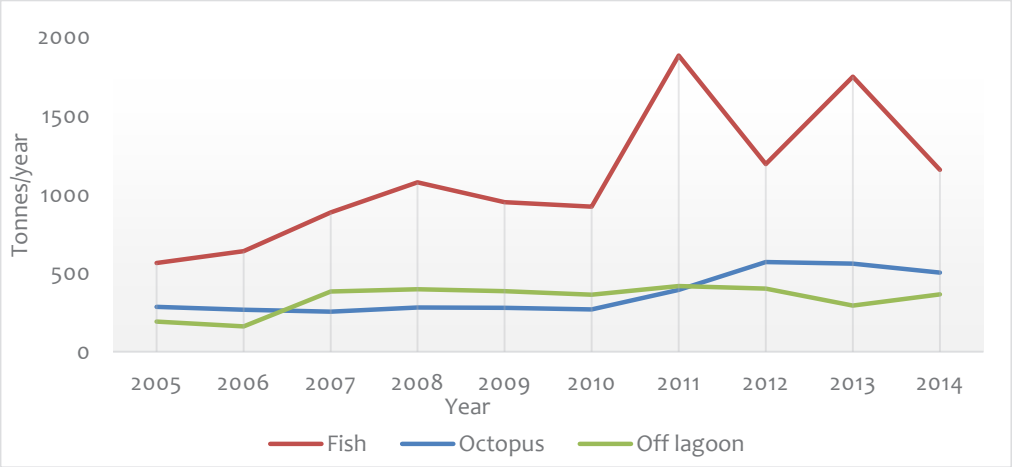
In the biodiversity sector, the development challenges, goals and the VAA strategies to address current problems and create new opportunities are very similar to those of Mauritius. In particular, the implementation of the VAA strategies (Table 3.9) in Rodrigues is expected to reduce vulnerability of biodiversity to climate change, improve ecosystems services, support eco-tourism, and provide forests for the enjoyment of the population of Rodrigues and visitors.

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *biodiversity* sector are given in Annex 12.

3.6.5 Fisheries

3.6.5.1 Climate change vulnerabilities

The main type of fisheries practiced in Rodrigues is artisanal fishery with line, basket trap and large net, octopus and off lagoon fisheries (Figure 3.14). There are 1 221 registered fishers out of which 190 are fisherwomen and 31 are large net fishers, and a fleet of 1973 registered fishing boats. In 2014, about 502t of octopus along with 1 158t of fish were caught within the lagoon, and 363t outside the lagoon (Figure 3.14). It is recognised that the lagoon around Rodrigues has degraded to the point of suffering from overfishing and this is largely due to the large number of casual fishers who use unsustainable fishing practices for their daily living. As regards octopus, since 2011, the practice of marine co-management of resources in Rodrigues by periodic octopus fishery closure (Box 3.6) has been successful in restoring gradually the stock.



Source: MoFED (2015)

Figure 3.14 Fish catch by type of activity in Rodrigues

The main critical ecosystems include mangroves, seagrass beds and coral reefs. In Rodrigues there are 493 fish species, 138 coral species, 175 gastropod species, 104 species of algae, 109 bivalve species, 74 species of echinoderms and 41 bryozoan species (Oliver and Holmes, 2004). Planted mangroves (Figure 3.15), cover an area of 24 ha (MoESD, 2009). The stresses on fisheries in Rodrigues are intense fishing and decreasing habitat and habitat quality, which are likely to be exacerbated by climate change. These developments may in turn cause local shifts in catch, altered growth rates of fish population and stock migration.

Credit: MoESDDBM

Figure 3.15 Mangrove at Baie Malgache

The fisheries sector is influenced indirectly by climate change. Rodrigues has a lagoon area of 240 km^2 with the South East Marine Protected Area (SEMPA) covering some 43 km^2 and four Marine Reserves. These areas are known to be very diverse and highly productive, but they remain relatively shallow which make the ecosystem vulnerable to climate change, especially when considering the rising trends of temperature and ocean acidification.

Box 3.6 Marine co-management of resources in Rodrigues with periodic closure of octopus fishery

As in Mauritius, coral and fish in Rodrigues are vulnerable to the effects of increased sea surface temperature, sedimentation increase with more frequent intense rainfall and fish reproduction is adversely affected by reduced mangroves (Section 3.2.5.1). The resulting socio-economic implications of climate change are expected to be significant in Rodrigues (as experienced in the past in the case of overfishing).

3.6.5.2 Adaptation policies

In order to address the challenges within the fisheries sector and progress towards reaching national development goals, RoM through the Rodrigues Regional Assembly, in collaboration with other relevant entities could undertake to implement suitable strategies (Table 3.28).

Periodic closure of octopus fishery in Rodrigues

Octopus exports dropped from about 411t in 1992 to an all-time low of 72t in 2011 most likely due to intensive fishing and ineffective enforcement of the regulations. In monetary terms the income went down from MUR 41.1 million to MUR 3.6 million To remedy the situation, a single annual '*Octopus close season'* from 15 August to 15 October was adopted by the Rodrigues Regional Assembly (RRA) and implemented in 2012. Alternative activities were provided to the 1 387 fishers so that they could earn a living during the period of closure.

Following the re-opening of the octopus-fishing season in October 2012, the mean catch per fisher, increased by a factor of five compared to the catch during the previous season. Since then, the exercise has been repeated every year with continued success (Figure 3.16).

In view of the overwhelming success, two close seasons are now being proposed as from 2016: 15 February to April and 15 August to 15 October.

Mauritius has adopted a similar scheme and its first annual *Octopus close season* is from 15 August to 15 October in 2016.

Credit: Rodrigues Regional Assembly

Figure 3.16 Re-opening of octopus fishing period attracts big crowds

Table 3.28 Adaptation policies aimed at reducing the vulnerabilities of the fisheries sector

Strategy	Means of implementation and expected results
Improve the health of marine ecosystems	The actions include improving governance, enforcing existing regulations over the existing marine protected areas, and expanding the protected areas to places that are sensitive and vulnerable to climate change. The rehabilitation and expansion of sensitive coastal habitats such as corals, seagrass and mangroves could also be undertaken
Adopt and promote sustainable fishing practices	This approach could be carried out through the identification and implementation of suitable sustainable small-scale aquaculture opportunities, provision of incentives to promote entrepreneurship for sustainable aquaculture and by encouraging and enabling fishers to fish outside lagoons
Improve capacity of institutions and fishers in understanding and managing the marine ecosystem	This strategy may be achieved through the sensitisation of fishers over the effects and impacts of climate change on the resources, and through an improved and harmonised monitoring of the marine environment

For the fisheries sector in Rodrigues, the development challenges, goals and the VAA strategies to address current problems and create new opportunities are very similar to those of Mauritius. In particular, the implementation of the VAA strategies (Table 3.11) in Rodrigues is expected to reduce the loss of marine habitat and thus improve landings and the competitiveness of the fisheries sector and in doing so improve the livelihoods of the inhabitants in the coastal areas.

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *fisheries* sector are given in Annex 13.

3.6.6 Health

3.6.6.1 Climate change vulnerabilities

Climate change will lead to negative health impacts. For Rodrigues the re-location of its vulnerable population may pose serious difficulties and disproportionately impact the island population, with resulting impacts of its health.

The circumstantial evidence from Mauritius and elsewhere (Section 3.2.6.1) argues for the fact that climate change may induce epidemic-prone diseases in Rodrigues. It will also increase the vulnerability in the health sector requiring increased health care services. As health is inextricably linked to development, the adverse impact of climate change may have profound socio-economic impacts on the island.

3.6.6..2 Adaptation policies

In order to address the challenges posed by health impacts of climate change and concomitantly attain the Sustainable Development Goals by 2035 in Rodrigues, RoM, through the Rodrigues Regional Assembly and in collaboration with other relevant entities, could adopt the three-pronged approach as in the case of Mauritius and given in Table 3.12.

In the health sector in Rodrigues, the development challenges, goals and the VAA strategies to address current problems and create new opportunities are very similar to those of Mauritius. In particular, the implementation of the VAA strategies is expected to reduce vulnerability to climate change, and decrease morbidity and mortality in Rodrigues (Table 3.13).

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *health* sector are given in Annex 14.

3.6.7 Infrastructure

3.6.7.1 Climate change vulnerabilities

Concentrated within an area of 108 km^2, are the main components that constitute Rodrigues's infrastructure sector, namely,

(i) *Land transport* – The main road network of Rodrigues, extending either landside of Port Mathurin to Baie Malgache in the West, Anse aux Anglais in the East, and uphill to Mont Lubin to the Centre extending to Pointe Coton on one side and Plaine Corail and Port Sud-Est on the other, aggregate some 50 km. Other secondary roads, tarred and untarred amount to some 6 km. There had been major improvements on the road network over the last 10 years and this has been accompanied by a marked increase of 39% in the number of motor vehicles over the period 2010 to 2014.

(ii) *Electricity supply* - A total of 33 GWh of electricity was generated, out of which 9% was from renewable sources primarily wind farms (Figure 3.17). Non-renewable sources are mostly derived from diesel and heavy fuel oil (CEB, 2011)

(iii) *Water resources* – Rodrigues is characterised by highly rocky reliefs and steep slopes and it lacks dams and impounding reservoirs. The run-off from rivulets flows rapidly to the sea. River abstraction, boreholes and a few springs are the main sources of water supply, providing some 7 500 m^3/day during periods of abundant rain, and as little as 3 000 m^3/day during dry spells. Newly constructed desalination plants provide a maximum of 2 000 m^3/day. The water requirement for a population of 42 000 (2014) is some 7 000 m^3/day for domestic consumption only. The shortage of water poses severe restrictions on development, and the impacts of climate change may further aggravate this situation.

Credit:MoESDDBM

Figure 3.17 Wind turbines at Trèfles

(iv) *Building infrastructure* – The building infrastructure comprise approximately 12 000 residential units, 340 institutions and public buildings, 50 industrial buildings, 375 commercial buildings and 85 unclassified buildings..

Climate change-related impacts similar to those in Mauritius have been *observed* on the infrastructural assets in Rodrigues, as follows:

(a) *Temperature rise* of 0.5 to 1.0^{0}C during the last ten years when compared to the 1961 – 90 long-term mean (Meteorological Services, 2016) has resulted in the deterioration of tarred surfaces, development of surface and thermal cracks, increased corrosion to steel and soil shrinkage, as is the case in Mauritius (Table 3.15)

(b) *Annual rainfall* over Rodrigues indicates significant variation from year to year but long-term analysis shows a decreasing rainfall trend (Meteorological Services, 2016). This results in an acute water stress in Rodrigues which is estimated to have only three weeks of water shortage during dry periods. In addition, the increase in frequency of extreme weather events has led to soil erosion, landslides and floods with ensuing consequences for infrastructure, as is the case in Mauritius (Table 3.15)

(c) *Sea level* data in SWIO based on reconstructed tide gauge data and Topex/Poseidon altimeter for the period 1950 – 2001 show a rise of about 1.3 mm/year (Meteorological Services, 2016). Figure 1.5 gives more recent data on sea level rise for the period 1987 to 2012 which shows a more significant rise of 5.6 mm/year. Such rises in sea level together with surges during adverse weather conditions are adequate to inundate the low-lying areas constituting almost three quarters of the capital, Port Mathurin

3.6.7.2 Adaptation policies

In order to address the challenges posed by climate change impacts on the infrastructure sector, RoM in collaboration with the Rodrigues Regional Assembly (RRA) and other stakeholders, could undertake to enforce adaptation policie, as is the case in Mauritius (Table 3.16).

(a) Structural measures

As for Mauritius, the structural measures include improvement of coastal, transport and building infrastructure and others as described in Section 3.2.7.2 and also in Table 3.16. Additional sectoral measures may comprise:

a) *Water infrastructure*
   (i) de-siltation of existing reservoirs to maintain their retention capacities
   (ii) rehabilitation and improvement of the distribution system of potable water
   (iii) construction of desalination plants powered by wind energy
   (iv) identification of potential small dam sites to cater for medium and long-term water needs of the population
   (v) construction of small dams across valleys and using high density polyethylene (HDPE) liner to arrest infiltration
   (vi) better design and planning of rain water harvesting techniques
   (vii) grey water recycling for irrigation

b) *Agriculture*: Increasing the number, resilience and height of retaining walls to terraces for crop plantation

(b) Non-structural

In addition to those mentioned for Mauritius and applicable to Rodrigues as given in Table 3.17, non-structural measures will also include:

(i) Training and capacity building on efficient use of water in all sectors, proper monitoring of quantity and quality of water, and improving cooperation and collaboration with end-users

(ii) More sustainable, cost-effective and eco-friendly buildings and infrastructure to protect workers, occupants and the environment

The implementation of the VAA strategies in Rodrigues as in the case of Mauritius (Table 3.18) is expected to reduce vulnerability to climate change by protecting existing infrastructures and incorporating more stringent

material and design criteria into new infrastructures, thereby protecting the population and the environment alike. The implementation of green technologies would continue to be subsidised to a large extent by the Government in order to encourage sustainable results in the long-run.

An integrated approach that identifies the intervention options, which turn challenges into opportunities, the corresponding required investments, and the resulting policy-induced avoided costs and added benefits in the *infrastructure* sector are given in Annex 15.

CHAPTER FOUR

CHAPTER 4 CLIMATE CHANGE MITIGATION ASSESSMENT-MITIGATION SCENARIOS

4.1 Introduction

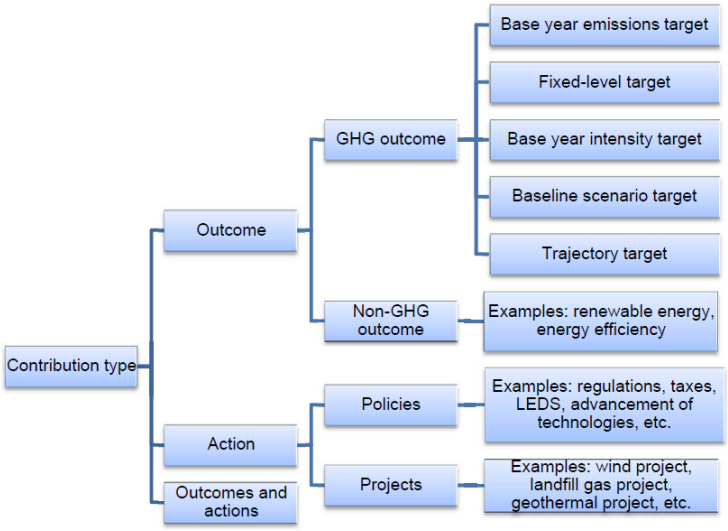
This chapter provides the details concerning mitigation scenarios for Mauritius in energy sector (energy industries and transport); non-energy sector (waste; agriculture; and LULUCF). As far as practicable, the scenarios have been aligned to existing sectoral policies, strategies and action plans, and have been informed by mitigation actions that were proposed in SNC. For TNC, the mitigation actions have been updated. In particular, the level of emission reductions has been aligned for consistency with the national targets that have been set in INDC to 2030.

The mitigation scenarios are reported to:

i) provide the methodology used to develop them, and
ii) explain the underlying assumptions.

4.2 Approaches used for mitigation assessment

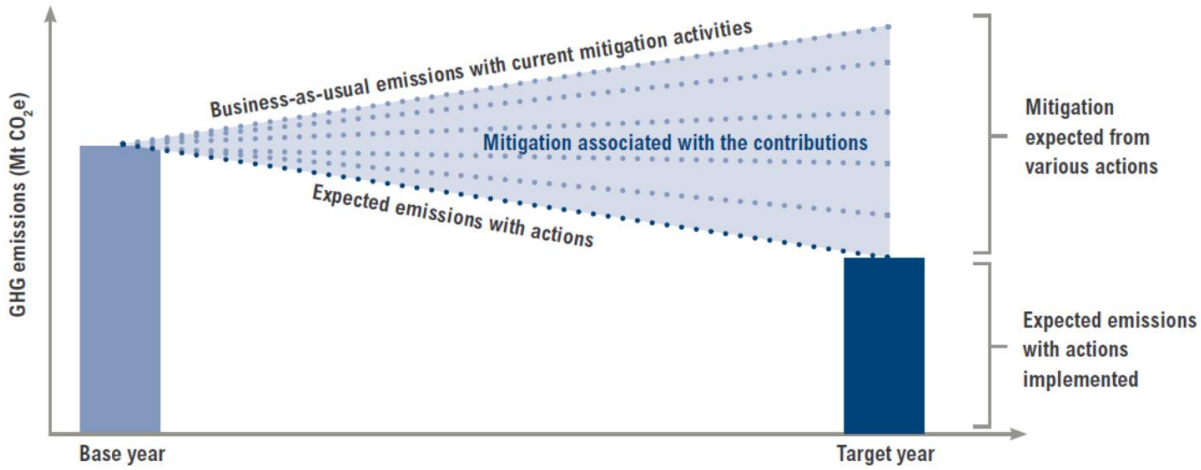
Mitigation assessments can be made based on a combination of three alternatives namely (i) a project- or activity-based approach, (ii) an outcome-based approach, or (iii) a combination of the two. These types of mitigation actions known as '*contribution type'* are depicted in Figure 4.1.



Source: WRI & UNDP, 2015

Figure 4.1 Different types of mitigation actions

In the mitigation analyses, both activity-based (bottom-up) and outcome-based (top-down) approaches have been adopted. The overall level of GHG emission reductions or sequestration has been calculated by developing business-as-usual sectoral baseline scenarios or the case when policies would be hindered due to prevailing barriers. The use of baseline scenarios to calculate the emission reduction accruing from mitigation actions is illustrated in Figure 4.2.



Source: WRI & UNDP, 2015

Figure 4.2 Assessing the emission reduction potential of actions using the baseline scenario approach

4.3 Mitigation assessment and abatement measures in the energy sector

This section describes the methods and assumptions that have been used to carry out the mitigation analyses i.e. by calculating the GHG emission reductions against sectoral baseline scenarios for the energy sector. The energy sector is the largest GHG emitting sector in Mauritius. Mitigation analyses have been carried out for the energy industries and transport sub-sectors.

4.3.1 Energy industries

The Long-term Energy Strategy 2009–2025 (LTES) is being updated and will cover the period up to 2030. The Energy Efficiency Master Plan has already been validated and the Renewable Energy Master Plan is being finalised. The mitigation scenarios propose to achieve a 35% renewable energy (RE) target by 2025, and maintain it in 2030. The technologies envisaged to reach these targets comprise energy efficiency (EE) and RE technologies (e.g. solar PV, wind, renewable biomass, and waste-to-energy (WTE)).

The baseline scenario has been developed through a comparative analysis of three sector models, including (i) MAED modelling carried out in the process of updating the LTES for MEPU, (ii) system dynamics modelling, and (iii) Mauritius 2050 Pathways calculator. The models provide reference or business-as-usual (BAU) scenarios up to the year 2050.

Although the MAED model has been carried out up to 2030 only, it provides useful information concerning the demand side energy efficiency over the period. Hence, the level of energy efficiency gains arising from the reduction of electricity demand was obtained from the MAED model with assumptions made on the evolution of energy efficiency up to 2050.

The simulations in required electricity generation obtained from the system dynamics model and from the Mauritius 2050 Pathways calculator are closely aligned up to 2045, but diverge by more than 25% in simulated results by 2050.

The baseline emissions analysis has been carried out using the results of the system dynamics model that is able to simulate electricity generation using either an endogenous or an exogenous calculation of GDP. By calibrating the

model to replicate historical electricity generation, the simulation of electricity generation using a 3.8% GDP growth rate (the average GDP growth rate of the last 10 years) has been adopted for simulating the baseline GHG emissions. The system dynamics model has been used recently to simulate the electricity generation scenarios published by the CEB in its Integrated Electricity Plan 2013-2022 (Deenapanray and Bassi, 2015).

The results of the mitigation scenario analyses are shown in Figure 4.3 in the form of mitigation wedges. So the difference between successive curves (starting with the 'Energy efficiency' option) gives the GHG emission reduction for the listed mitigation action. A hierarchy is applied in the scenario building process wherein it is assumed that the energy efficiency option will be implemented first, followed by wind, then solar PV and so on. This technology hierarchy cascades from the timing of the mitigation options between 2016 and 2030.

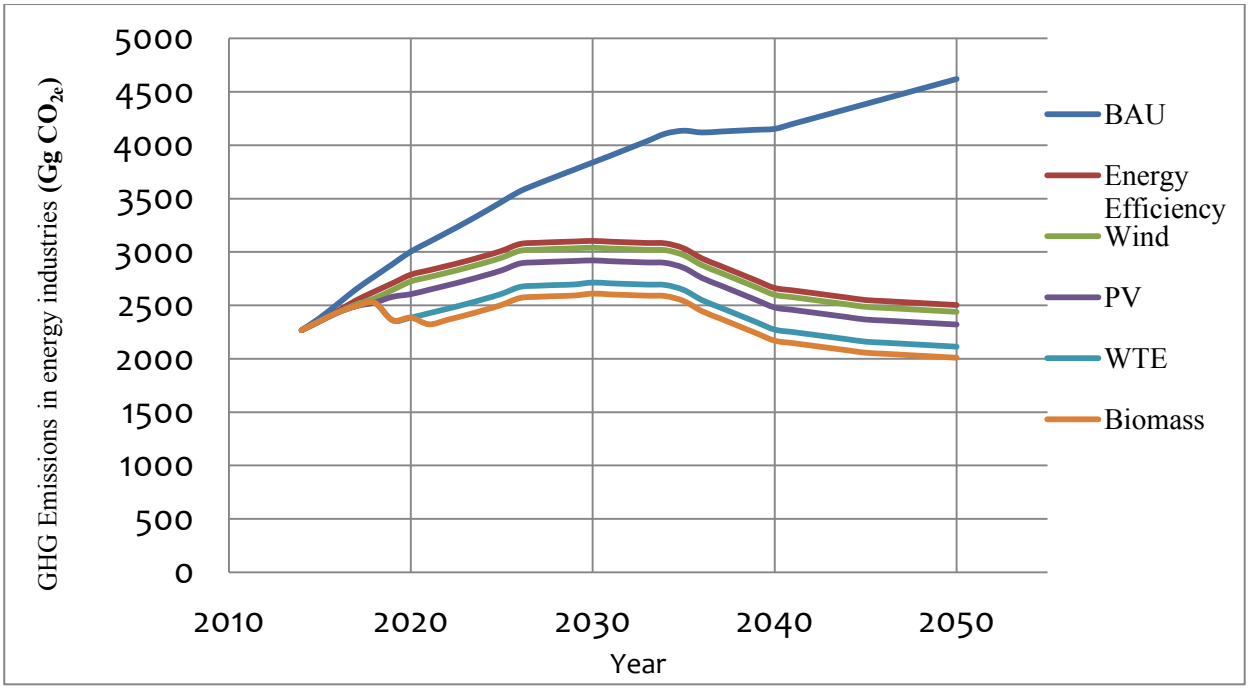


Figure 4.3 Mitigation scenarios in the energy industries (2015-2050)

The electricity generated has been converted into equivalent GHG emissions by multiplying by the standardised baseline grid emission factor for Mauritius (UNFCCC, 2016). The value is 0.9661 tCO_{2e}/MWh for intermittent RE; 0.915 tCO_{2e}/MWh for other projects in the first crediting period; and constant at 0.864 tCO_{2e}/MWh in the second and third crediting periods. The calculation and updating of the Tier 2 emission factor form part of the MRV mechanism which is discussed in Section 4.5.1.

In the BAU scenario (Figure 4.3), GHG emissions increase from 2 516 Gg CO_{2e} in 2016 to reach 4620 Gg CO_{2e} in 2050. The avoided emission for Energy Efficiency measures and the combined emission reductions of all supply side alternative mitigation technologies are given in Table 4.1. By 2050, the cumulative emission reduction of all measures is around 2 611 Gg CO_{2e} .

Table 4.1 Model estimates of avoided emissions in Gg CO_{2e} with respect to BAU for various scenarios up to 2050

Year	2016	2020	2030	2040	2050
Energy efficiency	67	216	734	1 490	2 117
Cumulative emission reductions of all the supply side alternative mitigation technologies	14	402	494	494	494
Total	81	618	1 228	1 984	2 611

Source: Figure 4.3

The scenario analyses and GHG emission reduction calculations for the energy industries are found in Annex 18(a) of e-version of TNC.

4.3.2 Land transport

The GHG emissions emanating from land transport arise from the combustion of three types of fuels, namely gasoline, diesel oil and LPG in motorised vehicles. The quantity of GHG emissions is not necessarily related to the number of vehicles. It is rather related to the distance that the vehicles travel in any particular year for functional purposes such as carrying passengers and freight. A parametric model has been developed (Baguant et al., 1996).

The model is composed of two components:

i) Passenger mobility measured in annual passenger-km travelled (PAX km/capita/year), which is parametrized as follows:

$$Passenger\ mobility, Y = Y_{sat}[1 - e^{kx}] \quad \text{(A)}$$

Where, Y_{sat} = 10 000 km/capita/yr,

k=-4.27 X 10^{-4}, and

x = GDP (constant 1980 US$) per capita.

ii) Freight mobility measured in tonne of freight/goods km per capita, which is parametrized as a linear relationship to economic growth as follows:

$$Freight\ mobility, y = ax - b \quad \text{(B)}$$

Where a = 0.52, and b = 26.16.

Equations (A) and (B) were used to project annual passenger mobility and freight mobility to 2030 using a GDP growth rate of 3.8% per annum. The GDP growth rate for the period 2031 to 2050 is set at 3.0%, based on expert guidance received from stakeholders.

A 2-layer model calibration was carried out. First, passenger mobility was assigned to the transport of passengers travelling by car (gasoline, diesel, LPG, hybrid and electric), dual purpose vehicles (gasoline, diesel and LPG), and buses (diesel) using the following parameters (i) number of each type of vehicles, (ii) annual distance travelled by vehicles, and (iii) passenger occupancy of the different types of vehicles. This calibration was carried out using data provided by the NTA for the years 2010 to 2015. The second level of model calibration was carried out to convert the passenger mobility disaggregated by vehicle type to fuel use. An energy balance was carried out using land transport fuel consumption published by Statistics Mauritius. The energy balance was carried out for the years 2010 to 2015 using the fuel intensities of the different types of vehicles.

A similar calibration was carried out for freight mobility, which was predominantly powered by diesel oil.
Once calibrated, the projected passenger and freight mobilities were converted into fuel consumption, and then into equivalent GHG emissions. Emission factors used in the IPCC software was used to calculate CO_2, CH_4 and N_2O emissions. BAU scenario is shown in Figure 4.4. The difference between the modelled GHG emissions and those calculated in the national inventory was 2.6% for 2010, 1.1% for 2011, 1.0% for 2012, and 0.03% for 2013. Under

BAU scenario, land transport GHG emissions is expected to increase from ~1 005 Gg CO_{2e} in 2015 to ~1 093 Gg CO_{2e} in 2020, to ~1 294 Gg CO_{2e} in 2030, to ~1 453 Gg CO_{2e} in 2040, and to ~1 645 Gg CO_{2e} in 2050.

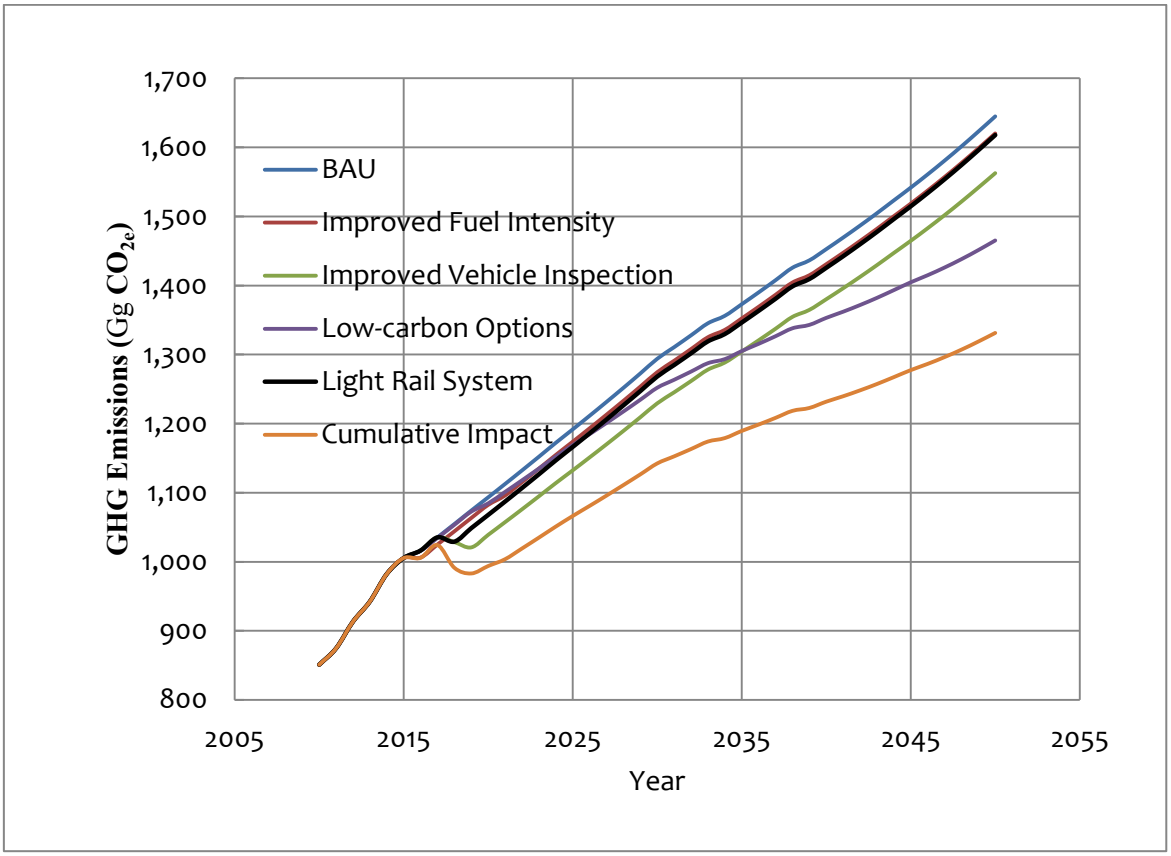


Figure 4.4 GHG emissions scenarios for land transport

For the four mitigation actions (a) improved fuel intensity, (b) improved vehicle inspection, (c) low carbon options, and (d) light rail system, the resulting reductions in GHG emissions over time frames of 2020, 2030, 2040 and 2050 are given in Table 4.2. The data are derived from Figure 4.4.

Table 4.2 Mitigation actions modelled to reduce GHG emissions in land transport

	Mitigation actions	Expected reduction in GHG emissions
(a)	Improvements in the fuel intensity of vehicles (applied to all vehicles) at the rate of 1% per year pre-2020, and increasing to 1.5% per year post-2020.	This measure yields 11 Gg CO_{2e} emissions reductions in 2020 relative to BAU scenario;19 Gg CO_{2e} in 2030; 22 Gg CO_{2e} in 2040; and 25 Gg CO_{2e} in 2050
(b)	Privatisation of vehicle inspection centres starting in 2017 leads to an overall reduction in GHG emission reductions of 5% in 2019.	An intermediate reduction level of 2.5% is achieved in 2018. Relative to BAU scenario, the resulting emission reductions are: 54 Gg CO_{2e} in 2020; 64 Gg CO_{2e} in 2030; 73 Gg CO_{2e} in 2040; and 82 Gg CO_{2e} in 2050
(c)	A low-carbon option has been modelled that combines three technologies: i) blended bio-ethanol produced in Mauritius ii) hydrid cars iii) electric cars	In all three cases, it is assumed that the low-carbon option will impact gasoline-fueled cars. Assuming there is a total available potential of 20 ML bio-ethanol per year, the low-carbon scenario accounts for a 25% penetration in 2020, and increasing by increments of 5% in subsequent years until 100% penetration is reached in 2035 (i.e. 50% in 2025 and 75% in 2030).

(d)	Light Rail System (LRS) generates modal shift away from private cars and buses along the Curepipe – Port Louis corridor	The impact of the LRS on road transport GHG emissions has been modelled taking into account the reduction in car and bus annual distance travelled as follows: 2018: cars – 109 540 000 km; buses – 10 547 000 km 2028: cars – 107 204 000 km; buses – 10 836 000 km 2038: cars – 115 300 000 km; buses – 11 330 000 km The reductions have been kept constant at their 2038 levels for the period 2039 to 2050. Also, 90% of the reduction in car passenger mobility is attributed to gasoline-fueled cars, and the remaining 10% to diesel-fueled cars.

The low-carbon option has used the share of passenger mobility by hybrid and electric cars shown in Table 4.3 that otherwise would have been allocated to gasoline-fuelled cars.

Table 4.3 Share of passenger mobility (%) allocated to hybrid and electric cars

Year	2020	2030	2040	2050
Hybrid car (%)	2.06	8.31	20.81	43.31
Electric car (%)	0.00	1.50	7.50	18.75
Emission reductions in Gg CO_{2e} using these low carbon technologies	9	42	99	180

Source: Figure 4.4

The scenario analyses and GHG emission reduction calculations for land transport are found in Annex 18(b) of e-version of TNC. The results derived from Figure 4.4 for the years 2020. 2030, 2040 and 2050 are summarised in Table 4.4.

Table 4.4 GHG emission reductions (in Gg CO2e) from land transport, with the net emission reductions relative to BAU scenario shown in brackets

	Scenarios	2020		2030		2040		2050	
	BAU	1 093		1 294		1 453		1 645	
(a)	Improved fuel intensity	1 082	(11)	1 274	(19)	1 431	(22)	1 620	(25)
(b)	Improved vehicle inspection	1 039	(54)	1 229	(64)	1 380	(73)	1 563	(82)
(c)	Low-carbon options	1 085	(9)	1 252	(42)	1 353	(99)	1 465	(180)
(d)	Light Rail System	1 067	(25)	1 268	(26)	1 426	(27)	1 618	(27)
	Cumulative reductions		(99)		(151)		(221)		(314)

Source: Figure 4.4

4.4 Mitigation assessment and abatement measures in non-energy sectors

This section presents the mitigation analyses for the non-energy sectors comprising waste sector (solid waste and wastewater), agriculture (crop and livestock), and LULUCF subsectors). The methods and assumptions used to carry out the mitigation analyses i.e. by calculating the GHG emission reductions against sectoral baseline scenarios for the non-energy sector are described.

4.4.1. Waste sector

4.4.1.1 Solid waste

Emissions from municipal solid waste (MSW) have been modelled by simulating the calculations given in the IPCC software. Projections in emissions have been calculated by assuming a 2% year-on-year increase in the quantity of MSW. The model calculates total waste generated as a product of population and per capita waste. In view of a

declining population after 2023 using demographic projections (Statistics Mauritius, 2015, a constant 2% growth in total quantity of waste represents a gradual increase in the per capita MSW generated). Since population projections are given for every 5 years, linear interpolation has been used to derive intermediate levels of population. The waste composition (by type of waste) has been kept the same as the breakdown used in the solid waste national inventory.

The projected year-on-year increase in per capita MSW generation is 2.23% in 2030 and 3.15% in 2050, taking into account declining population. BAU scenario also assumes that additional wells and piping system will be added to increase the capture of LFG (and methane) for electricity generation. It has been assumed that the methane capture increases to 85% of its total volume that is 18.31 Gg CH_4 in 2016 as compared to 15.92 Gg CH_4 in 2014. The baseline scenario described above is shown in Figure 4.5. The GHG emissions are: ~1,138 Gg CO_{2e} in 2015 (same for all scenarios); ~1,290 Gg CO_{2e} in 2020; ~1,691 Gg CO_{2e} in 2030; ~2,168 Gg CO_{2e} in 2040; and ~2,745 Gg CO_{2e} in 2050.

Four mitigation scenarios have been modelled and the results are given in Figure 4.5, and the GHG emission reductions achieved by each one of the scenarios are relative to BAU case. Annex 18(c) of e-version of TNC gives the details of the mitigation scenarios for solid waste management. The mitigation scenarios are as follows:

a) *Enhancing the capture of LFG* for either flaring or electricity generation. In this scenario, methane capture is increased to 40% in 2030; to 45% in 2040; and to 50% in 2050 – i.e. an absolute increase from 18.308 Gg CH_4 in 2016 to 34.375 Gg CH_4 in 2030, and to 64.061 Gg CH_4 in 2050. The GHG emission reductions derived from Figure 4.5 are given in Table 4.5. The Table also gives the net emission reductions (in brackets) relative to BAU scenario.

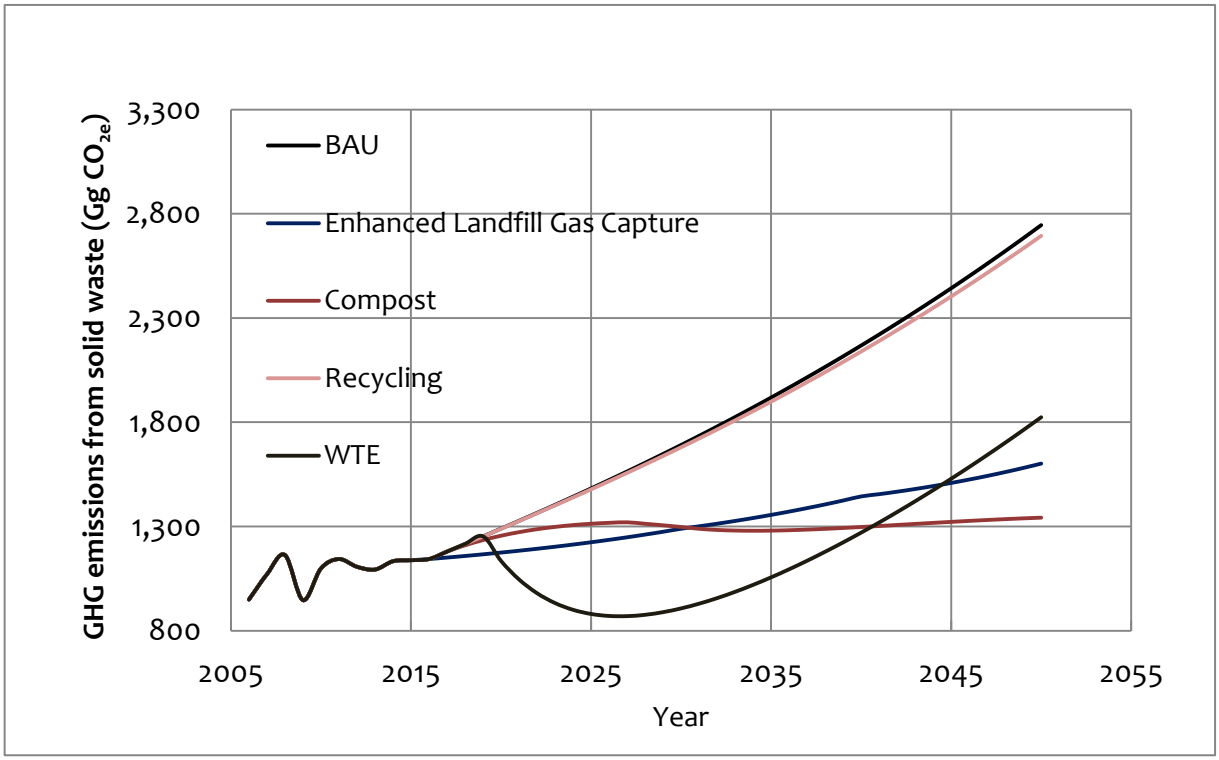


Figure 4.5 Mitigation scenarios in the solid waste sector (2006 to 2050)

b) *Composting of food, garden and paper degradables* that divert organic waste from the landfill, and hence reduce the quantity of methane generated at the landfill (all else being equal). The quantity of the waste that is diverted from landfill is 20% (2020), 30% (2030), 40% (2040), and 50% (2030) relative to their baseline values. Hence, the composting is additional to any that is being carried out already in the baseline situation. This incremental composting starts in 2017 at a rate of 2% and increases linearly to the above-mentioned targets. The avoided methane is ~34 Gg CO_{2e} in 2020 and increases to ~393 Gg CO_{2e} in 2030, and to ~1 403 Gg CO_{2e} in 2050. The results are summarised in Table 4.5. It is assumed that the composting process does not emit any methane, and the compost produced is used in agriculture to support bio-farming

c) *Recycling of paper and textile waste.* A scenario (yielding the least GHG emission reductions) has been modelled based on the approach used in the SNC to investigate the impact of recycling of paper and textile waste. The targets are to achieve recycling rates of 8% in 2020; 28% in 2030; 38% in 2040; and 48% in 2050. This scenario yields emission reductions between ~0.8 Gg CO_{2e} in 2020 and ~51 Gg CO_{2e} in 2050 (Table 4.5)

d) *A waste-to-energy (WTE) scenario* has been modelled for 2019 where 600 t of MSW is diverted from the landfill for energy production on a daily basis. As shown in Table 4.5, this scenario produces GHG emission reductions relative to BAU scenario ranging between ~155 Gg CO_{2e} (2020) and ~921 Gg CO_{2e} (2050). The emission profile of the WTE scenario is non-linear as shown in Figure 4.5 and the results are summarised in Table 4.5.

Table 4.5 GHG emission reductions (in Gg CO2e) from solid waste management, with the net emission reductions relative to BAU scenario shown in brackets

	2020		**2030**		**2040**		**2050**	
BAU	1 290		1 691		2 168		2 745	
Enhanced LFG capture	1 175	(115)	1 289	(402)	1 444	(724)	1 602	(1 144)
Composting of food, garden and paper waste	1 256	(34)	1 298	(393)	1 297	(870)	1 342	(1 403)
Recycling of paper and textiles waste	1 289	(0.8)	1 680	(11)	2 139	(29)	2 694	(51)
Waste to Energy (WTE)	1 135	(155)	907	(784)	1 270	(897)	1 824	(921)
Cumulative reductions		(304.8)		(1590)		(2520)		(3519)

Source: Figure 4.5

4.4.1.2 Wastewater

Emissions from domestic wastewater have been modelled by simulating the calculations given in the IPCC software. BAU scenario assumes that connection to the sewer system up to 2017 proceeds at the same rate as in 2013, thereafter decreasing by a factor of 4. In this case, the GHG emissions comprising both emissions of CH_4 and indirect N_2O (from protein intake) increase gradually over time from ~166 Gg CO_{2e} in 2020 to ~172 Gg CO_{2e} in 2050.

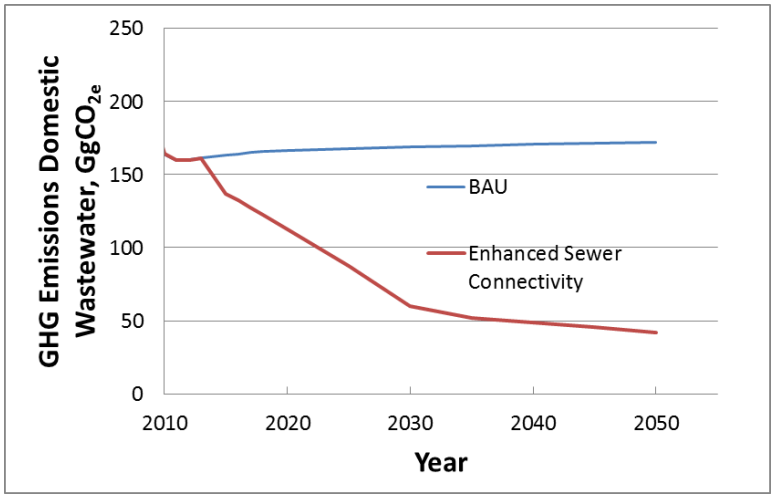


Figure 4.6 Mitigation scenarios for wastewater management (2010-2050)

The mitigation scenario is the implementation of the Wastewater Master Plan II to increase household connectivity to the sewer system up to 80% by 2033 (Figure 4.6). This is also a scenario that was modelled in the SNC. An additional 5% of households are assumed to be connected to the sewer system between 2035 and 2050. In the Enhanced Sewer Connectivity scenario, the utilisation of centralised aerobic wastewater treatment system increases from 0.25 in 2015 to 0.75 in 2030, and to 0.85 in 2050 with corresponding decreases in the use of septic systems. The protein intake has been kept constant at 27.32 kg/cap/yr (which is the highest value reached in 2013). The GHG emission reductions relative to BAU scenario are summarised in Table 4.6. The details of the calculations are given in Annex 18(d) of e-version of TNC.

Table 4.6 GHG emission reductions (GgCO2e) from domestic wastewater treatment (2020 -2050)

	2020	2030	2040	2050
Enhanced Sewer Connectivity	53.95	108.53	121.78	130.56

Source: Figure 4.6

4.4.2 Agriculture

The model for assessing GHG emission reduction scenarios in agriculture has followed the calculations used in the national inventories, and by establishing BAU scenarios for crop and livestock sub-sectors. The detailed calculations of GHG emissions for these scenarios are given in Annex 18(e) of e-version of TNC.

4.4.2.1 Crop

BAU and mitigation scenarios for the crop sub-sector are shown in Figure 4.7. The BAU scenario has been taken as the situation of no implementation of the policies, strategies and actions proposed in the Strategic Plan 2016 – 2020 (Ministry of Agro-Industry and Food Security, 2016).

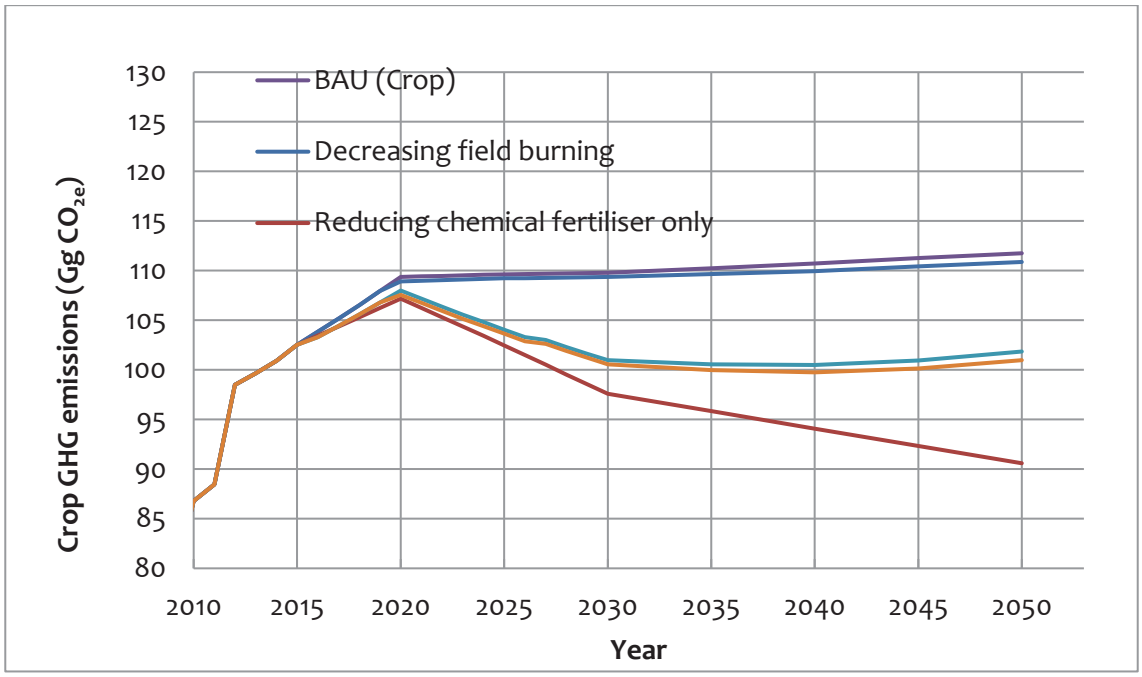


Figure 4.7 GHG emission scenarios in crop sub-sector

Three mitigation scenarios (a) decreasing field burning, (b) reducing chemical fertiliser only, and (c) bio-farming (reducing fertilisers and compost)have been modelled as per the options proposed in the Strategic Plan 2016 – 2020 (Ministry of Agro-Industry and Food Security, 2016) or mentioned in the SNC but not yet achieved (Table 4.7).

Table 4.7 Mitigation scenarios for the crop sub-sector

	Mitigation scenario	Description of scenario
(a)	Decreasing sugar cane field burning	Decrease from its present level of 10% of total area cultivated to 8% between 2020 and 2030; 7% in 2035; 6% in 2040; and to 5% in 2050.
(b)	Reduction in the use of N-containing chemical fertilizers	This scenario provides the largest emission reductions. It is assumed that the reduction starts in 2016 at a meager 1% of the baseline value in 2015, and decreases by 1% absolute per year until 2020. After 2020, the annual decrease is an absolute 2% to reach 25% in 2030. Thereafter, the decrease is 5% every 5 years. This scenario is shown by the curve in dark red, and accounts for direct N_2O emissions only.
(c)	Bio-farming scenario	Since it is unlikely that the use of chemical fertilizers will be reduced without any substitution, this scenario has been developed for investigating the co-use of compost produced from MSW in food crop cultivation. This scenario (lighter blue curve) increases emissions relative to scenario (b) due to the release of N_2O from the compost. This scenario also includes the increase in manure applied to soil with increasing livestock heads to enhance food security under the policy option. The curve shows the combined effect of reduced use of chemical fertilizers and use of compost, including the calculation of both direct and indirect N_2O generation

The results from Figure 4.7 are reproduced for the years 2020, 2030, 2040, and 2050 in Table 4.8.

Table 4.8 GHG emission reductions (in Gg CO2e) from agricultural crop, with the net emission reductions relative to BAU scenario shown in brackets

Emission scenarios	2020		2030		2040		2050	
BAU	109		110		111		112	
Decreasing field burning	109	(0.4)	109	(0.4)	110	(0.8)	111	(0.8)
Reduction in the use of chemical fertilisers only	107	(2.7)	98	(13.4)	94	(18.8)	91	(24.1)
Bio-farming (decreased use of fertilisers + uptake of compost in crop production)	108	(1.4)	101	(8.8)	101	(10.2)	102	(10.0)
Cumulative reductions	108	(1.8)	101	(9.2)	100	(11)	101	(10.8)

Source: Figure 4.7

4.4.2.2 Livestock

The model for carrying out mitigation scenario analysis for livestock management has been customised by replicating the national inventories from 2006 to 2013. Figure 4.8 shows the GHG emissions in livestock management for BAU and Policy scenarios. BAU scenario reveals the expected change in GHG emissions from the livestock sub-sector in the absence of the Strategic Plan 2016 – 2020 (Ministry of Agro-Industry and Food Security, 2016).

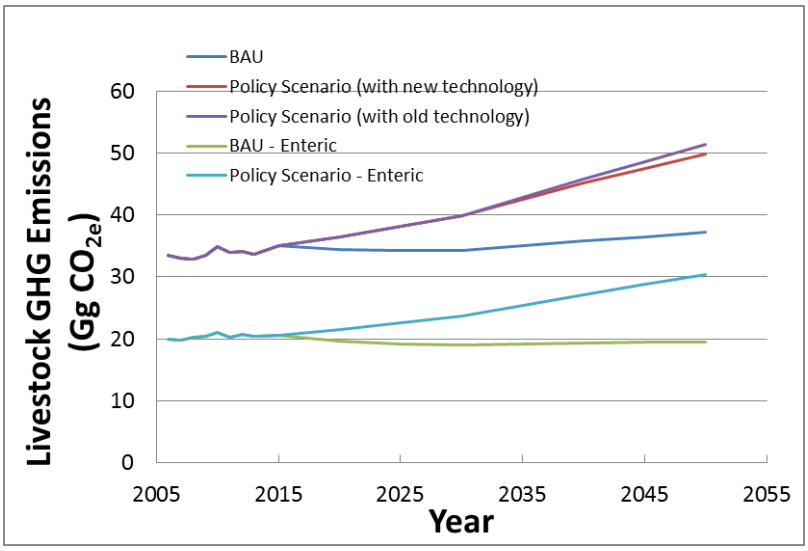


Figure 4.8 Mitigation scenarios in livestock management (2006-2050)

The model assumes that the technological options used for livestock manure management remains unchanged from that used in 2013 (i.e. old technology) up to 2050. The only change relates to the number of animal heads as shown in Table 4.9. The corresponding changes that are expected under the Policy scenario are listed in Table 4.10. The mitigation scenario analyses are given in Annex 18(e) of e-version of TNC.

Table 4.9 Expected change in livestock heads in BAU scenario over the period 2015-2050

Production (heads)	2015	2020	2025	2030	2035	2040	2045	2050
Cow	2 900	2 700	2 500	2 400	2 400	2 400	2 425	2 450
Other cattle	6 100	5 800	5 600	5 500	5 500	5 500	5 515	5 530

Imported beef (annualised figure)	2 000	2 100	2 200	2 300	2 650	3 000	3 250	3 500
Goat	26 000	25 500	25 500	25 000	25 000	25 000	24 900	24 800
Sheep	2 600	2 700	2 700	2 800	2 900	3 000	3 000	3 000
Broiler (annualised figure)	5 300 000	5 500 000	5 700 000	5 800 000	5 950 000	6 100 000	6 300 000	6 500 000
Layer	650 000	675 000	685 000	690 000	710 000	725 000	737 500	750 000
Duck	6 000	7 000	8 000	9 000	10 500	12 000	12 500	13 000
Pig	21 000	22 000	22 000	22 500	22 750	23 000	23 000	23 000
Deer (under paddock system)	16 000	15 000	15000	15 250	15 350	15 500	15 750	16 000

Source: FAREI

Table 4.10 Expected change in livestock heads under the Policy scenario (2015-2050)

Production (heads)	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Cow	2 900	3 000	3 200	3 400	3 700	4 000	4 250	4 500
Other cattle	6 100	6 300	6 720	7 140	7 570	8 000	8 500	9 000
Imported beef (annualised figure)	2 000	2 100	2 200	2 300	2 650	3 000	3 250	3 500
Goat	26 000	26 700	28 000	30 000	32 500	35 000	37 500	40 000
Sheep	2 600	3 000	3 500	4 000	5 000	6 000	7 000	8 000
Broiler (annualised figure)	5 300 000	5 500 000	5 700 000	5 800 000	5 950 000	6 100 000	6 300 000	6 500 000
Layer	650 000	675 000	685 000	690 000	710 000	725 000	737 500	750 000
Duck	6 000	7 000	8 000	9 000	10 500	12 000	12 500	13 000
Pig	21 000	22 000	23 000	24 000	27 000	30 000	32 500	35 000
Deer (under paddock system)	16 000	17 000	17 500	18 000	19 000	20 000	21 000	22 000

Source: FAREI

The Policy scenario is also accompanied by changes in the manure management system (i.e. new technology) used in the rearing of dairy cow, other cattle, and pigs. As time progresses, there is a higher penetration of anaerobic treatment of manure as opposed to solid storage or aerobic treatment of manure. Table 4.11 shows the evolution of these technologies for the management of swine manure. The technological options for dairy cow and other cattle can be found in Annex 18(e) of e-version of TNC

Table 4.11 Manure management system for swine manure under the Policy scenario for period 2015-2050

Technological options	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Solid storage	0.5	0.4	0.4	0.4	0.2			
Aerobic treatment	0.25	0.3	0.3	0.3	0.35	0.4	0.32	0.25
Anaerobic digestion	0.25	0.3	0.3	0.3	0.45	0.6	0.68	0.75

Source: FAREI

Under BAU scenario, the total livestock GHG emissions (combined emissions from enteric fermentation and manure management) is relatively small and changes from ~34 Gg CO_{2e} in 2020 to ~37 Gg CO_{2e} in 2050. Over this

period, emissions from enteric fermentation accounts between 19.24 Gg CO_{2e} (i.e. 52 % in 2050) and 19.4 Gg CO_{2e} (i.e. 57% in 2020) of total emissions.

Under the Policy scenario that favours enhanced livestock rearing for increasing the national food security, there is a significant increase in GHG emissions from ~36 Gg CO_{2e} in 2020 to ~50 Gg CO_{2e} in 2050. The intermediate values are ~40 Gg CO_{2e} in 2030 and ~45 Gg CO_{2e} in 2040. Emissions from enteric fermentation occupy a higher share in total livestock emissions ranging between 59 % (2020) and 61% (2050).

The Strategic Plan 2016 – 2020 of the Ministry of Agro-Industry and Food Security (2016) mentions that emissions of CH_4 from enteric fermentation might be minimised (and output per unit of GHG maximised) by optimising the ruminant feeding regimes. The potential mitigation impact of this suggestion has not been modelled because of the lack of verifiable data regarding the expected changes in the CH_4 emission factors from enteric fermentation for the different animal species covered in the mitigation analyses. Instead, a scenario has been modelled to investigate GHG emissions arising from the changes in livestock heads shown in Table 4.10 but with no changes in manure management system. This scenario results in an additional increase of 1.5 Gg CO_{2e} in 2050 relative to the Policy scenario.

4.4.3 LULUCF

A model has been customised for the calculation of carbon sequestration**.** It is based on the replication of the calculations in the national inventories, including the calculation of soil carbon. BAU assumes that the carbon stock is maintained at its 2014 level based on the observation that the stock of trees has remained unchanged between 2006 and 2014. An exception is the increase in the area of mangrove forests due to ongoing baseline initiatives (Table 4.12). The loss of carbon stock due to fuelwood removal decreases by ~7.4% and ~6.6% annually for eucalyptus and pine wood >20 years, respectively (Table 4.12). The disturbed area has been kept constant at the average between 2006 and 2014 (i.e. at 100 ha per annum).

Table 4.12 Selected parameters used in the LULUCF BAU scenario

		2015	2020	2030	2040	2050
Mangrove forest (ha)		182	187	197	200	213
Wood removal (m^3/yr)	DLL Eucalyptus	528	478	300	200	100
	WUL Pine>20 yr	708	650	550	300	100
Fuelwood removal (m^3/yr)	DLL Eucalyptus	1 769	1 204	557	400	100
	WUL Pine>20 yr	1 587	1 125	565	350	100

Source: Forestry Services, Ministry of Agro-Industry and Food Security

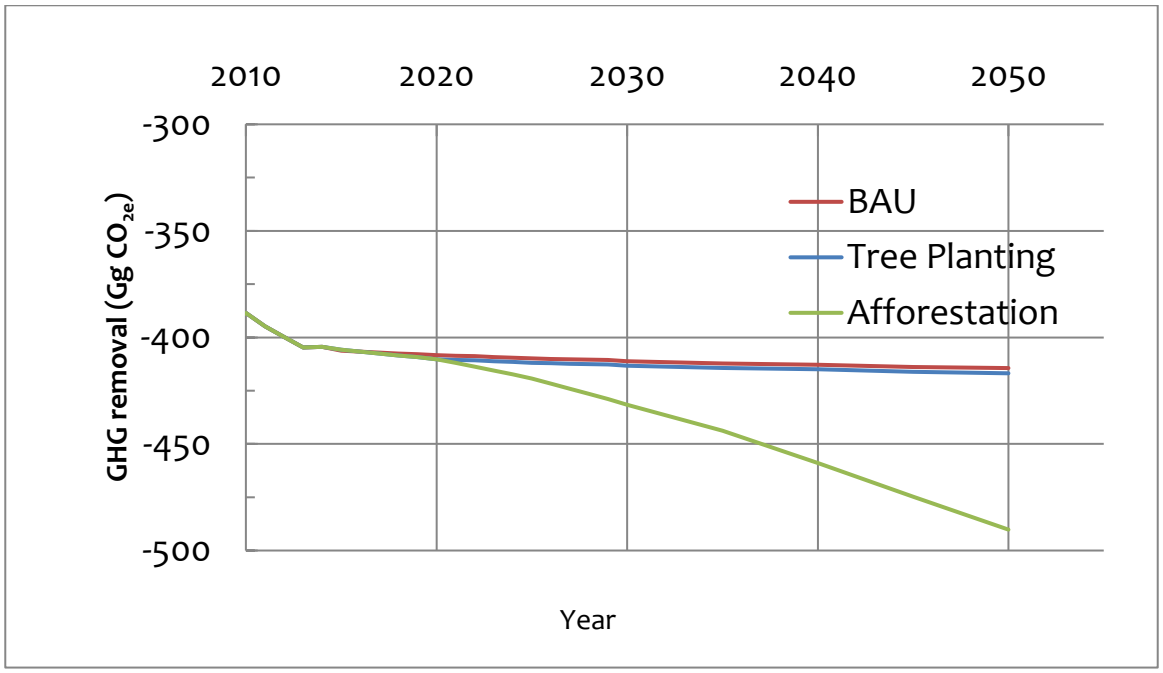


Figure 4.9 Carbon sequestration scenarios in LULUCF (2010-2050)

The Strategic Plan 2016 – 2020 of the Ministry of Agro-Industry and Food Security (2016) makes provision for tree planting between 2016 and 2020. A total of 100 000 plants are expected to be planted annually. However, some are ornamental plants and some are for replanting clear-felled forest areas and gaps. Because of the inclusion of ornamental plants, the number of plants that add to net carbon sinks is less than that mentioned in the Strategic Plan. Further, it should be noted that trees planted in clear-felled forest areas and gaps are merely replacing trees that were already accounted in BAU scenario. Hence, these trees are not included in the policy scenario in order to avoid double accounting. In the Tree Planting scenario shown in Figure 4.9, the number of trees planted outside forest areas and their distributions in terms of native and exotic trees are captured in Table 4.13. The areas of Dry Lowland (DLL), Moist, and Wet Upland (WUL) forests planted with different exotic species are specified in the calculations shown in Annex 18(f) of the e-version of TNC.

Table 4.13 Parameters for Tree Planting scenario for trees outside forest areas

Parameters	**2016**	**2017**	**2018**	**2019**	**2020**
Total area planted (ha)	25	35	40	45	50
Approximate number of trees	30 100	38 500	44 000	49 500	55 000
Ratio of native to exotic plants	1.17	1.25	1.50	1.75	2.00

Source: Forestry Services, Ministry of Agro-Industry and Food Security

The net increase in carbon sink arising from the Tree Planting scenario (Figure 4.9) is marginal at 1.90 $GgCO_{2e}$ in 2020; 2.14 $GgCO_{2e}$ in 2030; 2.14 $GgCO_{2e}$ in 2040; and 2.45 $GgCO_{2e}$ in 2050.

A scenario was developed in the SNC to investigate the impact of afforesting 5 000 ha of abandoned sugar cane land on GHG sinks. Although the abandoned land is yet to be made available for afforestation, an Afforestation scenario has been developed to investigate the change in stock of GHG sinks by afforestation of 5 000 ha of ex-sugar cane land between 2021 and 2050. The Afforestation scenario, therefore, builds on the Tree Planting

scenario that covers only the period 2016 to 2020. It is assumed that all of the 5 000 ha of land is available in the agro-ecological zone of Dry Lowland (DLL). The parameter used in the Afforestation scenario are summarised in Table 4.14.

Table 4.14 Area afforested with native and exotic species in the Afforestation scenario

Time period	Area planted with native tree species (ha/yr)	Area planted with exotic tree species (ha/yr)		
		Araucaria	Eucalyptus	Tabebuia
2021 - 2025	50	12.5	25	12.5
2026 - 2030	75	18.75	37.5	18.75
2031 - 2035	75	18.75	37.5	18.75
2036 - 2040	100	25	50	25
2041 - 2045	100	25	50	25
2046 - 2050	100	25	50	25

Source: Forestry Services, Ministry of Agro-Industry and Food Security

However, due to competing land uses that have higher monetary added value, and as evidenced by the fact that none of the land has been afforested to date, it is unrealistic to assume that 5 000 ha of land that was previously under sugar cane cultivation will be afforested. Consequently, an Afforestation scenario was run using only 1 000 ha of abandoned sugar cane land. The relative breakdowns between native and exotic species are unchanged – i.e. the only change in Table 4.14 is dividing all parameters by factor 5. The increase in GHG sequestration relative to BAU scenario for the three scenarios is summarised in Table 4.15.

Table 4.15 Summary of GHG sequestration (GgCO2e) in LULUCF

	2020	**2030**	**2040**	**2050**
Tree Planting	1.90	2.20	2.44	2.68
Afforestation (5 000 ha)	1.90	20.48	46.14	75.80
Afforestation (1 000 ha)	1.90	5.81	10.94	17.12

Source: Figure 4.9

4.5 Measurement, Reporting and Verification system

A Measuring, Reporting and Verification (MRV) System is needed for GHG mitigation/sequestration actions to support NAMAs and BURs. The development of a MRV mechanism, while appearing homogeneous when referring to a 'system', can be quite complex. This is especially so when the MRV System has to cater for multiple mitigation sectors/sub-sectors. The mitigation scenarios discussed in Section 4.4 have been carried out against a reference or BAU scenarios. The emission reduction scenarios have been developed using either a project-based level analysis using non-GHG inventory parameters (e.g. energy industries and transport) or analysis using the parameters in the IPCC software (e.g. agriculture, waste and LULUCF). In the last case, the MRV mechanism coincides with that needed for maintaining a robust national GHG inventory.

This section provides the list of parameters and their units of measurement for monitoring the GHG emission reduction given in the scenario analyses of Section 4.4. Where applicable, the institutions responsible for collecting and archiving the data are listed.

4.5.1 MRV for the Energy sector

4.5.1.1 Parameters needed for mitigation scenarios MRV for energy industries

The parameters that need to be monitored for energy industries, the methodologies and data source are listed in. Annex 20. These include the share of Low Cost Must Run (LCMR) power plants/units in the electricity system in the past 5 years; various parameters related to the annual data from each power plant; net calorific value (NCV) and emission factor of each type of fuel used; annual electricity generated from renewable energy sources, and avoided electricity through demand side management

4.5.1.2 Parameters needed for mitigation scenarios MRV for the land transport sector

The parameters that need to be measured and reported for computing and verifying the GHG emission reductions arising from land transport are given in Annex 21. These parameters including passenger and freight mobility are those used in the model developed in Section 4.3.1.2 and detailed in Annex 18(b) of the e-version of TNC. It is proposed that the data should be collected and archived at the National Transport Authority (NTA), and that a QAS put in place with the technical support of Statistics Mauritius (SM).

4.5.2 MRV for Non-energy sectors

As discussed in Section 4.3.2, the mitigation scenarios carried out for the non-energy sectors have adopted the structure/parameters used to calculate the GHG inventories. In these specific cases, the MRV system is identical to that required to calculate the sectoral GHG inventories – i.e. agriculture (crop and livestock), LULUCF and waste (solid waste and waste water).

4.5.2.1 Waste sector

(a) Parameters needed for solid waste mitigation scenarios MRV

The parameters that need to be measured in order to calculate, report and verify the GHG emission reductions emanating from solid waste management are listed in Annex 22. It also provides the methodologies and data source for each of the elements. The parameters include population, waste/capita, composition of waste, quantity of sludge, quantity of industrial waste, Quantity of waste diverted from landfill for alternative uses, LFG capture, Degradable Organic Carbon (DOC) in various types of solid waste, and Fraction of DOC dissimilated

4.5.2.2 Agriculture

(a) Parameters needed for agricultural crops mitigation scenarios MRV

The section covers the parameters that need to be measured in order to calculate, report and verify the GHG emission reductions emanating from crops. The parameters used in the agricultural crops mitigation scenarios are listed in Annex 23.

(b) Parameters needed for livestock management mitigation scenarios MRV

The parameters used in the livestock management mitigation scenarios include enteric fermentation and direct N_2O emissions from livestock manure management. The details of the parameters including the methodologies and data source are listed in Annex 24.

4.5.2.3 LULUCF

(a) The parameters used in the LULUCF sequestration mitigation scenarios are listed in Annex 24

The parameters needed for sequestration scenarios MRV include the area of land planted/forested with trees by type; average annual above-ground biomass growth; ratio of below-ground biomass to above-ground biomass; wood and fuelwood removal; area affected by disturbance; Fraction of biomass lost in disturbance¸ Average above-ground

biomass of areas affected; and carbon fraction of dry matter. The parameters needed, the methodologies proposed and the data type and source are given in Annex 25.

CHAPTER FIVE

CHAPTER 5 INTEGRATION OF CLIMATE CHANGE CONSIDERATIONS AND DISASTER RISK REDUCTION (DRR) INTO SUSTAINABLE DEVELOPMENT PLANS AND PROGRAMMES

5.1 Introduction

The Government has adopted a series of proactive and integrated approaches to deal with climate change adaptation and mitigation which are among its top priorities for the period 2015to 2019. Over the last six years, a number of policy measures has been adopted in the context of climate change. In view of its commitment to address climate change in collaboration with all nations, RoM was among the first 15 countries to sign and ratify the Paris Agreement in New York on 22 April 2016.

5.2 Measures taken to integrate climate change considerations into sustainable development policies and actions

5.2.1 Vision 2030

Government has set up a High-Powered Committee to prepare a Blueprint for Vision 2030 which comprises action plans for immediate priorities like air access policy, poverty alleviation, employment creation and sustainable development through Innovation. The 2030 Agenda for Sustainable Development will guide policy making and resource mobilization for the next 15 years. The SDGs, which include a Goal on climate change, are being integrated within Vision 2030.

5.2.2 Intended Nationally Determined Contributions (INDC)

In September 2015, RoM submitted its Intended Nationally Determined Contributions (INDC) (GoM, 2015). In March 2016, the Cabinet has agreed to an Action Plan for the implementation of measures contained in the INDC. RoM aims through its INDC to abate GHG emissions by 30%, by the year 2030, relative to the business-as-usual scenario by transitioning to a low-carbon development path through accrued utilisation of renewable energies, subject to provision of grant finance, technology development and transfer, and capacity building. In order to fulfil totally its commitments and achieve climate change resilience through the implementation of adaptation and mitigation measures, financing of the order of USD 5.5 billion (conservative amount) is required.

The INDC Action Plan and the National Climate Change Adaptation Policy Framework (Box 5.1) include measures on land drainage and infrastructure, coastal zone, water, food security, health and biodiversity as well as mitigation measures in sectors such as renewable energy, energy technologies, low emission transport, and waste management.

5.2.3 Public Sector Investment Programme 2016 - 2018

Disaster risk concerns linked to climate change issues are taken on board in public investment plans.
The Public Sector Investment Programme (PSIP) 2016-2018 makes provisions for:

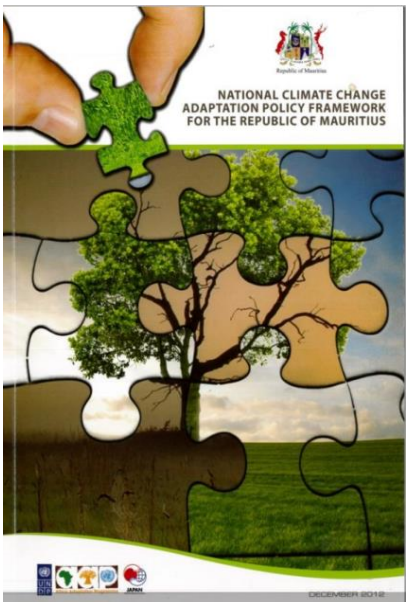
a) the purchase of critical disaster risk equipment, specialized vehicles and equipment for National Emergency Operations at a total cost of MUR 10 million
b) the installation of a Multi-Hazard Early Warning, Emergency Alert and Advisories System, at the total cost of MUR 35 million
c) the upgrading, maintenance and construction of new drains in flood prone areas

d) the training of some 150 community members in disaster prone areas
e) the construction of a refuge centre in the Quatre Soeurs region by June 2017. This centre will be dedicated for use by the community members in the event of landslides or other disasters in the South Eastern region of the island.

The creation of a new Department of Climate Change at MoESDDBM has already been approved. The Department, once established, has as mandate to formulate a 10-year Climate Change Investment Programme by FY 2017/2018 and will take on board various cross-sectoral and overlapping actions on climate change.

5.2.4 National Climate Change Adaptation Policy Framework

The Government commissioned a National Climate Change Adaptation Policy Framework in 2012 (Box 5.1) , under the Africa Adaptation Programme (AAP) (Figure 5.1). The Framework aims at integrating climate change and disaster risk reduction into core development policies, strategies and plans.



Source: MoESDDBM

Figure 5.1 Poster on National Climate Change Adaptation Policy Framework

5.3 Disaster Risk Reduction Strategic Framework and Action Plan

In line with the *Hyogo Framework for Action* (HFA) 2005-2015 and the *Sendai Framework for Disaster Risk Reduction (2015 – 2030)*, a Strategy and Action Plan for Disaster Risk Reduction, mainstreaming the likely effects of climate change was prepared under the AAP. The 2013 DRR Strategic Framework and Action Plan takes into consideration the substantial area of RoM, which is exposed to inland flooding, coastal inundation and landslides.

The Government has enacted a National Disaster Risk Reduction and Management Act in July 2016. The new Act provides for a legal framework to the National Disaster Risk Reduction and Management Centre (NDRRMC) for the prevention and reduction of the risk of disasters; mitigation of the adverse impacts of disasters; disaster preparedness; effective response to disasters; and, management of post-disaster activities, including recovery and rehabilitation. The Act also provides for the setting up of a National Disaster Risk Reduction and Management Council, which will lay down national guidelines and oversee the implementation of the Management Policy, Management Plan and Strategic Framework related to National Disaster Risk Reduction.

Box 5.1 Key sectoral policy goals (Adaptation Policy Framework)

The National Climate Change Adaptation Policy Framework

Key policy goals for water demand and supply

i) *Develop a long-term national water management plan which incorporates and addresses climate change concerns including catchment and watershed protection and saltwater intrusion*
ii) *Incorporate the national adaptation strategy for the water sector into the land use planning and management processes*
iii) *Promote the strengthening of national water management agencies to ensure the sound management of water resources*
iv) *Assess and address needs for water storage and distribution infrastructure to ensure water availability during drought periods*
v) *Undertake measures to increase the resilience of aquifers and rivers to maximize water availability and reduce degradation of water quality*
vi) *Promote initiatives to identify and, where necessary, exploit non-traditional water resources such as sea-water through desalination.*

Key policy goals for agriculture and terrestrial ecosystems

i) *Develop a national adaptation strategy for the agriculture sector, as part of the national climate change adaptation strategy, to address impacts over the short, medium and long term*
ii) *Include adaptation policies into the national policy formulation process*
iii) *Formulate and implement any other such strategies and measures which may help to ensure food security and sustainable food production*
iv) *Endeavour to transform the food crisis into an opportunity for farmers and to build resilience in order to reduce the country's food dependency on imports*
v) *Ensure the maintenance and operation of a Food Security Fund to sustain the implementation of adaptation measures.*

Key policy goals for fisheries and marine ecosystems

i) *Promote and facilitate the undertaking of ongoing multi-disciplinary assessment of coastal and marine ecosystems, to ensure that needs of marine life are understood and taken into account for fisheries and coastal zone management*
ii) *Strengthen fisheries governance at national and regional levels*
iii) *Ensure the continuation, expansion and strengthening of capacity for artisanal fishers*
iv) *Identify and promote alternative fishery and resource use activities (e.g. aquaculture) where impacts on ecosystems and natural resources preclude the continuation of traditional activities*
v) *Endeavour to create and maintain appropriate infrastructure for storm forecasting, signalling systems and safe refuges for dealing with rising sea level and increased storminess.*

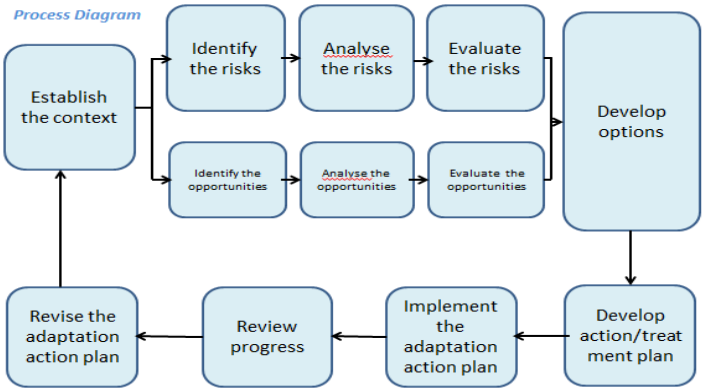
Key policy goals for tourism and coastal management

i) *Ensure that appropriate physical planning guideline such as coastal setbacks are enforced for new tourism developments, and possibly consider the extension of the coastal setback to 45 metres (from 30 metres)*
ii) *Undertake measures to incorporate tourism development with natural resources management such as ICZM to preserve ecosystem services*
iii) *Facilitate the protection and rehabilitation of tourism resources, including natural resources such as beaches and man-made resources (infrastructure)*
iv) *Continue working with stakeholders in the tourism sector to develop a strategic plan that incorporates climate change considerations and appropriate measures such as water conservation programmes as well as general safety and sustainability concerns (e.g., hotels with over 75 rooms are already requested to recycle and reuse water.*

5.3.1 Climate Change Charter for Local Authorities

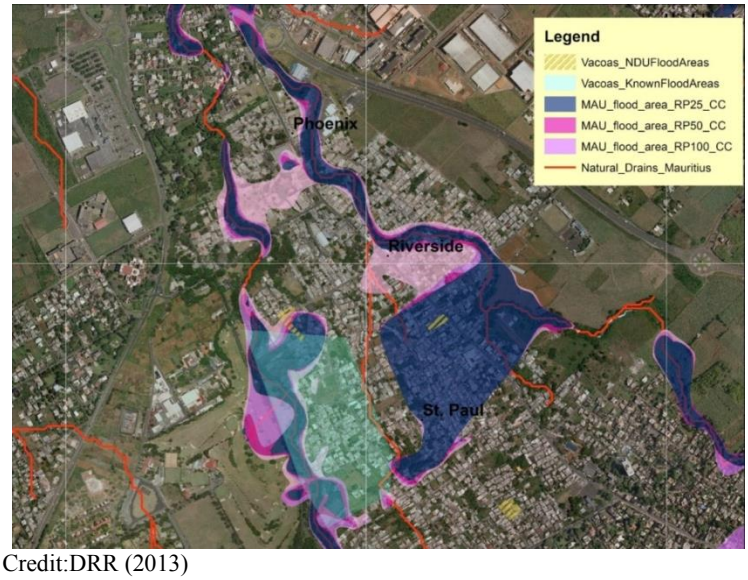
In order to mainstream climate change in the development agenda of local authorities, a *Climate Change Charter for Local Authorities* has been developed with the objective of initiating and upscaling actions on adaptation to the adverse impacts of climate change and on the mitigation of GHGs emissions at their respective council and community levels. Vulnerability assessment and identification of adaptation option toolkits for three local authorities, namely Municipal Council of Vacoas-Phoenix (MCVP), Moka District Council and the Municipal Council of Curepipe have been developed to help them implement prevention, protection and preparedness measures to address the adverse effects of climate change and extreme weather events.

In the case of MCVP, the approach adopted, with the participation of stakeholders is given in Figure 5.2. Figure 5.3 shows the flood hazard map for Phoenix and St. Paul areas.



Source: ICLEI Oceania Local Government Climate Change Adaptation Toolkit

Figure 5.2 Toolkit process diagram



Credit:DRR (2013)

Figure 5.3 Flood hazard map for Phoenix and St. Paul areas

Similar toolkits will be developed for other local authorities.

5.3.2 Agriculture

In order to address the challenges posed by climate change impacts and simultaneously progress towards reaching national targets of food security and competitiveness in the agriculture sector, a Strategic Plan 2016-2020 for the Food Crop, Livestock and Forestry (GoM, 2016) is currently being implemented with the overall goal 'to raise the national food security level by maintaining self-sufficiency in those agricultural products where it is possible and by generating a significant, concomitant increase in local production of others'. This should be achieved through a shift to sustainable agricultural practices and by using methods of production and protection that are eco-friendly but conducive to safer and better human nutrition. The Plan focuses on promoting sustainable management of land, water and other natural resources, and on building capacity to enable farmers to face climate change and move on to 'climate-smart agriculture'.

For the sugar sector, the research and development plan for period 2016-2020 (MSIRI, 2016) aims at contributing to the long-term sustainability for a resilient Mauritian cane industry capitalizing on the multi-faceted potential of the sugar cane plant to deliver a multitude of components, either naturally or industrially with limited impact on the environment.

5.3.3 Land Use and Forestry

Various legislations have been enacted and policies formulated to protect forests. The latest legislation for the management and protection of biodiversity is the Native Terrestrial Biodiversity and National Parks (2015).

Moreover, several strategies and action plans have been formulated to halt and reverse the trend of forest loss and degradation. Some major documents that emphasises forest protection and restoration are: The National Forest Policy (2006), Strategic Plan for the Food Crop, Livestock and Forestry Sectors, National Biodiversity Strategy & Action Plan (2016 – 2020), The Protected Area Network (PAN) and the PAN expansion strategy.

5.3.4 Biodiversity

The Mauritius Fifth National biodiversity report to the CBD is a key policy document informative to the resilience of Mauritian biodiversity to climate change impacts. The report also earmarks ecosystem-based adaptation to climate change as a priority for Mauritius biodiversity.

The National Biodiversity Strategy and Action Plan (NBSAP) highlights some of the key adaptation options. It includes the building of ecological resilience at landscape scale by protecting habitats and reducing anthropogenic pressures while increasing connectivity by establishing conservation linkages across the landscape and thereby facilitating the adaptation of species to climate change. NBSAP is currently under review and it is planned to include measures to conserve and sustainably use the biodiversity of the country. It will pave the way for Mauritius to meet its commitments regarding the 20 Aichi targets. A Protected Area Network Expansion Strategy (PANES) has been drafted.

5.3.5 Water sector

Projections made using the MAGICC_SCENGEN model indicates that the utilisable water resources will decrease by up to 13% by 2050. The changes in pattern of rainfall with more episodes of heavy rainfall of short duration separated by longer dry spells are expected to allow only a reduced amount of precipitation to reach the storage system. These changes are projected to exacerbate water scarcity in Mauritius. Increase in storage capacity is therefore critical to meet future water demand.

Improving water security and the regularity of potable water supply for the population is among the top priorities of the Government. The Government is planning to reform and modernize the supply and distribution of water. Its

Master Plan for "*Development of the Water Resources in the Republic of Mauritius*" provides a road map to realize the integration and management of water resource up to horizons 2025 and 2050.

The Midlands Dam has improved the supply of domestic and non-potable water, and the irrigation of the northern flatlands of Mauritius. To respond to the need for more water storage and retain water during flash flood from runoff to the sea, additional water dams are being planned. The Bagatelle Dam is under construction and the building of two additional dams are planned to further increase water storage so as to meet water demand in the future and expected decrease in rainfall as a consequence of climate change.

Credit: lemauricien.com

Figure 5.4 Bagatelle Dam under construction

The Government recognises the importance of rain water harvesting in reducing water consumption. It has therefore introduced a scheme whereby

i) soft loans are being provided to households to purchase water tanks for rain water harvesting
ii) crop/livestock farmers are being provided with partial funding as grant for the acquisition of appropriate equipment to collect, store and use rainwater on-farms for agricultural production solely, and light structures for collection of rain-water.

For the period 2016/2017, a budget of MUR 7.2 million has been earmarked for MoESDDBM to enhance the rainwater harvesting system scheme for local authorities (market and fairs), Government agencies (Government buildings), schools and NGOs. The objectives of the scheme are to:

i) encourage local authorities, schools and Government agencies to use rainwater for non-potable water needs such as washing their yards, use in toilets, and watering of gardens
ii) reduce water costs for local authorities which have a high level of water usage for markets and fairs
iii) improve public awareness of rainwater harvesting through the development of a brochure for use by schools and community groups

5.3.6 Coastal Zone Management and Tourism

Coastal resources and ecosystems provide vital goods and services, which contribute significantly to the socio-economic development of the country in terms of foreign earnings and employment. Hence their protection and conservation that take into account climate change impacts are of high priority. A *Guideline for Climate Change Adaptation Strategy Coastal Setback* has been developed with the collaboration of the Japan International Cooperation Agency (JICA). This innovative tool will help guide planners, developers and policy makers in selecting the most appropriate set back, based on site specifications and on risk and vulnerabilities of environmental sensitive areas and those arising from long-term erosion, sea level rise and wave surges during extreme events. Table 5.1 provides the list of coastal zones examined and the proposed setback.

Table 5.1 List of coastal zones examined and proposed setback

Coastal zone	Proposed setback
Baie du Tombeau	50m
Pointe aux Canonniers	50m
Mon Choisy	40m
Bras d'Eau	30m
Quatre Cocos (Verger) and Trou d'Eau Douce	40m
Ile aux Cerfs	Only climate-resilient measures and activities can be considered
Pointe d'Esny	30m
Bel Ombre	50m
Le Morne	60m
Flic en Flac	30m
Albion	30m
Pointe aux Sables	30m
Grand Sable	30m

Source: MoESDDBM

In order to move the tourism sector to a low carbon growth path, the Ministry of Tourism and External Communications has developed a Mauritian Standard as a management system for sustainable tourism which is to be submitted to the Global Sustainable Tourism Council for recognition and accreditation.

5.3.6.1 Ecosystem-based adaptation

The visible and measurable effects of climate change in the coastal zone of RoM have become more prominent over the last ten years. They reflect increases in the rate of negative changes in the coastal zone, due to climate change and an increase in the number of vulnerable sites. As a way to maintain the vitality, aesthetics and ecological functioning of the coastal ecosystems, the Government, with the assistance of JICA, has developed a Coastal Conservation Plan under the project for Capacity Development on Coastal Development and Rehabilitation in RoM (June 2015). Among the 20 coastal areas which were selected for the basic study, 14 were identified as priority areas for implementing a coastal zone conservation plan.

5.3.6.2 Mangrove propagation for the protection of coastal resources and enhancing carbon sequestration

Mangroves are almost five times more effective than land forest in sequestering carbon. They also protect coastal zones from heavy waves and beaches from erosion. In the Technical Needs Assessment Report (GoM, 2012), vegetation restoration was recommended as one of the priorities for the protection of coastal zones. As a consequence, an intensive mangrove propagation programme is being promoted to increase mangrove forest following a drastic decline in mangrove cover which stood at only 45 ha in 1980 (Table 5.2)

Table 5.2 Mangrove areas in hectares

Year	1980	1990	2000	2010	2015
Areas under Mangrove (ha)	45	70	90	145	182

Source: Food and Agriculture Organization of the United Nations, 2007 and AFRC 2016

A Mangrove Propagation Programme with the aim of protecting and rehabilitating denuded areas and sensitising the public about the importance of the ecosystem was implemented in 1995 by the Government. From 1995 to 2004, around 384 700 mangrove seedlings have been successfully planted over the coastal strip.

Several NGOs are now engaged in mangrove propagation with funding from the private sector and international agencies. Two species exist in Mauritius. The dominant *Rhizophora mucronata* Lam. (Figure 5.5) covers almost 95% of the area under mangrove, and the remainder comprise the rarer *Bruguiera gymnorrhiza* (L.) Lam.

Credit: ADD

Figure 5.5 Newly planted *Rhizophora mucronata* field at Case Noyale with the historic Le Morne Mountain in the background

5.3.7 Energy sector

The objective in the energy sector is to reduce dependency on fossil fuels, encourage the use of renewable sources, and manage demands through energy efficiency measures while ensuring energy security. The Government has set a target for increasing electricity generation from renewable energy sources to at least 35% by 2025 and maintaining at the same level until 2030. The technologies envisaged to reach these targets comprise energy efficiency and renewable energy technologies including solar PV, wind, renewable biomass, and waste-to-energy. The Long-term Energy Strategy, the Energy Efficiency Master Plan and the Renewable Energy Master Plan were discussed in Section 4.3.1.

5.3.7.1 Actions for energy efficiency to reduce fossil fuel imports

Energy Efficiency (EE) is considered as a potential solution to the dependency on fuel import and to reducing the growing demand for electricity. Several actions are aimed at promoting EE:

i) The Energy Efficiency Act 2011 established the Energy Efficiency Management Office (EEMO) in 2011 to develop and implement strategies, programmes and action plans, including pilot projects, for the efficient use of energy

ii) The Building Control Act 2012 foresees that each building shall, among others, be designed, constructed and maintained in such a way as to guarantee the protection of the environment, save energy and optimise energy consumption for the proper operation of the building and mitigation of heat island effect in urban areas.

In 2014, a report on Consolidated Assessment of Potential for Energy Efficiency and Demand Side Management in Mauritius, and Current Incentive Structures estimated the EE potential from the perspective of three scenarios

namely (i) no measures, (ii) the base case, and (iii) EE. The average annual electricity reduction potential by the measures in the existing Action Plan 2011-2015 (the base case scenario) in comparison to the no measures scenario until 2030 is 396.1 GWh/year. By applying the additional measures of the EE scenario in comparison to the base case scenario until 2030, the reduction potential is 198.8 GWh/year. The total annual reduction potential of electricity by using the measures (ii) and (iii) is 594.9 GWh/year.

5.3.7.2 Use of solar water heaters to reduce electricity consumption

Government is offering incentives to households to purchase solar water heaters (SWHs) in an attempt to reduce electricity consumption. Phase 1 of this scheme was launched in 2008 and provided grants of MUR 10 000 (about $315 USD) per SWH. 24 000 households benefited from the scheme at a cost of MUR 250 million (about $7.9 million USD). During Phase 2 (2012), 14 600 applicants and during Phase 3 (2012)
19 700 applicants benefitted from the scheme. The Government will continue with SWH scheme (Phase 4) whereby at least another 14 000 households will benefit from a grant. To this effect MUR 90 million has been earmarked in the June 2016/June 2017 budget. To date, some 70 000 SWHs have been installed since 2008.

Additional loan facilities and incentives exist alongside SWH schemes. An amount of €60 million is being allocated for investment through 2017, which may help finance larger SWH projects at the commercial and industrial level (Agence Française de Développement, 2014). The Mauritius Commercial Bank has also offered free SWHs to customers taking housing loans above MUR 1 million ($31,400 USD).

5.3.8 Infrastructure

The Government recognizes energy efficiency and energy conservation as proven means to deal with the energy and environmental challenges lying ahead, and to promote sustainable development. The Energy Efficiency Building Code (EEBC) is viewed as one initiative aimed at achieving energy efficiency in the building sector.

In 2012, EU funded a project to establish a comprehensive framework to promote the construction of sustainable buildings in Mauritius and Rodrigues. More recently, in 2015, under a UNDP funded project, the Government architectural specifications and construction methods were reviewed to include green building requirements.

The Mauritius Commercial Bank at the Ebène business hub of Mauritius (Figure 5.6) is the first building in the Southern Hemisphere to achieve a Building Research Establishment Environmental Assessment Method (BREEAM) rating.

Credit: MCB

Figure 5.6 Mauritius Commercial Bank in Ebène business hub

The MPI&LT oversees the implementation of infrastructure projects, such as roadways and Government buildings and the management and development of land transport infrastructure. The Ministry is expected to build capacity to adapt to the new requirements in the EEBC.

In order to integrate climate change into Environmental Impact Assessment (EIA) in RoM, a report on recommendations for mainstreaming climate change into the EIA framework was prepared under the Africa Adaptation Programme.

5.3.9 Health sector

In order to address the challenges posed by the health impacts of climate change and at the same time attain the Sustainable Development Goal 2030, actions have been initiated by the Government, in collaboration with other relevant entities, to strengthen climate-resilient health systems for enhanced preparedness to cope with the anticipated increase in disease burdens from climate-sensitive diseases such as vector-borne diseases, respiratory and diarrheal diseases; diseases and injuries associated with extreme events and worsening of food security and nutrition. The resilience of the health system could be tested during an epidemic, such as the Ebola virus outbreaks in parts of West Africa in 2015 and the chikungunya outbreaks in Mauritius in 2006.

5.3.9.1 Health Services response

In the event of calamities such as cyclones and floods, a 24-hour watch is provided by the five regional hospitals and the SAMU Emergency Service. Well-equipped SAMU ambulances manned by personnel trained in emergency services attend to patients requiring urgent health services and transfer to hospitals, if admission is required.

The health services response to epidemics has been reinforced through the elaboration of contingency plans to cater for increased hospital surge and provision of isolation facilities. The Souillac Hospital has been upgraded with isolation facilities and trained health care providers for highly contagious diseases. With regard to casualties from cyclones, tsunamis and other disastrous events, emergency plans exist in all regional hospitals to deal with such situations.

5.3.9.2 Vector Surveillance and Vector Control Programme

Vector Surveillance and control activities are operational throughout the year. An integrated approach has been adopted, focusing on environmental management to eliminate breeding sites, ensure community mobilisation, and the use of chemicals such as the environmental friendly pyrethroids as larvicides or insecticides. A monitoring unit for vector surveillance has been set up at the Ministry of Health and Quality of Life. Regional Integrated Vector Management (IVM) Inter-sectoral committees have been set up in all five regions. The committees are activated during periods of outbreaks of mosquito-borne diseases.

5.4 Poverty reduction

In 2015, Government, with technical assistance from UNDP, has embarked on the development of a "*Marshall Plan Against Poverty*" to eliminate poverty, and reduce inequality and social exclusion in Mauritius and Rodrigues.

The project will evaluate the efficiency of ongoing programmes on poverty alleviation and social protection, and review existing policies and framework programmes and make proposals for an integrated sustainable approach. The causes of poverty will also be investigated and recommendations formulated on ways to address them with greater focus on the self–sufficiency of individuals and households. The Marshall Plan will, among others, cover social protection, social housing, social inclusion and community development, access to education and development of competencies/capacities, and employment and sustainable livelihood/economic opportunities for the most vulnerable groups, especially those people with disabilities. The Plan will also cover women empowerment, youth economic empowerment, access to services, including, electricity, water, sanitation, transportation, ICT facilities and environmental protection and its relation with social integration.

Mauritius has seen rapid economic growth and development in the last few decades. This development has resulted in improved livelihood of the population, which has led to an increase in environmental issues. As a result, the preservation of the fragile environment is one of the challenges that have to be addressed if the country is to continue with its impressive record of economic growth.

The Marshall Plan will integrate factors such as climate change, disaster risk reduction and environment protection in order to achieve the SDGs that comprise national poverty eradication as a priority.

5.5 Gender

As women play a crucial role in climate change adaptation and mitigation actions (*Women, Gender Equality and Climate Change, UN Women Watch 2009*). They are increasingly involved along with men in all decision-making processes on climate action. This approach will be a significant factor in meeting the challenge of climate change and in achieving the long-term objectives of the UNFCCC.

Gender has also been dealt with as a cross-cutting policy issue in the National Climate Change Adaptation Policy Framework which was formulated under the Africa Adaptation Programme (AAP). The planned Nationally Appropriate Mitigation Actions for Low Carbon Island Development Strategy (NAMA) project will also take into account gender aspects and impacts.

The Mauritius INDC also takes into account gender issues. The importance of gender mainstreaming is duly recognised in forthcoming initiatives such as the booklet *"Guide pour la famille"*, which illustrates practical actions which can be taken at household level to combat climate change. The Climate Change Bill makes provision for gender consideration in initiatives on climate change.

MoESDDBM is presently reviewing its Gender Policy Statement of 2012 which adheres to the operational guidelines of the National Gender Policy Framework (2008). The Statement provides a framework for mainstreaming gender in policies, programmes and activities of the MoESDDBM. The Framework further provides guidelines to the public and private sectors, the media and civil society organisations to incorporate gender in their policies and programmes. It highlights key sectoral interventions and focuses attention on emerging areas so as to promote women's equal participation with men as decision-makers and equal partners in shaping a sustainable development society. A user-friendly pamphlet on women and climate change has been developed under the AAP. In addition, a DVD entitled '*fam ek sanzman klimatik'* has been produced for public awareness raising and education on climate change.

5.6 Waste management

5.6.1 Solid waste management

Locally, each household produces around 400 to 600 kg of organic waste annually, which has severe impact on the economy and the environment. The Government has introduced the Household Compost Scheme (HCS) to help the local authorities to reduce significantly the quantity of organic waste sent to the landfill and eventually contribute in reducing GHG emission. Under the HCS Phase 1, 12 000 compost bins were distributed in 2012. Under Phase 2, in 2014, around 12 000 compost bins and an equal number of mixing tools have been distributed. In Rodrigues, 1 000 compost bins and mixing tools have been distributed.

During Phase 3, a budget of MUR 10 million has been earmarked for the period 2016/2017 whereby 10 000 compost bins and 10 000 mixing tools will be distributed. Some 5 000 compost bins will be made available to registered small planters.

5.6.2 Wastewater management

Under the Mauritius Second Wastewater Master Plan Study 2012, a number of projects have been identified to provide road maps for the development of wastewater infrastructure. The implementation of these projects will

increase the percentage of households connected to public sewer network to about 80% by 2033. Some of the innovative projects include:

i) The treatments plants at St Martin and Grand Baie that treat wastewater up to tertiary level for irrigation during dry periods and in regions where there is scarcity of water supply. Thus, planters in the western region use the treated wastewater from the St Martin Waste Water Treatment Plant (WWTP), whereby planters are currently receiving about 19 000 m^3/day of treated effluents whilst the promoters of the Mon Choisy IRS project are using about 400m^3/day of treated waste water.
ii) The St Martin WWTP that is using methane gas obtained from anaerobic digestion of sludge to produce about 25% electricity demand of the WWTP.

5.7 Activities related to technology transfer

A Technology Needs Assessment (TNA) was carried out in 2012, with the technical support of URC (Denmark) and the UNEP's Division of Technology, Industry and Economics (Paris). Its key aim was to bridge the gap between the mere identification of appropriate technologies and the design of action plans that would enable RoM to implement technologies that reduce GHG emissions and support adaptation to climate change that are consistent with national development priorities.

The report has assessed the technology needs for adaptation in the water, agriculture and coastal zone sectors, and mitigation technologies in the energy industries (Box.5.2). A multi-stakeholder process has been adopted for the identification and prioritisation of technological options using a linear additive Multiple Criteria Analysis framework. A total of 128 technologies have been identified and 12 have been recommended.

Box 5.2 Technology needs for adaptation in four selected sectors

Technology Needs Assessment (2012)

Some of the technologies recommended in the TNA for the priority sectors are as follows:

i) *Agriculture*: Integrated Pest Management and micro-irrigation
ii) *Water*: Rainwater harvesting at residential level and hydrological modelling and desalination technology for effective water resources management
iii) *Coastal Zone*: Dune and vegetation restoration, rock revetment and wetland protection
iv) *Energy*: Utility-scale wind energy and industrial and commercial waste heat recovery using boiler economiser

5.8 Research to adapt to and mitigate climate change

In 2014, climate change was integrated in the amended Mauritius Research Council Act. A representative of the Climate Change Division is a board member of the Council. Within the Africa Adaptation Programme (2010-2012), research projects related to climate change were undertaken and details are available in the Chapter on Research and Systematic Observations.

CHAPTER SIX

CHAPTER 6 TECHNOLOGY TRANSFER AND DEVELOPMENT

6.1 Introduction

Mauritius has previously benefited from technical assistance financed by the Global Environment Facility (GEF) to implement the TNA project that provides a robust methodological approach to developing mitigation action plans in the form of Technology Action Plans (TAPs) to support the transfer and diffusion of environmentally sound technologies (ESTs).

A learning-by-doing approach was adopted in developing the mitigation action plans using the TNA process. It is recommended that the process for mitigation technology development and transfer should be reinforced when developing the First BUR.

6.2 Methodology

The TNA can be defined as a three step process as follows:

i) Identifying and prioritizing mitigation technologies using multi-criteria analysis (MCA)

ii) Carrying out detailed barriers analysis for prioritized technologies and to find solutions to overcome barriers. This step also involves determining the enabling framework to promote the prioritized technologies

iii) Developing the technology actions plans (TAPs).

The process was applied to the mitigation technologies discussed in Chapter 4.

6.2.1 Selection of MCA criteria and indicators

The approach used in the TNA project was adopted for selecting MCA criteria and indicators based on the MCA4Climate framework. The criteria and indicators listed in Table 6.1 were selected for technology prioritisation. The MCA covers the period up to 2030 in order to be aligned with the INDC timeframe.

Table 6.1 Criteria and indicators for mitigation technology prioritisation

Criteria	Indicators	Measurement scale	Weight
Financing needs	Direct incremental cost	MUR/tCO_2	0.15
Implementation barriers	Ease of implementation e.g. non-financial barriers	Likert scale: 0 (highest barrier) – 100 (lowest barrier)	0.15
Climate-related	GHG reduction or sequestration	tCO_2 (to 2030)	0.25
Economic	i) Catalysing private investments ii) Reduction in energy import bill iii) Replicability	i) Likert scale: 0 (lowest) – 100 (highest) ii) M MUR (million MUR) (to 2030) iii) Likert scale: 0 (lowest) – 100 (highest)	0.15 0.10 0.05
Social	i) Impact on health ii) Job creation	i) Likert scale: 0 (lowest) – 100 (highest) ii) Quantity (to 2030)	0.05 0.10

6.2.2 Barriers analysis

The transfer and development of technology assumes that mitigation technologies face barriers and constraints in the baseline situation. The Logical Problem Analysis (LPA) is used to identify the root causes of main barriers hindering the diffusion of mitigation technologies. Barrier decomposition is carried out using a multi-stakeholder process to generate a Problem Tree (PT). Measures to overcome the root causes that impede the transfer and development of mitigation technologies are obtained by mirroring the PT (RoM, 2013).

6.2.3 Results of MCA

The results of MCA are summarised in Annex 16. The annex also provides the MCA calculators that have been customised for each sector, including the calculation of quantifiable indicators. The ranking of mitigation (or sequestration) technologies has been done using the weighted sum of scores after normalising the scores of all indicators on a Min-Max (i.e. 0 to 100) scale.

6.3 Results of Barriers analysis

The methodology used to arrive at the root causes of the barriers faced by a technology is described for the case of the scaling up of wind energy in the energy industries.

The PT for the scaling up of wind energy in Mauritius is shown in Figure 6.1. It shows that utility-scale wind energy faces four major constraints for realising its full transfer and diffusion in Mauritius. These are: high investment cost (financial barrier), low grid absorption capacity (technical barrier), competing land uses (policy/regulatory barrier), and social acceptability (social/behavioural barrier). When these barriers persist, there is limited penetration of grid-tied wind energy implying higher dependence on imported fossil fuels for electricity generation. This situation translates into lower energy security, higher import energy bill and higher GHG emissions due to combustion of fossil fuels to generate electricity.

The four barriers are de-convoluted to obtain their root causes. In this case, the root causes are: the lack of transparent pricing mechanism for wind energy, the lack of storage capacity for energy of intermittent source, the lack of geospatial information regarding the practical potential of wind energy, and the lack of information on the pros and cons of wind energy. A root cause presents an opportunity for an intervention or mitigation measure for transforming the root cause into an opportunity for removing or reducing the barriers that prevent the transfer and diffusion or scaling up of the mitigation technology.

The further transfer and development of utility-scale wind energy will require the following mitigation measures:

i) establishment of a transparent pricing mechanism for wind energy

ii) enhancing the capacity for storing renewable energy of intermittent sources

iii) development of geospatial information regarding the practical potential of wind energy

iv) Dissemination of information regarding the advantages and disadvantages of wind energy

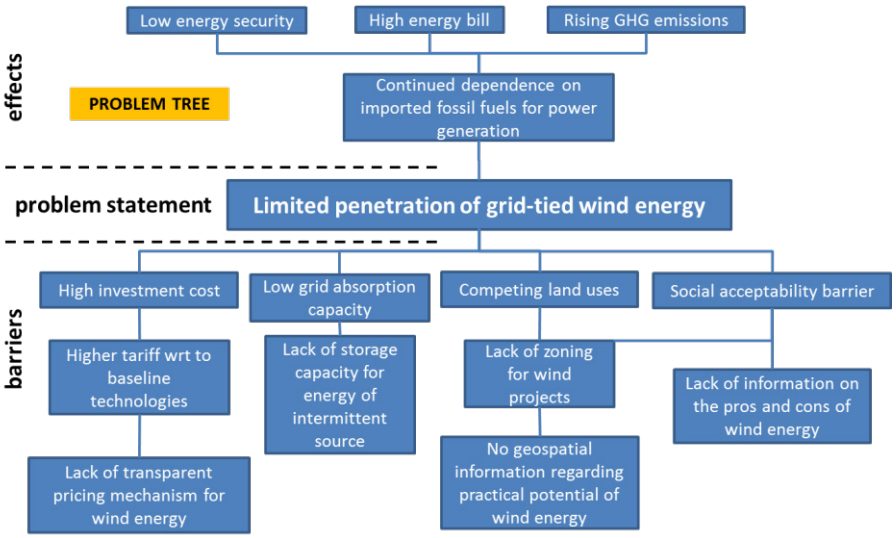


Figure 6.1 Problem Tree (PT) for the implementation of grid-tied wind energy

As shown in Figure 6.2, an objective tree (OT) is developed to identify the measures to include in the action plan for the transfer and development of the mitigation technology.

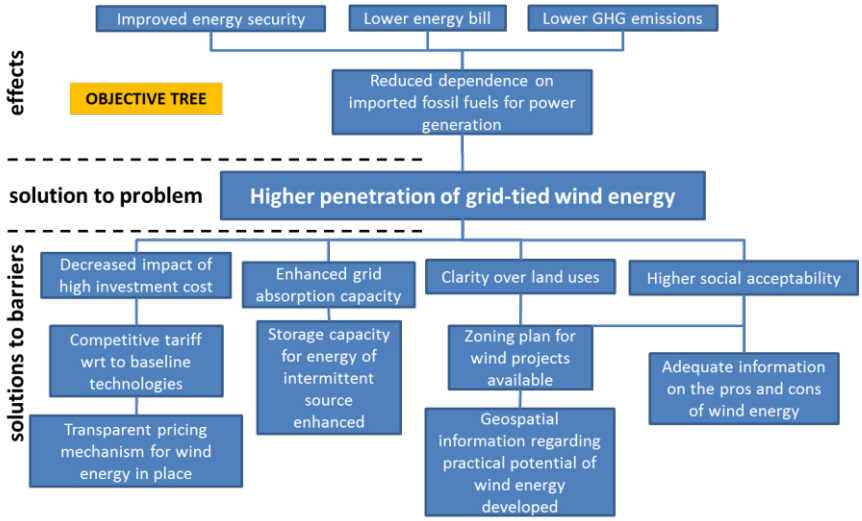


Figure 6.2 Objective Tree for the increased diffusion of grid-tied wind energy

6.4 Mitigation Technology Action Plans

Using the approach discussed in section 4, and addressing the barriers faced by the mitigation technologies, mitigation technology action plans have been developed as summarised in Table 6.2. The costs of implementing the mitigation measures for agricultural crops to 2020 have been estimated, and are given in Annex 17. The cost of implementing the measures for the other sectors and sub-sectors will be work out under in the First Biennial Update Report.

Table 6.2 Sectoral mitigation action plans

Technology	Prevailing barriers	Mitigation measures
Energy Industries		
Energy Efficiency (EE)	Financial	Financial instruments developed and capitalised to promote EE
	Behavioural	Promote the use of lifecycle analysis to better understand the benefits of EE
	Market	Capacity building to develop the technical capacity of end users to identify EE measures, including auditing, prioritising interventions and cost-benefit analysis
	Institutional	• Increase the number of staff of the EEMO so that it can better fulfil its mandate • Enhance networking of national stakeholders to solicit ideas and encourage entrepreneurs in EE
Wind energy (onshore)	Financial	Improve transparent bidding procedures and pricing mechanism for renewable energies, including wind energy
	Technical	Invest in energy storage for renewable energies of intermittent sources (e.g. battery)
	Policy / regulatory	Generate geospatial information of wind potential to develop a zoning plan for the implementation of wind energy
	Social / behavioural	Increase awareness of the pros and cons of wind energy in Mauritius, with focus on the ways to mitigate any of its negative impacts
Solar PV	Financial	Improve transparent bidding procedures and pricing mechanism for renewable energies, including solar PV
	Technical	Invest on energy storage for renewable energies of intermittent sources (e.g. battery)
	Policy / regulatory	Generate geospatial information of solar PV potential to develop a zoning plan for the implementation of utility-scale solar PV
Waste to Energy (WTE)	Social / behavioural	• Carry out a feasibility study concerning the appropriateness of alternative WTE options in Mauritius • Generate and communicate information to wider public regarding the pros and cons of alternative WTE technologies • Develop a zoning plan for locating WTE plant
	Technical	• Include impacts of air emissions on health in feasibility study on the appropriateness of alternative WTE options • Waste streams segregated according to calorific values eases choice of feedstock for energy generation
	Financial	• Invest in infrastructure for waste segregation at source • Establish incentives and disincentives to promote sorting of waste at source
Biomass	Financial	Improve transparent bidding procedures and pricing mechanism for renewable energies, including renewable biomass
	Policy / regulatory	• A biomass strategy and action plan is developed to support renewable electricity generation (biomass policy can be developed as an integral part of an integrated sustainable agro-forestry policy) • Generate geospatial information of renewable biomass potential to develop a zoning plan for the implementation of renewable biomass for power generation (among other aims within the ambit of an integrated sustainable agro-industry strategy)
Road Transport (Land)		
Improved fuel intensity	Technical	System established to make spare parts available on local market
	Information / Awareness	Display of fuel efficiency information is made mandatory through changes in legal / regulatory requirements

Technology	Prevailing barriers	Mitigation measures
	Behavioural	Create awareness programme on the benefits of new technology
Improved vehicle inspection	Financial	Review vehicle examination fees in order to provide visibility on return on investments for private vehicle examination stations
	Human skills	Develop training programme to skill personnel manning the examination stations
	Social / behavioural	Create awareness programme to dispel technology stigmatisation as being against the poor
Hybrid cars	Financial	• Develop financial model for owning and operating a hybrid car using life cycle assessment in order to increase willingness to pay among consumers • Review financial/economic incentive scheme to make uptake of hybrid cars more attractive thereby also increasing scale of economies for parts and batteries
	Behavioural	Create awareness by providing full information on the technology benefits
Ethanol blend	Financial	Design and implement financial incentives for the uptake of blended fuel
	Technology	Establish clear guidelines regarding the stock of gasoline-driven vehicles that may use blended fuel
	Informational	Design awareness campaign to make technical information on blended fuel available to end users
Solid Waste		
LFG capture	Financial	Develop appropriate financial incentives (e.g. tariff for the sale of electricity) for generating electricity from LFG capture when oil price is low
	Policy / legal	Streamline the procurement agreements between parties at the landfill
Recycling of paper and textile waste	Market imperfection	Create conditions to limit the number of recyclers in order to achieve scale of economies for private investments
	Policy / regulatory	Develop and implement ISWM
	Technical	Develop resources mobilization plan to make funding available for sorting of waste at source and collection of sorted waste
	Social / behavioural	Establish incentives and disincentives to promote sorting of waste at source
WTE	Covered under Energy Industries above	
Composting	Covered under Agriculture (Crop) below	
Agriculture (Crop)		
Compost (from MWS) used in biofarming	Network	Create a network of all stakeholders that is used to identify projects of national interests
	Technical	Invest in R&D for the comparative analysis of compost or chemical fertiliser on crop productivity, impact on health and the environment
	Social / behavioural	• Develop awareness campaigns for promoting the benefits of sorting of waste at source • Establish incentives and disincentives to promote sorting of waste at source
	Financial	Resources mobilization plan in place for making financing available for setting up the infrastructure needed to carry out sorting of waste at source and for the collection of the sorted waste
Crop burning	Economic	• Invest more in mechanical harvesting • Develop self-thrashing cane varieties
	Institutional	Institutional capacity building for enforcement
	Awareness	Make available the necessary resources to create awareness about the benefits of limiting crop burning

Technology	Prevailing barriers	Mitigation measures
Reducing the use of chemical fertilisers (Climate-Smart Agriculture)	Regulatory	Put in place a regulation for controlling the use of chemical fertilisers in crop production
	Institutional	Establish a regulatory body for overseeing the use of chemical fertilisers in crop production
	Awareness / perception	Make available the necessary resources to create awareness about the benefits of limiting the use of chemical fertilisers (within the broader ambit of promoting biofarming)
Agriculture (Livestock)		
Biogas digesters	Policy / regulatory	Policy instruments established for promoting biogas digesters for treating livestock waste
	Cultural / behavioural	Identify applications of methane gas produced from biodigesting of swine waste while being culturally sensitive (e.g. street lighting in uninhabited areas and on-farm energy applications)
	Technical	• Set up model farm that integrates the use of biodigesters for livestock waste treatment (model farm also demonstrates the necessary accessories to use biogas) • Develop technological guidelines for the treatment of animal waste for different livestock species • Capacity building for developing local technical expertise for constructing, operating and maintaining biodigesters
	Awareness	• Make available the necessary resources to carry out sensitization of potential end users • Use model farm to create product visibility
Composting	Policy / regulatory	Policy instruments established for promoting composting for treating livestock waste
	Cultural / behavioural	Identify niche applications of slurry from swine waste while being culturally sensitive (e.g. use of compost in agro-forestry applications)
	Technical	• Set up model farm that integrates the use of composting for livestock waste treatment • Develop technical guidelines, accompanied with capacity building, to develop the skills of farmers on composting and its use in agriculture • Develop a standard for composting using animal waste
	Awareness	• Carry out a feasibility study to establish the market potential for composting animal waste • Make available the necessary resources to carry out sensitization on the benefits of composting livestock waste
Fertigation	Financial	Put in place the necessary incentives for the uptake of fertigation
	Cultural / behavioural	Identify niche applications of slurry from swine waste while being culturally sensitive (e.g. orchards for appropriate export markets)
LULUCF (Forestry)		
Afforestation / Tree Planting	Financial	• Carry out feasibility study to establish the practical potential of agro-forestry Note: See policy and market measures below.
	Market	• Provide clear targets for tree planting/afforestation at scale in order to provide market visibility Note: Done in conjunction with policy measures below. It is expected that the market visibility will also create a market pull for making available the necessary mechanisation technology
	Policy	• Carry out feasibility study to establish the practical potential of agro-forestry • Develop zoning for afforestation based on outcomes of feasibility study

Technology	Prevailing barriers	Mitigation measures
		(to be carried out in conjunction with developing a biomass strategy for the power sector as discussed above)
	Institutional	Enhance institutional R&D capacity in plant propagation techniques, nursey management and mechanization through the development of technical guidelines and best practices
	Human skills	• Make available adequate resources to equip training facilities • Capacity building to develop expertise in plant propagation and nursery management

CHAPTER SEVEN

CHAPTER 7 SYSTEMATIC OBSERVATION AND RESEARCH

SYSTEMATIC OBSERVATIONS

7.1 Introduction

The earliest climate observation in Mauritius dates back to 1774. Climate analysis started during the 19th century but climate change research is very recent. In line with Article 5 of the Convention, the status of climate observation and climate change research as well as the need to strengthen these are discussed in this chapter. The strategies and action plans to address the gaps and needs in both areas are considered.

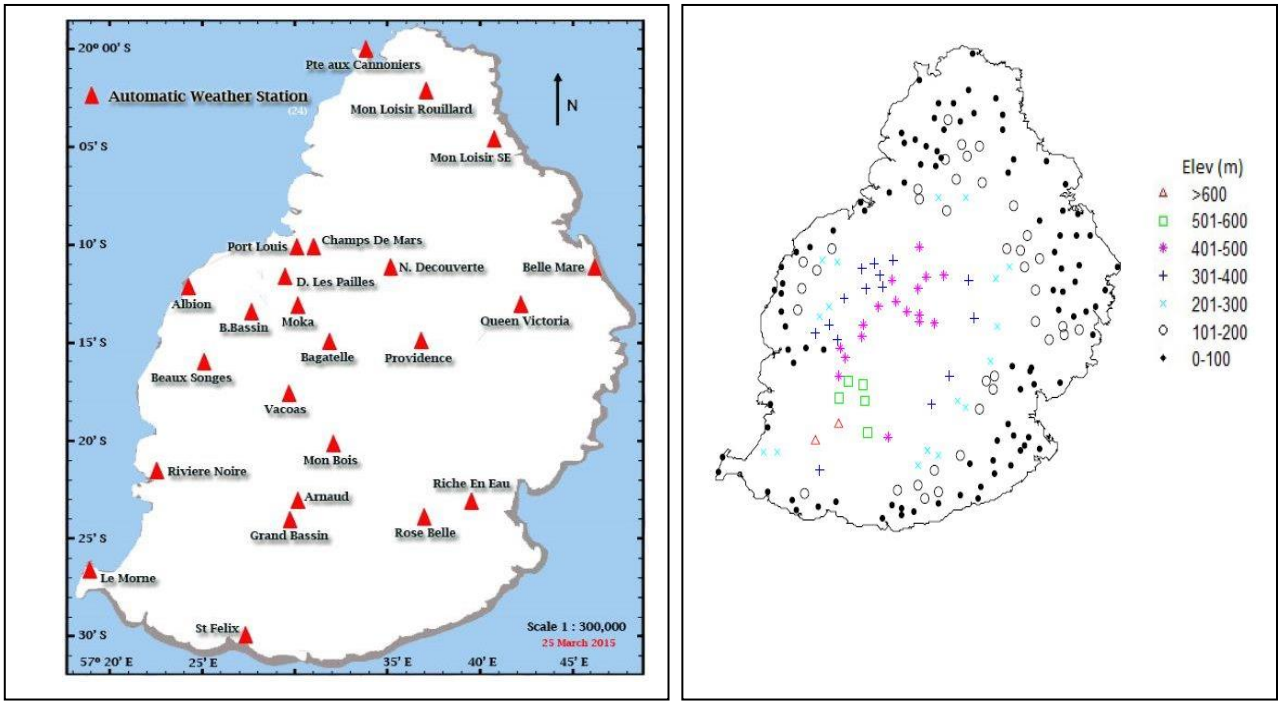
7.2 Current systematic observations and requirements

Several of the *Essential Climate Variables* (ECVs) (GCOS, 2015) of the climate system, namely the atmosphere, ocean and land surface are observed in RoM. Observations of the ECV of ocean and land need to be reinforced while new sets of observations in support of climate change mitigation and adaptation, and of sustainable development activities need to be put in place.

7.2.1 Atmospheric observations

7.2.1.1 Weather and climate observations

In Mauritius, systematic weather observations started in 1853. The network has been extended and modernised gradually to serve a growing number of operational, reporting and research activities. To a large extent, the data meet the requirements of the Convention and other national needs and commitments. The Mauritius Meteorological Services (MMS) operates a well-established network of six synoptic stations, namely two in Mauritius, two in Rodrigues, one in St Brandon and one in Agalega, in line with WMO's Guide to Climatological Practices. In addition, there are in Mauritius 23 Automatic Weather Stations (AWS) and 180 climate stations with 16 measuring temperature (Figure 7.1), and in Rodrigues three AWS and 14 rainfall stations. Two volunteer observers regularly provide weather observations to the MMS. Mauritius also has an upper air observation station at Vacoas to measure the temperature, wind and moisture variables of the troposphere.



Source: MMS

Figure 7.1 Location of AWSs (left) and rainfall stations at different elevations (right) in Mauritius

7.2.1.2 Satellites imagery and Weather radar observations

MMS has been receiving satellite images from polar orbiting weather satellites since the mid-1960s. At present, imageries from Meteosat geostationary satellites are available every 15 minutes. A new Doppler weather radar offered as grant by the Government of Japan, and costing about 1.9 billion Japanese Yen (approx. USD 13.4 million), is expected to become operational in March 2018. It will contribute to the improvement of weather forecasts and reduce vulnerability through the enhancement of preparedness against extreme weather events such as cyclones and flooding. Other locations such as Rodrigues, Agalega and St Brandon are ideally located for the installation of weather radars to ensure a continuous weather watch for advance warning and preparedness for the benefit of all countries of the region.

7.2.1.3 Agrometeorological observations in Mauritius

Seven AWSs have been installed in the course of 2013 and 2014 over Mauritius within the framework of an Agricultural Decision Support System (ADSS) under the Africa Adaptation Programme (AAP). They are located at strategic locations, namely Wooton, Reduit, Barkly (Figure 7.2), Plaisance, Plaine Sophie, Flacq, and Richelieu (MoESDDBM, 2016).

Credit: MoESDDBM

Figure 7.2 AWS (Barkly)

Real time meteorological data can be accessed by farmers to help them in decision-making with respect to irrigation schedule, optimum sowing date and timely pest and disease management. The data are also being used by

researchers for the modelling of crop yield and disease and in the development of weather index-based insurance scheme and risk management strategies.

7.2.1.4 Ambient air monitoring

Urban morphology such as height and density of buildings, and infrastructure strongly influence temperature and airflow in the surroundings and within buildings. Urban areas are known to play an important role in climate change mitigating. The National Environmental Laboratory (NEL) of the MoESDDBM is actively involved in ambient air monitoring both in emergency situations, and for observations and trend analyses. NEL is presently equipped with two mobile ambient air monitoring stations which are fitted with automatic ambient air monitoring analysers (both *particulate matter* such as PM-10, and *gaseous pollutants* such as sulphur dioxide, oxides of nitrogen, carbon dioxide and carbon monoxide) which are capable of 24hr continuous monitoring. NEL has also acquired a High Volume Sampler for Particulate Matter monitoring, a Portable Gas Analyser (2013) and two fixed stations (2015) to enhance monitoring of the quality of ambient air throughout Mauritius. Reports generated by NEL have helped in decision-making such as in the amendments brought to the Environment Protection Act 2002.

7.2.2 Ocean observations

7.2.2.1 Wave observation

MMS has been observing wave amplitude, direction and period at Blue Bay since 1995. Another wave rider, deployed by the Mauritius Oceanography Institute (MOI) in January 2012, is located at Roches Noires to the Northeast of Mauritius.

7.2.2.2 Monitoring of sea level rise

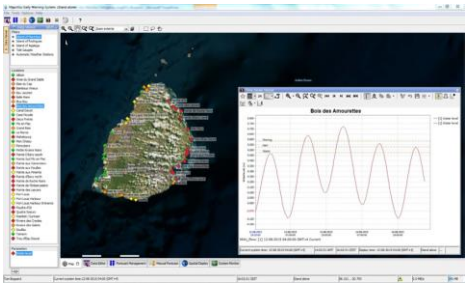
Continuous sea level monitoring in the region started in 1986 as part of the WMO/IOC Global Sea Level Network (GLOSS) programme. Two floating type sea level monitoring stations were established at Port Louis and Rodrigues in 1986. A sea level monitoring station was installed at Agalega in November 2008. Furthermore, two wave hunters, used by JICA in a wave monitoring project in the lagoon in 2015, have been handed over to MoESDDBM and are presently under the custody of MOI and MMS.

7.2.2.3 Ocean parameters

The Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island operates a network of 15 stations to monitor various ocean parameters in the lagoon around Mauritius including Sea Surface Temperature (SST). SST data are also available from MMS and MOI.

7.2.2.4 Storm Surge Forecasting System for Mauritius

MoESDDBM, with the assistance of Deltares of the Netherlands, has developed a storm surge model in the context of the Climate Change Adaptation Programme to increase the climate resilience of coastal communities (Figure 7.3). The project, funded by the Adaptation Fund, was completed in August 2015.



Credit: MoESDDBM

Figure 7.3 Snapshot from Early-Warning System: Water level time series (with thresholds) for Mauritius

The storm surge forecasting system has been installed at MMS. The model which covers Mauritius, Rodrigues and Agalega, produce six hourly forecasts up to 72 hours. The high resolution model forecast enables more effective preparedness to mitigate loss of life in the event of storm surge caused by tropical cyclones.

7.2.2.5 *Assessing the potential of wave energy for power generation*

A *'High Penetration Renewable Energy Road Wave Resource Assessment and Wave-Integrated Micro-grid Design in Mauritius'* project funded by Australian Government started in November 2015 and is being implemented by MRC in partnership with Carnegie Wave Energy Ltd. The aim of the study is to assess the potential of wave energy for electricity production. In this context, a wave monitoring device has been deployed at sea off Souillac at a depth of about 50 m to monitor wave parameters over a period of 6 months (Figure 7.4).

Credit: MRC

Figure 7.4 Wave monitoring buoy off Souillac

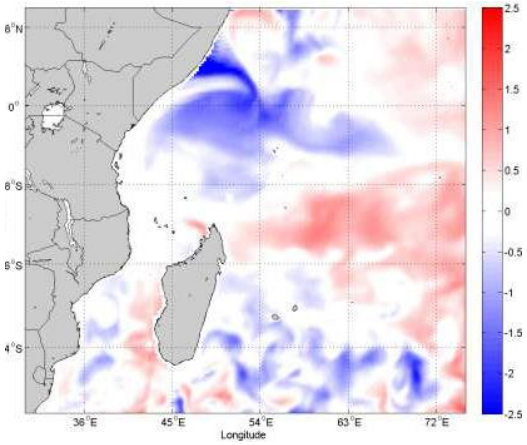
7.2.2.6 *Regional wave monitoring network*

At the regional level, ocean waves are being monitored at Reunion and Mauritius. The Outer Islands Development Corporation (OIDC), in collaboration with MMS and MOI, is considering the installation of a wave measuring device off Agalega. The deployment of two wave rider buoys in the regions of St. Brandon and Rodrigues would complement effectively the wave measuring network in the data-sparse SWIO. In addition, a wave measuring network to the South of the Mascarenes, as recommended by the WMO/IOC Western Indian Ocean Marine Application Programme (WIOMAP), needs to be established to monitor heavy swells approaching the region from the Southern Oceans and would thus contribute much in providing advance information for early warning and preparedness.

7.2.2.7 *Operational ocean services*

Operational oceanography is gradually being developed in the region under the Monitoring for Environment and Security in Africa (MESA) programme.

MOI prepares and publishes an Oceanography Bulletin (MOI, 2016) on a monthly basis in support of operational ocean services in its capacity as the Regional Implementation Centre for the IOC thematic action on 'Marine and Coastal Management'. The Bulletin consists of a series of charts depicting mean monthly values of chlorophyll-a concentration, monthly chlorophyll-a concentration, monthly anomalies in chlorophyll-a, sea surface temperature (Figure 7.5), and sea surface height with brief comments.



Source: MOI (2016)

Figure 7.5 Sea Surface Temperature anomaly in °C (July 2016)

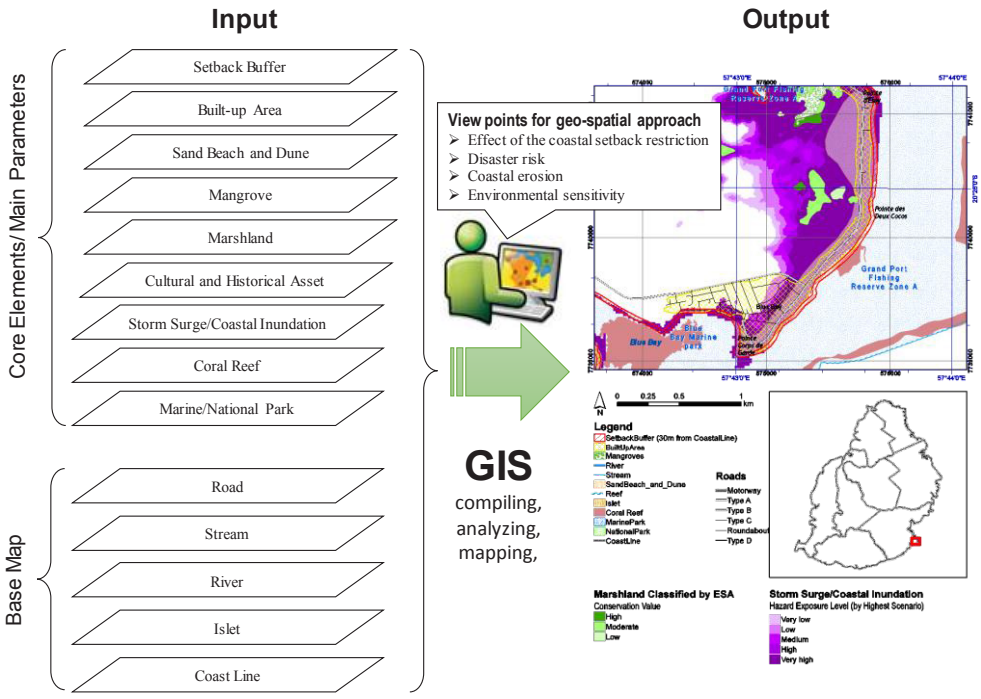
7.2.3 Coastal erosion monitoring

7.2.3.1 Guideline for Climate Change Adaptation Strategy (Coastal Setback)

Until very recently a uniform coastal setback of 30m from the high water mark was applied island wide. The JICA's funded Project *'Capacity Development on Climate Change Measures in the Republic of Mauritius'* using a GIS-based approach has established a new coastal setback Guideline for Climate Change as an Adaptation Strategy in 2016.

Field surveys were a key component of this project for ground-truthing and socio-economic considerations.

The conceptual diagram of the methodology using geo-spatial approach is shown in Figure 7.6.



Source:DRR (2013)

Figure 7.6 Conceptual diagram of the methodology (Geo-Spatial approach)

The guideline proposes a minimum site specific setback for 13 sites (Table 5.1), which ranges between 30 m to 60 m except for low lying islets. Setback for other sites can be derived from the GIS based maps prepared in the context of this guideline. Long-term monitoring will be required to refine this guideline.

7.2.3.2 Shoreline monitoring

A monitoring programme has been established as from 2013 at various sites where coastal protection works in terms of rock revetment, flexible revetment and sand recharge have been carried out. The sites include Poudre d'Or, Cap Malheureux,

Credit: MoESDDBM

Figure 7.7 Severe erosion at Albion public beach

Grand River South East, Quatre Soeurs, Baie du Cap, Bain Boeuf, Le Morne, La Prairie, and La Preneuse. Under the

'*Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius'* project, it has been found that at Albion (Figure 7.7),

Mon Choisy and Bel Ombre 17 % of the coast has been eroded, 23 % has been accreting, and 59 % is stable with severe erosion. Coastal conservation plans have been prepared for the following 14 sites namely Pointe aux Cannoniers, Mon Choisy, Quatre Cocos/Trou d'Eau Douce, Ile aux Cerfs, Pointe d'Esny, Bel Ombre, Le Morne, Flic en Flac, Albion, Pointe aux Sables, Albion (lighthouse), Grand Sable, Baie du Tombeau and Bras d'Eau.

7.2.3.3 Standardisation and harmonisation of oceanographic observations

In the light of the monitoring activities, there is a need for standardisation and harmonisation of these efforts for enhanced research output. For example, the measurement of SST at key sites should be standardised and guidelines/manuals prepared and used for the purpose. Other variables that could be monitored in a systematic and harmonized way include sea-surface salinity, surface current (coastal), ocean colour (satellite), ocean acidity, and phytoplankton.

7.2.4 Ground observations

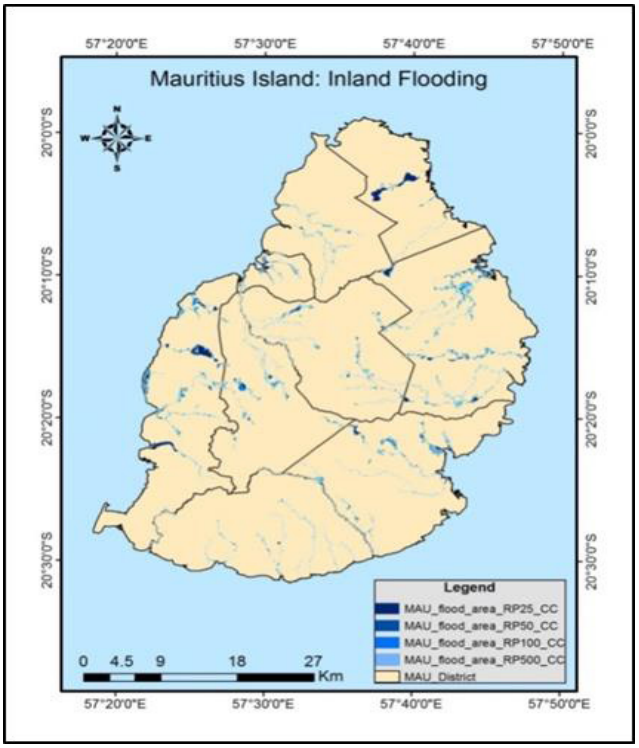
7.2.4.1 Water resources

The Water Resources Unit (WRU) monitors river flows at about 100 gauging stations. Some are equipped with continuous water level recorders. For others, daily or twice weekly water level readings are taken. It also observes groundwater levels island-wide. WRU uses the data to assess and evaluate water resources to meet sectoral demands by relevant institutions and to study the potential impact of climate change.

7.2.4.2 Observations of areas prone to flooding and landslides

The recent disastrous flooding calls for a *Flood Forecasting and Early Warning system* using up-to-date facilities for monitoring, analysis and communication. Plan to install automatic flood sensors in selected streams following the recent flooding episodes is under consideration. Regions prone to flooding and landslides have been identified (Figure 7.8) (GoM 2012, DRR, 2013). Some of the current stations need to be strengthened so as to monitor rainfall and other relevant parameters. AWS are planned at Fond du Sac (North) for monitoring inland flooding and at Souillac, Surinam (South), and at Quatre Soeurs (East) for monitoring landslides.

MoESDDBM is working closely with local authorities to put in place customized toolkits to enhance their preparedness and resilience to the impacts of climate change. The regions most at risks from flooding with return periods of 25, 50, 100 and 500 years have been identified (Figure 7.8). A close-up for each region has been prepared, For example, that the toolkit for the Municipality of Vacoas-Phoenix is given in the customized *'Toolkit for Climate Change Vulnerability Assessment and Identification of Adaptation Options for the Municipal Council of Vacoas/Phoenix'* (Figure 5.3 in Section 5.3.1).



Source: DRR (2013)

Figure 7.8 Flood prone areas with return periods of 25, 50, 100 and 500 years

At the regional level, the MESA-SADC Flood Service uses high resolution satellite images and Numerical Weather Prediction models for monitoring the status before, during and after a flood event. The Service, which includes the prediction of flood occurrence in the SADC region, is being designed and developed. The Mauritius component is hosted at the University of Mauritius in collaboration with the National Disaster Risk Reduction Management Centre under the aegis of MoESDDBM.

7.2.4.3 Phenology observation

Study on phenology has been explored but is still very limited due to non-availability of systematic phenological observations. Some studies have found significant correlation between phenological traits (flower budding, flowering, fruiting and leafing) and parameters such as the calendar month, site and individual trees as is the case with the litchi tree (Box 7 1).

Box 7.1 Observations on Litchi phenology

Litchi phenology

Observations were carried out on (i) flower emergence and development, and (ii) fruit set, fruit development and maturity on two sites, namely Pamplemousses (altitude 50m) and Reduit (altitude 250m) from 2010 to 2014. At Reduit, litchi varieties which are late bearers and which require more hours of low temperature for floral initiation either did not flower or if they did, there was no fruit set. This has been associated with the high day temperature (above 25^0C as from the month of October) based on four years of observation. Similarly, at Pamplemousses, from July onwards, day temperatures remained above 25^0C. This has led to numerous flower panicles reverting to vegetative phase with a consequent low production. On the other hand, the rapid rise in day temperature to 28^0C and 29^0C at Reduit and 30^0C and 31^0C at Pamplemousses had hastened fruit maturity in early December at Reduit, and November at Pamplemousses. Observations will be on-going on the sites.

Credit: FAREI

Figure 7.9 Litchi tree laden with ripe fruits

Phenology calendars have been produced for 43 natives and 16 introduced species and these have proved useful in studying the impacts of climate change or variability on phenology (MWF, 2010) as well as on the health and changes in species and ecosystems.

7.2.5 Gaps and Needs in systematic observations

Several gaps and needs in systematic observations including new sets of data required in the assessment of vulnerability and climate change impacts have been identified. Some of them are listed in Table 7.1.

Table 7.1 Some of the needs and gaps in systematic observations

Data type	Requirements to fill gaps and needs in systematic observations
Atmospheric observations	Rainfall and wind data are missing in some areas prone to flooding including landslides and other extremes weather events (Section 7.2.4.2)
	Establishment of weather radars at Rodrigues, St Brandon and Agalega (Section 7.2.1.2)
Terrestrial observations	Real time monitoring and transmission of water levels to enable early warning of river flooding. The relevant institutions may provide assistance to institutions involved in issuing flood warnings (Section 7.2.4.2)
	Extension of systematic phenological observations (Section 7.2.4.3)
Ocean observations	Extension of observational coverage of important oceanographic variables and improvement in the standardization of currently observed variables (Section 7.2.3.3)
	Systematic and standardised monitoring at regular intervals of coastal erosion in key areas and also after heavy waves and storm surges (Section 7.2.3.3)
	Deployment of wave rider buoys in the regions of St. Brandon and Rodrigues and a network in the South of the Mascarene Islands (Section 7.2.2.6)
	Enhancement of the observation of sea-surface salinity, surface current, ocean colour, ocean acidity and phytoplankton (Section 7.2.3.3)
	Further coordination and harmonisation among institutions involved in ocean observations (Section 7.2.3.3)
New standardized data sets to assess vulnerability and climate change impacts	New sets of reliable, publicly available and standardized data in support of mitigation, adaptation and sustainable development and in the assessment of the vulnerability of key sectors to the impacts of climate change (Section 7.2)

7.2.6 Strategy for improving systematic observations and meeting the gaps and needs

Currently not all climate information needed under the Convention is available. In this connection, there is a need to develop and apply guidelines and manuals to ensure standardization and harmonization so that the observations in all domains are scientifically reliable for mitigation, adaptation and climate change studies and research. These aspects as well as the needs and gaps summarised in Section 7.2 could be integrated into a Strategy and Action Plan for systematic observations of the atmosphere, the ocean and land areas.

RESEARCH

7.3 Research on climate change mitigation and adaptation

7.3.1 Research undertaken under the Africa Adaptation Programme

An inter-ministerial committee was set up to identify research gaps and needs with regard to climate change adaptation in key sectors and encourage the application of the results in climate change-related activities. A list of priority areas for research was established. Based on this exercise, MoESDDBM in collaboration with MRC have supported some eleven research activities on climate change covering various fields under the MRC Unsolicited Research Grant Scheme (URGS) (Box 7.2).

Box 7.2 Research on climate change adaptation and on the use of coal/bagasse ash under AAP

Research projects under AAP

Climate change-related	
Evaluation of the vulnerability of coastal communities to climate change in the island economies. The case of the Republic of Mauritius.	University of Mauritius
Use of compost by farmers as an adaptation strategy for climate change: Land application and simulation studies.	
Climate Change and agriculture in Mauritius - impacts and vulnerability assessment.	
Energy futures of Mauritius in a carbon constrained world	Ecological Living In Action Ltd.
Assessing the impacts of climate change on the Phenology of Native Mauritian Plants.	Mauritius Wildlife Foundation
The use of system dynamics approach to identify integrated coastal zone planning and management indicators for Mauritius: A performance evaluation model.	University of Technology, Mauritius
Modeling the Influence of Large Scale Circulation Patterns on Precipitation and a Multivariate Drought Analysis for Mauritius,	Scinova Consulting Ltd.
Development of Offshore Wind Maps for Mauritius	Mauritius Research Council
Coal/Bagasse ash	
Safe and Sustainable Utilisation of Coal/Bagasse Ash in Agro-ecosystems as Soil Amendment for Crop Protection.	University of Mauritius
Assessing the Potential Use of Coal Ash and Bagasse Ash as Inorganic Amendment in the Composting Process of Municipal Solid Wastes: Improvements in Compost Quality for Agronomic Applications,	
Encapsulated Use of Bottom Ash in Concrete.	

Source: AAP

A mapping exercise to identify research programmes and capacity at tertiary level on climate change was conducted in 2014 within the framework of Southern African Regional Universities Association **(**SARUA). The exercise resulted in the Mauritius Country Report on gaps and needs at individual and institutional levels in the areas of research, teaching, community engagement, policies and programmes relating to adaptation and mitigation to

climate change. The sugarcane industry relies on research for ensuring its efficiency and competitiveness. Some of the ongoing research in the sugarcane sector is given in Box 7.3.

Box.7.3 Ongoing research in the sugarcane sector

Research in the sugar cane sector at MSIRI

i) Development of varieties for the non-irrigated regions to mitigate the effects of climate change and limited water
ii) Selection of varieties for their high biomass or enhanced fibre content, in view of bio-energy production
iii) Development of alternatives such as bio-fertilizers, soil conditioners, growth promoting substances and organic sources of nutrients to the conventional synthetic/mineral fertilisers
iv) Weed management strategies to reduce the amounts of herbicides used by sugar cane growers

Source: Research and Development Plan 2016-2020 for a resilient Mauritian cane industry, Mauritius Sugarcane Industry Research Institute (MSIRI), Mauritius Cane Industry Authority, August 2016. http://www.msiri.mu

The Climate Technology Centre Network (CTCN) has approved a project proposal for Mauritius which aims at enhancing the resilience of the Port of Port Louis against the adverse impacts of climate change. The research component aims at undertaking a location-specific climate risk assessment for the Port, both land-based and sea-based, that will identify current vulnerabilities and future risks, analyse and evaluate the risks, identify and prioritise adaptation options using a multi-criteria analysis, and set a monitoring baseline.

7.3.2 Research at tertiary level

Research in the field of climate change is starting to gather momentum at the tertiary level. The University of Mauritius Research Journal and the Journal of the Institution of Engineers Mauritius have recently published climate change-related articles. A few articles from RoM have been published in peer-reviewed international journals.

7.3.3 Initiatives at regional level

7.3.3.1 Migration and adaptation to climate change

RoM in collaboration with the International Organisation for Migration (IOM) has started the implementation of the project *Migration, Environment and Climate Change: Evidence to Policy* (MECLEP). This project is being implemented in six pilot countries including Mauritius (and Rodrigues) and is co-funded by EU. The project started in January 2014 and is expected to be completed by December 2016. Under the project a survey is being carried out in Port-Louis, Flic en Flac/Bambous and Rodrigues in order to understand the patterns of migration and how migration can contribute to better adapt to climate change.

7.3.3.2 Green Cooling Africa Initiative

Mauritius and three other African countries namely Ghana, Kenya and Namibia are involved in the Green Cooling Africa Initiative (GCAI) under CTCN. The research components of this project comprise the establishment of a robust GHG Inventory for the Cooling Sector and an analysis of the Technological Gap between BAU and Internationally Available Best Technological Options. The aim is to come up with *'Policy and Regulatory Framework'* recommendations and a *'Regional and Country Specific Technology Roadmap'*. Some of the activities that are planned include exchange of tools being developed, know-how and expertise, as well as the exchange of experiences between the countries involved.

7.4 Research gaps and needs on climate change

Research on the impacts of climate change and on adaptation and mitigation is quite limited. A shift in mind-set and behaviour is thus needed to ensure the engagement of institutions and scientists in climate change research and in the SARUA Climate Change Development (CCD) programme. An example of some of the gaps and needs highlighting those related to impacts, response, modelling and policy uptake are given in Box 7.4.

Box 7.4 Examples of gaps and needs in climate change research in RoM

A few examples of gaps in climate change research in some areas

Socio-economic impacts;

i) Limited study on the impacts of climate change on various key socio-economic sectors
ii) Socio-economic impacts of climate change on local communities
iii) The economic value of ecosystem services and their vulnerability to climate change alongside examining sea level rise, lagoon dynamics, and creating risk profile
iv) Impact of ocean acidification on marine ecosystem in Mauritius

Modelling

v) The frequency and severity of extreme weather and disaster risks management in a changing climate
vi) Impacts of climate change on tropical cyclone in the Southwest Indian Ocean basin
vii) Greater detail in the projection of climate parameters for impacts studies
viii) Modelling of extreme weather in a marine environment
ix) Downscaling climate change variables to island scale in the Southwest Indian Ocean

Sectoral

x) Energy resource surveys (wind map) as well as surveys into building construction, energy usage and presence of 'green' development
xi) Mangrove and sea grass as carbon sinks
xii) The need for multidisciplinary and interdisciplinary research

Adaptation and mitigation

xiii) Applying indigenous knowledge to climate change adaptation
xiv) Mitigation-related response including energy use assessments; transport sector/per passenger emission research; road development; accessibility of car versus public transport assessments

Policy

xv) Need to enhance research uptake into policy

Funding

xvi) Why research is a low priority in Government institutions-is it only financial

Source: MoESDDBM

7.5 Strategy and Action Plan for promoting climate change research

The above sample list of research requirements and likely training needs, highlight the urgent need for a climate change research strategy, that would include the application of the outcomes in the planning, policy making and implementation of measures related to mitigation and adaption in key sectors. It would be vital to establish a suitable strategy and action plan which would consider access to data, downscaling GCM model to study climate change impacts, access to climate information, suitable means for publication and institutional aspects.

7.5.1 Data accessibility

Data of research interest are generated by both public and private institutions. For some projects, data may cost more than 40% of a research project budget and this element needs to be considered at the project design stage. On

several occasions, proposals have been made to develop a centralized system for the collection of environmental and statistical data. In the absence of such a system, it is important that baseline data from all sectors be made accessible to researchers. An open data policy should be envisaged at national level.

7.5.2 Downscaling of General Circulation Models (GCMS) to Mauritius scale

Detailed climate change projection of key meteorological parameters is a vital input in various models used in impact studies of key socio-economic and environmental sectors. In TNC, climate change projections from recent projects have been used for impacts studies and for adaptation options. It is very important that climate change scenarios are continuously updated to project more realistically future climate and its impacts.

7.5.3 Information on climate change research

Research findings from various institutions and individual authors are available in various journals, newsletters, proceedings, in-house publications and as grey literature. These need to be catalogued for accessibility. It is advisable that researchers be provided with suitable tools and facilities to access the literature. The Climate Change Information Centre (CICC) (Section 8.4.3) could be developed further to serve as a depository of all publications on climate change.

7.5.4 Institutional aspects

As regards institutional aspects, the Strategy and Action Plan could consider the following:

i) The establishment of dedicated unit within the MoESDDBM or another appropriate institution dedicated to climate change research
ii) The training of more marine scientists, environmental managers, environmental engineers, technicians, environmental economists, green architects, energy auditors and managers
iii) The establishment of a programme to promote the exchange of scientists between RoM and friendly countries for capacity building and conducting climate change research.

CHAPTER EIGHT

CHAPTER 8 EDUCATION, TRAINING AND PUBLIC AWARENESS

8.1 Introduction

Education, Training and Public Awareness (ETPA) are fundamental to enhancing the capability of the population to understand, mitigate and adapt to climate change and contribute to the transformation of RoM into a low carbon and sustainable economy. The growing national awareness and concerted efforts to address climate change-related issues are largely the result of accelerated and determined actions in implementing Article 6 of the UNFCCC Convention. Some of the progress achieved and gaps identified are discussed.

8.2 Formal and Informal education

Free education (Section 1.5) serves as an enabling environment to the gradual extension and consolidation of climate change education at both formal and informal levels.

8.2.1 Formal education

At the formal level, there have been several initiatives by MOE&HR,TE&SR in collaboration with Mauritius Institute of Education (MIE), to bring climate change education for sustainable development (CCESD)to learners at early childhood, primary, secondary, and pre-vocational levels. Climate change education is taught through some carrier subjects and outreach programmes is mostly taught as a component of *Education for Sustainable Development (ESD)*, through outreach programmes.

8.2.1.1 Pre-primary and Primary level education

At the early stages, pupils are exposed to very basic information, skills and concepts related to climate change including terms like hot, cold, windy day, rainy day as well as cyclone and flooding. Thereafter, topics covered include global warming, sea level rise, threat to biodiversity and the importance of trees and renewable sources of energy. In order to offer a practical-based education and demonstrate some elements of sustainable living, 24 primary and 26 secondary Government schools in Mauritius have been equipped with photovoltaic (PV) solar panels, seven primary and 18 secondary schools have installed rain harvesting systems, while 108 Government primary (51%) and 60 secondary schools (88%) have established green corners and endemic gardens. Several private secondary schools have also established endemic gardens within their premises. On the other hand, all schools are implementing a waste segregation project. The 46 primary schools and 17 secondary schools of the Service Diocésain de l'Education Catholique have respectively seven and two rain harvesting systems, 34 and seven green corners, eight and 23 PV cells. In Rodrigues, the Terre Rouge Government School is using suitably treated harvested rainwater for drinking purposes (Box 8.1).

Box 8.1 Rain harvesting in Rodrigues

Rain harvesting at Terre Rouge Government School in Rodrigues

Tap water from the main network is available on average only once every three weeks. Hence, water storage and water saving is an integral part of the routine life of the inhabitants. Rain harvesting at household level has traditionally been a common practice to overcome water shortage. In most cases, water storage tanks occupy nearly 30% of a house area. At Terre Rouge Government school, rain water is collected from the school roof. One part of the water is filtered for drinking (Figure 8.1), and another is used for gardening, toilet flushing and cleaning.

Credit: Rodrigues Commission for Environment

Figure 8.1 Drinking water from rain harvesting after filtering and purification

8.2.1.2 Secondary level education

At the secondary level, climate change education aims at developing the understanding of issues that promote sustainable living. While climate change, as a standalone subject, has not yet been introduced, related topics are taught as part of physics, chemistry, biology, geography, general paper, languages and marine science programmes. Non-science stream students are also exposed to climate change issues. Practical topics taught include carbon sequestration by trees, waste reduction through composting (Figure 8.2) and water and energy saving. Students are offered incentives to set up environment, science and health clubs that deal with issues such as food security, clean drinking water and environment protection.

Credit: MIE

Figure 8.2 Demonstration of School compost project

8.2.1.3 Tertiary level education

Climate change education at tertiary level is generally regarded as an important component of RoM's quality education. Several institutions offer climate change-related topics as part of modules on sustainable development, environmental science, environmental and chemical engineering, and agricultural science (Section 1.5; Box 8.2). Some students have signified their interest in the courses.Each year research on climate change and related subjects are conducted by undergraduates and post graduate students and their dissertations are published.

8.2.2 A new System of Education

The MOE&HR,TE&SR, has initiated a Nine-Year Continuous Basic Education Reform which has been introduced as from 2016 and climate change issues are being integrated in the National Curriculum Framework (NCF).

Box 8.2 Courses and programmes in climate change

Examples of courses and programmes covering climate change issues

- MSc course in Sustainability for Business, Society and Environment (University of Technology Mauritius, since 2013)
- A professional development course in Climate Change and Coastal Zone Management on the impacts of climate change on coastal areas (University of Mauritius).
- Research activity on a carbon management framework in 2014/2015 (University of Technology Mauritius in collaboration with Middlesex University (Mauritius branch campus).
- Elective module in ESD offered to PGCE students at the Mauritius Institute of Education

Source: MoESDDBM

8.2.3 Informal education

All educational institutions and sectoral Ministries are engaged in some form of informal climate change education. Practical and hands-on activities are conducted outside the classroom to consolidate the knowledge gained in class. These include tree planting and visit to greening programmes such as mangrove propagation, waste segregation and compost making. Rain harvesting and solar PV systems have been installed in some schools to demonstrate the concept of water saving and the potential of renewable sources of energy respectively (Section 8.2.1.1). Several NGOs are involved in informal education on climate change.

8.2.3.1 Informal education during special events

Ministries and national institutions usually take advantage of annual celebrations of international events such as World Environment Day, World Meteorological Day, Earth Day, World Water Day and World Oceans Day, to focus on some aspects of climate change. On these occasions, some of the activities include exhibitions, distribution of information materials, organization of essay and drawing competitions, project presentations, debates and SLAMs

8.3 Training in climate change

Some 2600 professionals from various sectors, including engineering, architecture, law, education, environment and health have been trained in climate change in the context of AAP. Some 750 teachers have been trained on mainstreaming climate change into the education sector. In addition, a series of train the trainer programmes targeting women, youth and educators have been conducted. A total of 439 persons were trained between September 2013 to February 2016 on coastal engineering and cost benefit analysis under the Climate Change Adaptation Programme in the Coastal Zone of Mauritius.

8.3.1 Training of educators

There is no standalone module or course on training in climate change education for educators. However, early childhood educators are trained to teach basic aspects of climate change (Section 8.2.1.1). The educators of other levels receive exposure through seminars, co-curricular activities and elective modules on ESD that have a strong component on climate change education. Educators in Mauritius, Rodrigues and Agalega have been sensitised on climate change issues through in-house seminars using climate change education kits for primary and secondary school educators and students. These resources were developed by national institutions and were used in sensitisation through various means including the use of a Mobile Graphic Exhibition. Teachers' trainers and educators were trained on CCESD through a UNESCO-funded project.

8.3.2 Other training activities in climate change

In the context of the preparation of TNC, a series of training and capacity building activities were conducted on topics such as GHG inventory, mitigation analysis, and vulnerability assessment and adaptation in Mauritius and Rodrigues. Some 40 persons from several Ministries and national institutions have acquired basic skills in dealing with climate change-related issues through overseas training provided in collaboration with countries including Japan, India, Singapore and China as well as by international organisations such as WMO, UNEP, IPCC and UNFCCC.

8.4 Public awareness of climate change – The Strategy and Plan of Action

The MoESDDBM has formulated a *Climate Change Information, Education and Communication Strategy and Action Plan 2014 – 2016* to enhance awareness and instil a climate risks mitigation and adaptive management mind-set. The objective is to sensitise about 400 000 citizens by 2016 and one million citizens by the year 2020. To achieve the objective on climate change, the Strategy aims to enhance public:

(i) access to information
(ii) awareness raising and education
(iii) participation and engagement in addressing and responding to related issues

8.4.1 Tools and resources for Training and Public Awareness

In the context of its Climate Change Strategy and Action Plan (Section 8.4), and with partial funding under the Africa Adaptation Programme (2010), MoESDDBM in collaboration with MIE and other institutions has developed climate change education kits including a considerable number of resource materials for training and public awareness campaigns including presentations, pamphlets, booklets, a comic strip, factsheets, videos on key issues and manuals for educators at primary and secondary levels. A Training Manual and a Toolkit on Climate Change for youth has been used to train some 600 youth leaders. MoESDDBM has also developed a manual on climate change for women to provide them with a basic understanding of climate change and practical measures to ensure that their day to day activities are eco-friendly. These materials are available online on the website of the CCIC. A mobile unit '*Bis Lamer (Sea Bus)'*,set up by Reef Conservation, has embarked on a public awareness campaign for primary and secondary schools and the public. (Box 8.3).

Box 8.3 Mobile education unit on ocean and eco-systems

***Bis Lamer,* Marine Mobile Education Unit**

A Marine mobile unit, *Bis-Lamer*, for the sensitisation of students and the public on climate change and related issues was launched on the 9 September 2014 through funding from Rogers and Company Ltd. Several themes are developed during the sessions such as climate change and its impacts on Mauritius, and how eco-system services especially those provided by wetlands, mangroves, sea grass and coral reefs help the population to be more resilient to natural calamities. Over the period July 2014 to June 2016, about 10 770 students (Figure 8.3) and 4 350 adults benefited from the sensitisation programme. The outreach of *Bis-Lamer* included 125 primary and secondary schools, fishers, boat and tourism operators, Scouts groups, NGOs, hotels, private companies, commercial centres, foundations, coastal communities and the general public.

Credit: Reef Conservation

Figure 8.3 Students visiting the "Bis lamer"

Under the 'Capacity Development on Climate Change in the Republic of Mauritius' project (2014-2016), MoESDDBM with the support of JICA has developed four innovative and customized climate change sensitization materials, namely:

i) A climate change video clip

ii) An interactive 3D digital model, to help citizens understand the impacts on coastal zone due to sea level rise and storm surges
iii) A climate change card game which is a self and group learning tool for climate change terminologies (Figure 8.4)
iv) Nine climate change imaginary island depiction panels illustrating the causes and consequences of climate change and the possible solutions to these problems

Credit: MoESDDBM

Figure 8.4 Training of Trainers on the Cards game at Sir Abdool Osman State College, Phoenix

8.4.2 Awareness-raising activities for specific groups

The materials developed enabled focussed sensitisation and awareness-raising activities for different target groups primarily students, youth, women, senior citizens, private sector groups, professionals, agricultural community (Figure 8.5) and the general public. The materials helped to reinforce on-going sensitisation programmes of various institutions including the National Women Council, Social Welfare Centres, Community and Youth Centres and NGOs.

Credit: MoESDDBM

Figure 8.5 Sensitisation of the representatives of the farmers' community at Plaisance

Box 8.4 Climate change information on CCIC website

Information available on CCIC website

- Articles and updates on a daily basis on latest information on climate change
- Reports, publications and video published by the MoESDDBM
- Data on selected climate change indicators for the period 2000 to 2013
- Real time meteorological data from seven agrometeorological stations
- Digital toolkit for key sectors
- Links to international organisations

Source :MoESDDBM

8.4.3 Climate Change Information Centre (CCIC) - access to climate change information

As part of national response strategy aimed at public access to climate change information, a Climate Change Information Centre (CCIC) was set up in July 2013 following a recommendation of the National Climate Change Adaptation Policy Framework formulated under the Africa Adaptation Programme. The mission of the CCIC is to contribute to national resilience building through information dissemination, education, communication, awareness-raising and capacity building. It aims to inspire and empower people to take effective action to mitigate and adapt to climate change. The Centre provides information on climate change to all stakeholders including the public and private sectors, policy makers, professionals, public, women, students, researchers and NGOs (Box 8.4).

8.5 Regional and International cooperation

RoM participates in and benefits from various regional and international programmes. A few of the prominent ones are presented.

8.5.1 Argo and Globe Education Programme

Box 8.5 Examples of awareness-raising activities under adaptation programmes

Awareness-raising activities

Africa Adaptation Programme(AAP)
Series of awareness raising campaigns such as exhibitions, talks, research symposia, dramas and SLAM by students of primary and secondary schools. targeting over 50 000 people from civil society in particular youth, women and community organisations

Africa Fund Board (AFB)
Training component under Climate Change Adaptation Programme in the Coastal Zone of Mauritius. (Box 8.3)

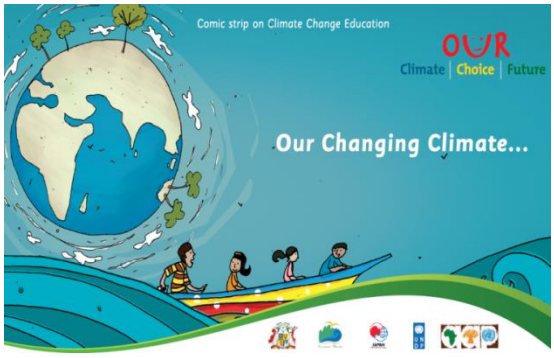
Source: MoESDDBM

MOE&HR,TE&SR has embarked on an innovative Education Outreach Programme namely Argo with Lady Amber Research Vessel, funded by UNESCO. The Argo programme is a global array of more than 3 000 free-drifting profiling floats that measures the temperature and salinity of the upper 2 000 m of the ocean for use in climate, weather, oceanographic and fisheries research. Students and educators from some 80 state and private secondary schools have received training and participated in the ARGO Educational Programme in 2013 and 2014. Workshops have been organised for rectors, high officials of the Ministry and other stakeholders of the education sector.

The Global Learning and Observation to Benefit the Environment (GLOBE) Programme was initiated in 2014. It is now being implemented in some pilot schools to enable students, educators and scientists to understand better the eco-system and climate change issues and undertake scientific research. GLOBE Programme has been endorsed by an MOU signed by the US Embassy on behalf of NASA and MOE&HR,TE&SR to inculcate climate change education among young people.

8.5.2 Africa Adaptation Programme and Adaptation Fund Board

AAP and the Adaptation Fund Board (AFB) (2013-2018) have funded several activities that focus on Training and Public Awareness (Box 8.5).



Credit: MIE
Figure 8.6 Comic strip under AAP

8.5.3 Women's Forum 2016 on climate change

The Forum was first of its kind for the African region and was attended by 350 local and foreign participants including scientists, policy makers and business leaders from Africa, Europe and Asia. The focus of the debate was on climate and health solutions; climate, agriculture and biodiversity best practices; green innovations; sustainable energy; and, water and sanitation for Africa and SIDS. It raised awareness on climate change particularly among women.

8.5.4 Eco-schools - Indian Ocean Programme

The Eco-Schools pilot programme, in the context of the ISLANDS project of the Indian Ocean Commission, funded by the European Union, was launched in April 2015 in 28 public and private, primary and secondary schools. The pilot schools join nearly 50 000 schools in 62 other countries worldwide, and work together to achieve the international standards of excellence in ESD and gain recognition in the form of Bronze, Silver, and ultimately the

Green Flag Awards. Out of the 28 pilot schools from RoM, seven have achieved the Bronze Award and 11 have achieved the Silver Award. This year the Eco-Schools programme is open to all schools in Mauritius on a voluntary basis and 43 new schools have already registered.

8.6 Progress, and Gaps and Needs in awareness raising

8.6.1 Progress in awareness arising

Since the Second National Communication (SNC, 2010), surveys show a growing awareness of the threat of climate change to society, the economy and the environment. A Multi-Purpose Household Survey (Statistics Mauritius 2012) found that 60.8% of the 5640 households surveyed were aware that GHG emission from fossil fuel combustion was responsible for climate change and 81.5% perceived that climate change was the cause of abnormal weather, flooding and sea level rise. Similarly, a recent survey (ADD, 2015) conducted among women indicated that 80% of the respondents were aware of climate change and its potential adverse impact on future weather, food and water security, health, biodiversity and coastal resources.

8.6.2 Gaps and Needs

8.6.2.1 Gaps and needs from surveys

The two surveys (Section 8.6.1) shows that the issues related to climate change are not universally understood though a majority have some implicit understanding. A mapping exercise conducted in 2014 with the assistance of JICA expert team targeting Ministries, private sector, international development partners and NGOs observed that:

(i) about 40% of those surveyed was still not aware that fossil fuel burning was largely responsible for climate change
(ii) in spite of the large number of institutions from the public and private sectors and NGOs involved in awareness-raising, most of them did not have a dedicated team to cover climate change issues
(iii) several Ministries, national institutions and NGOs involved in ETPA activities tend to target the same audience.

Box 8.6 Use of surveys to identify needs and evolution in the level of awareness

Some of the needs identified by the surveys

(i) access to updated climate change-related data for research
(ii) availability of up-to-date information on the number of graduates majoring in environment and climate change subject areas
(iii) availability of information on related activities in schools and tertiary level institutions
(iv) more collaborative synergies between tertiary education institutions and other organizations and an effective system of monitoring and evaluation at regular intervals of the measures implemented
(v) necessity for better coordination and optimisation of collaborative synergies and of resources among stakeholders

Source: MoESDDBM

Some of the other needs identified are given in Box8.6.

8.6.2.2 Gaps and needs from other sources

A number of other issues related to the strengthening of formal and informal education and awareness-raising have been identified. These include:

a) the gradual integration of climate change-related studies in the formal and informal education schemes at least as part of the sustainable development
    i) Initiate the development of certified education courses that cover causes and impacts of climate change and adaptation measures
    ii) Develop collaborative fellowship programmes of study in the region by offering scholarships and training support

iii) Build a dedicated network for professionals and adaptation experts involved in vocational training and higher education

iv) Strengthen the continuous training of trainers programme and develop innovative and appealing resource materials

b) The implementation of the Strategy and Plan of Action (Section 8.4) to address the gaps and needs (Sections 8.6.2)

i) Improve access to technical information, ensure regular communication and undertake more awareness campaigns

ii) Strengthen the synergy among Government agencies, the private sector and NGOs

iii) Ensure the further involvement of the public and in particular youth and women in policy- and decision-making and in the development of national communications and mitigation and adaptation actions

iv) Upgrade CICC facilities to serve as a comprehensive platform and a unique source of information and eventually a Regional Observatory on Climate Change available to the public, students, Government personnel, researchers, non-Government organizations, businessmen and the media (Box 8.7)

v) Undertake surveys at regular intervals on how climate change affects the daily lives of the population and to monitor progress, understanding and attitude change

Box 8.7 Strengthening CICC as a centre of excellence

Strengthening of CCIC as a centre of excellence for climate change activities

There is a need to develop CCIC as a full-fledged data and information centre on climate change issues. It may establish a permanent interactive exhibition, and operate a network of expertise at national, regional and international level so that it can effectively serve as *a Centre of Excellence.* To this end, some specific actions include:

a) Redesign the ergonomics of the CCIC and make it more user-friendly and attractive taking advantage of new development in Information and Communication Technology
b) Enhance publicity about the CCIC through the publication of a flyer/poster to be distributed widely to schools, public and private sector and NGOs
c) Reactivate the National Climate Change Education Team comprising the MoESDDBM, MOE&HR, TE&SR, MIE, NGOs, academic centres, and educational and vocational training centres to coordinate climate change educational activities to promote and create synergies
d) Provide information on the CCIC website with regular updates, and publish research results on climate change which can be applied for mitigation and adaptation to enable the public to make more informed decisions
e) Update the list of publications on climate change produced locally besides those of the MoESDDBM
f) Design and prepare information materials accessible on the CCIC aimed at various audiences with focus on the local context to harmonise and standardise training and public awareness programmes

Source: MoESDDBM

CHAPTER NINE

CHAPTER 9 CAPACITY BUILDING

9.1 Introduction

Capacity-building for climate action is at the core of Article 11 of the Paris Agreement, and is fundamental in preparing communities for climate change and protecting them against its possible impacts. Various capacity-building initiatives have been undertaken by RoM to move forward with the sustainable development and climate change agendas. Increased emphasis is being placed on institutional strengthening and enhancement of human capital. Capacity-building for the mitigation of climate change and adaptation to it is being promoted in most socio-economic and environmental sectors.

Relevant aspects of capacity building relating to education, training and public awareness (ETPA) have been elaborated in Chapter 8. This chapter outlines complementary capacity building initiatives undertaken at the national level and identifies the needs and gaps. In particular, given its experience in preparation of TNC, RoM has a need for capacity building in carrying out GHG inventory, the establishment of a statistical system for GHG emissions, enhancing adaptation to climate change, and improving decision making for coping with climate change at local level. RoM is willing to enhance its regional and international cooperation in order to further strengthen its capability to cope with climate change.

9.2 Institutional mechanisms and programmes

As a party to the UNFCCC, RoM has undertaken numerous activities over the past years to develop the capacity of stakeholders in addressing climate change issues. This includes several capacity-building programmes/projects under various sectors such as agriculture, fisheries, tourism, infrastructure, disaster risk reduction, education, health and environment. Institutional strengthening and development of human capital are important enabling conditions for transitioning to low carbon economy, building resilience to the impacts of climate change and attaining SDGs. This principle is enshrined in the National Climate Change Adaptation Policy Framework for Mauritius (Section 5.2.4; Box 5.1).

The policy on climate action in Mauritius targets capacity building at individual, organisational and system-wide levels in a holistic manner. In this context, a series of capacity-building initiatives was undertaken. A few are listed in Table 9. 1

Table 9.1 Examples of capacity building aimed at individuals, organisations and system-wide

Area of focus	Specific capacity building exercise
TNC-related	• Mitigation • Vulnerability Assessment • GHG Inventory • Use of GIS
Implementation of strategies	• Mainstreaming of climate change in various sectors
Coastal zone	• Adaptation to climate change in the coastal zone • Development of coastal setback • Coastal protection and rehabilitation
Same amendment to be ensured in whole document. Done only one place	• Weather forecasting and Early Warning System • Landslide management • Sustainable land management
Energy	• Energy conservation • Energy efficiency • Training was provided to 60 local auditors out of whom 42 have been certified and 10 industrial energy audits have been carried
Awareness raising	• Development of innovative sensitisation materials • Eco driving
Policy formulation	• Technology needs assessment • Pathway calculator

Trainings were carried out by local and international consultants and were delivered to concerned stakeholders including public and private sectors, NGOs, research institutions and academia. A list of major projects including a component on capacity building and institutional strengthening in Mauritius is given in Table 9.2.

Table 9.2 List of major projects including key component on capacity building in Mauritius

Project	**Training/Capacity Building/Research activities undertaken**
African Adaptation Programme for the Republic of Mauritius (2010-2013)	• Research under AAP (Section 7.3.1): MRC has funded **11** research projects, eight of which deal with climate change adaptation
Climate Change Adaptation Programme in the Coastal Zone of Mauritius (2012 -2018)	• Development of Post Graduate course on coastal engineering • 13 Short continuous professional development courses • ≥500 officers from the Governmental and parastatal sectors trained on coastal engineering, cost benefit analysis, Climate change, ICZM, DRRM in coastal zone, ocean data collection and analysis (Sep 2013 – Sep 2016). • Four Training manuals produced and training materials freely available on website: lcms.uom.ac.mu • Ten Comprehensive research projects and international networking developed with international institutions • Capacity building for 60 women of Grand Sable Women Planters, Farmers, Entrepreneurs' Association on diversified and alternative livelihoods (project awarded the Island Bright Spot Award) • Capacity building for 60 persons on the use of the Early Warning System for storm surge (3 days probabilistic and 6 hour deterministic forecasting system)

Technology Needs Assessment (2011-2013)	• Capacity building on Multi Criteria Analysis and Identification of feasible technologies (50 participants) • Reinforcement of capacity building of research and extension to identify and adapt green and environment friendly technologies
Capacity Development on Climate Change Measures in Republic of Mauritius (2014-2016)	• Technical exchange: five officers trained in Japan • Three official training sessions for 30 educators and Headmasters, 25 youth cadres and 65 women and four awareness raising sessions for 45 farmers, 40 senior citizens, 30 working adults and the general public (over 10 000) have been carried out • Training on the development of a climate-resilient and site-specific guideline for coastal setback
Third National Communication (2014 – 2016)	• Mitigation: training of 40 persons on mitigation assessment, Multi Criteria Analysis, Technology Needs Assessment and barrier Analysis • Vulnerability Assessment and Adaptation: training of 50 persons and four local experts on biodiversity, health, fisheries and infrastructure • GHG Inventory: training of 55 persons on data collection, Use of Methodology for Inventory, IPCC Inventory Software, training of 22 persons on Geospatial Technique for Assessing LULUCF to Support GHG Inventory by RCMRD; Key Category Analysis, and Quality Assurance / Quality Control
Mauritius 2050 Pathways Calculator (2014-2015)	• Two officers trained at the Department of Energy and Climate Change on the methodology of the 2050 Pathway Calculator
Preparation of Intended Nationally Determined Contributions (2015) and INDC Action Plan (2016)	• Technical capacity provided to transition towards a low-carbon development path through greater utilisation of renewable sources of energy and to adapt to the negative impacts of climate change • CB needs identified in various sectors such as Water Resources Management; Agriculture (IPM, irrigation, climate smart agriculture); climate smart fisheries; health sector; marine and terrestrial biodiversity (assessment, management and monitoring); critical coastal infrastructures; and Disaster Risk Reduction.
Global Fuel Economy Initiative (2013 –2014)	• Half-day seminar on eco-driving for 50 fleet managers of the private and public sector • Advance training course on eco-driving was conducted for 25 Government officials and representatives of the Driving School Association
Removal of Barriers to Energy Efficiency and Energy Conservation in Buildings and in Industry (2007-2014)	• Under the SIDS-Dock mechanism, training provided to local auditors and 30 industrial energy audits carried out. • Capacity building on energy saving in the building sector including development of an Energy Efficiency Building Code Compliance Scheme (EEBCCS); software development, training, examination and certification of energy compliance assessors for the EEBCCS and organisation of workshops for dissemination of information to the construction industry and the public in general
Capacity Development on Coastal Protection and Rehabilitation in the Republic of Mauritius (2012 – 2015)	• Three officers of ICZM Division attended technical exchange training in Seychelles; six officers of RoM attended CB on coastal protection in JICA, Japan and two officers attended CB on coral reef monitoring in JICA, Japan. • Capacity building on coastal protection and rehabilitation: preparation of coastal conservation plans for 14 coastal areas; technical guidelines on beach conservation measures; beach and coral reef monitoring and Environmental Impact Assessment for coastal development projects; and implementation of the 'gravel beach nourishment' demonstration project at Grand Sable Village.

Capacity Development on Landslide Management in the Republic of Mauritius (2012 – 2015)	• The Landslide Management Unit (LMU) has implemented the CB plan on landslide investigation/analysis, design and construction/supervision through on the job training, seminars and training in Japan • Organisational establishment-posting of six engineers was decided in March 2014 • Coordination with other stakeholders - As collaboration of all stakeholders is essential to deal with landslide issues, the tasks and responsibilities of LMU as well as the other stakeholders were defined and finalized through a wide consultative process.
Improvement of the Meteorological Radar System – Phase II (2016 - 2018)	• The project comprises the installation of an S-Band Solid State Doppler Radar together with Data Display and Communication Systems and the construction of a new Radar Tower Building with an exhibition hall for the public at Trou-aux-Cerfs. • The radar is expected to be operational by March 2018 and staff of the Meteorological Services will be provided CB on the use of the radar data for application in general weather forecasting
Capacity building for Sustainable Land Management (SLM) in (2009- 2013)	• Capacity building for SLM in appropriate Government and civil society institutions/ user groups in Mauritius and Rodrigues, and mainstreaming of SLM into Government planning and strategy development.
Toolkit for Climate Change Vulnerability Assessment and Identification of Adaptation Options for Local Authorities (MoESDDBM)	• Training of seven staff of local authorities (Municipality of Vacoas-Phoenix) on the use of GIS for vulnerability assessment due to climate change
Drill on DRR at the level of Local Authorities	• Training of 75 staff of local authorities (Dictrict Council of Flacq, Municipality of Quatre Bornes, District Council of Savanne) and 110 members of the public through drills on Disaster Risk Reduction and Management
Capacity building of staff of the MoESDDBM	• 67 officers of the MoESDDBM have attended various trainings and capacity building programmes on climate change issues outside Mauritius e.g. India, China, Japan, Singapore, Kenya, Thailand, Germany, Botswana, South Africa, etc. (2010-2016).

9.3 Promotion of South-South and North-South cooperation with other institutions

South-South and North-South cooperation, including cooperation among SIDS is critical at the bilateral, sub-regional and regional levels in strategic areas, such as information and communication technology, trade, investment, capacity-building, disaster management, environment, food, agriculture, oceans, water, energy, health and education. Several regional climate change adaptation programmes have been implemented by the Indian Ocean Commission with the support of the European Union, in which Mauritius has participated. Table 9.3 provides a list of these regional projects.

Table 9.3 South-South and North-North Cooperation

Regional project	Capacity Building Component
The ISLANDS programme for the Implementation of the Mauritius Strategy for SIDS of the ESA-IO region. Project cost: EUR10 M.	This programme provides valuable opportunities to identify and develop mechanisms, national and regional frameworks, tools and partnerships to implementing measures for promoting SD and to address common challenges such as coral reef degradation, natural disasters, and climate change. Regional training on DESINVENTAR and CAPRA to allow countries to put in place their national databases and undertake national country risk profile are conducted.
The Smartfish programme for the Implementation of a Regional Fisheries Strategy in the ESA-IO region (2011-2014). Project cost: EUR 21 M.	The overall objective is to contribute to an increased level of social, economic and environmental development and deeper regional integration in the ESA-IO through the sustainable exploitation of marine and lake fisheries resources.
Project to reinforce the capacity of members of the IOC to adapt to climate change (2009-2012). Project cost: EUR 3 645 000	The main objective of this project was to establish regional cooperation between Member States of the IOC to better facilitate adaptation to climate change. Participating countries include Comoros, Madagascar, La Réunion, Mauritius, and Maldives
A programme to support the IMF Regional Technical Assistance Centres (AFRITACs) of the ESA-IO. Project cost: EUR 15 M.	The programme aims at improving the design, implementation, and monitoring of sound macroeconomic policies, and enhanced regional harmonisation and integration in ESA-IO Member States to assist them in the implementation of the regional integration agenda of their regional organisations.
Coastal, Marine and Island Specific Biodiversity Management in the ESA-IO Project cost:: EUR 15 M.	The programme aims at developing and strengthening over five years the national and regional capacities for sustainable participatory management of coastal, marine and island specific biodiversity in the islands states and coastal states of the ESA-IO region.
Programme for the Renewable Energy development and Energy Efficiency improvements in IOC Member States. Project cost: EUR 15 M.	The programme aims at establishing the conditions for the development, investment and sustainable management of renewable energy and improvements in the efficiency of energy use in the IOC region.
Migration, Environment and Climate Change: Evidence for Policy project. Implemented by the IOM and MoESDDBM and supported by EU and IDF (2014-2016). Cost: EUR 2.4 M.	The project aims to contribute to the global knowledge base on the relationship between migration and environmental change, including climate change. The innovative research will aim to formulate policy options on how migration can benefit adaptation strategies to environmental and climate change. Participating countries: Dominican Republic, Haiti, Kenya, Mauritius, Papua New Guinea and Viet Nam.
Setting up of the Commonwealth Climate Finance Access Hub in Mauritius (2016). Australia has pledged USD 1 M to the hub.	The programme aims to support capacity development for Small States, including SIDS, LDCs and other vulnerable countries. The purpose is to enable these countries to access and effectively utilise climate finance. This capacity development is intended to facilitate long-term unlocking of access to means of implementation covering the entire scope including technology transfer.
Switch Africa Green Project Project cost: EUR 19 M funded by EU and is being managed by UNEP, UNOPS and UNDP (2014- 2017)	The project aims at promoting a shift to SCP patterns with a view to achieve sustainable development. The objectives are to encourage green business development and eco-entrepreneurship through adoption of resource efficient production practices and create an enabling environment, with clear policies, regulatory frameworks and economic incentives which will encourage the green entrepreneurship. Participating countries: Burkina Faso, Ghana, Kenya, Mauritius, South Africa and Uganda.

9.4 Capacity building - Gaps and needs

In spite of the numerous activities taken in common with several countries, RoM faces numerous challenges in mitigating, and adapting to climate change. These challenges arise from gaps in knowledge and understanding, and the ability of RoM to address them is constrained by insufficient capacity, research infrastructure, and inherent constraints in accessing finance and technology.

The Rio National Reporting and NCSA reports lay strong emphasis on the constraints placed by capacity limitations at the systemic, institutional and individual levels, and stress that capacity building is an essential requisite for more effective resource management and sound environmental governance. Following the synthesis report of the Intended Nationally Determined Contributions (INDC) for RoM, several needs in various sectors have been identified as listed in Table 9.4 for Mauritius and in Table 9.5 for Rodrigues.

Table 9.4 Capacity-building needs identified in the INDC for Mauritius (2015)

Sectors/Actions	Capacity building needs
Water resources - To improve forecasting, management, protection and quality of water resource	• Build national capacity on the use of a hydrological model • Additional capacity building and equipment are required
Agriculture – To strengthen capacity to develop biological control techniques (sugarcane and non-sugarcane production) as part of the Integrated Pest Management (IPM) Strategy	• Increase capacity for pest and disease surveillance and early detection • Strengthen capacity to produce sugar cane variety diseases resistant
Agriculture – To promote efficient irrigation techniques	• Build a research network and improve research capacity • Build capacity of researcher, extension farmers and entrepreneurs involved in design and installation of irrigation
Agriculture - To develop climate smart agriculture (crop and livestock)	• Training and capacity building on climate change and climate smart agriculture for all stakeholders at all level (policy,technical, financial, monitoring) with emphasis on knowledge sharing and improved coordination mechanism
Climate Smart Fisheries	• Strengthen human resources capacity • Strengthen institutional capacity (Strengthen research, data collection, information sharing and dissemination of results; Improve coordination mechanism and consultative process; and Build technical capacity of all stakeholders).
Climate change adaptation to the health sector	• Strength surveillance capacity in the field and in the laboratory. • Additional support will be required for technology transfer and capacity building to mainstream climate change in health sector, improve food and water quality control
Climate change adaptation measures to improve marine and terrestrial biodiversity resilience	• Capacity building in biodiversity assessment, management and monitoring • Additional support will be required for coral rehabilitation in terms of capacity building and appropriate techniques, research on climate change impacts on biodiversity and for the implementation of the National Biodiversity Strategy and Action Plan (NBSAP) 2015-2020.
Critical coastal infrastructure	• Additional support will be required for capacity building in coastal engineering field

Table 9.5 Capacity-building needs identified in the INDC for Rodrigues (2015)

Sector	Capacity Building Needs
Agriculture	• Improve sustainable water management by improving water storage water harvesting, promoting irrigation and building capacity
Capacity building	• Increase level of awareness in the formal and non-formal education system on rain harvesting, energy saving, responsible agriculture practices, improve pre- and post- harvest management practices (supply chain integration, logistics, value addition, marketing) and climate change issues
	• Increase awareness on climate change issues of group leaders, NGOs, entrepreneurs on thematic such as renewable energy, recycling activities, sustainable living
	• Develop module of training of trainers/teachers on climate change issues to be incorporated into the national education curriculum
Tourism	• Promote sustainable tourism (renewable energy, local products, sustainable resources management) • Additional capacity building and financial support required.
Health	• Mainstream climate change adaptation in health sector to be able to respond to population increase and its additional climate-related health burden. • Additional support will be required for technologies transfer and capacity building to Mainstream climate change in health sector, improve food and water quality control
Limited capacity	• Strengthen education and awareness on climate change adaptation • Additional capacity building and financial support required

9.5 Priority measures for capacity-building

Some of the priorities in the short-term for RoM relate mainly to furthering technical knowledge and skills as core competencies in the near-term. These are expected to help RoM to move and accelerate on a pathway of climate resilience and fulfil its international obligations related to climate change including the implementation of INDC and subsequent Nationally Determined Contributions (NDCs).

Table 9.6 Examples of additional technical knowledge and skills required

Topic	Type of capacity building needed
Modelling	Downscaling and modelling
GIS	Advanced IT skills for application of GIS
GHG emissions and inventories	Calculation of GHG emissions as footprint assessment GHG inventories using specialized tools and knowhow for assessing the carbon sink potential Calculation of emission from waste
Vulnerability	Vulnerability assessment and modelling
Adaptation and mitigation	Identification, assessment and promotion of adaptation and mitigation technologies including endogenous ones to accelerate adaptation and mitigation Project design, preparation, implementation and MRV system Conducting cost benefit analyses for adaptation and mitigation measures Multi-criteria process in mitigation
Natural disasters	Formulation of preparedness plan to better address natural catastrophes
Empowerment, awareness and resilience building	Empowerment of communities at risk through capacity building and awareness campaigns of the dangers of climate change and how to develop resilience to extreme weather events
Energy	Training to personnel on the new equipment and Automatic Generation Control (AGC) software in Smart Grid System Household energy efficiency-institutional capacity Capacity building to energy auditors and development of skills of installers

RoM is committed to promoting sustainable development, eradicating poverty and improving the livelihoods of its people by the implementation of strategies that build resilience and capacity to address its unique and particular vulnerabilities. RoM is investing significant financial resources, despite its limited means, in the implementation of most of the measures identified above (Table 9.6). The process can be facilitated by international cooperation, including through further efforts by multilateral partners, that is more responsive to the particular needs of SIDS.

CHAPTER TEN

CHAPTER 10 NETWORKING AND INFORMATION SHARING

10.1 Introduction

Networking and information sharing at national and international levels are needed when addressing climate change-related issues. In particular, the preparation of a national communication requires an inter-institutional approach. For this purpose, the challenge of accessing the broad range of data across disciplines inspires collaborative solutions involving policy and decision makers, public and private sectors, academia, civil society, and the public. RoM is gradually building on its experience to develop a platform that will use information systems for networking and information sharing on a continuous basis and respond effectively to meeting its reporting and other obligations under the Convention.

10.2 Experience in networking and information sharing

RoM's network arises from its participation in international (Figure 10.1) and regional climate-related programmes including the Indian Ocean Commission's ACCLIMATE and ISLANDS projects, SADC's Climate Change Programme, WMO's Climate Forecast Forum in Eastern and Southern Africa and WMO's Tropical Cyclone Committee for the South West Indian Ocean.

Figure 10.1 Global networking and data sharing

At national level, RoM has acquired considerable experience. In 2013 it established a Climate Change Information Centre (CCIC) at MoESDDBM (Sections 8.4.3; Box 8.7). The mission of CCIC is to contribute to the building of an optimal level of resilience through information dissemination, education, communication, awareness raising and capacity building. The activities are meant to inspire and empower people to take effective action on climate change-related issues.

The Centre provides consolidated information on climate change to various stakeholders such as the public and private sector organizations, women, students, researchers, educators, NGOs and various professionals. CCIC also distributes the latest updates on climate change at national and international levels on a timely basis to various stakeholders and policy makers via e-mail. GIS software is available to facilitate sound decision-making by integrating GIS in environmental monitoring and planning for future development. Since the creation of the CCIC, over 15 000 visitors have accessed the CCIC webpage and some 1 000 articles have been sent to about 200 stakeholders.

Several Ministries, national institutions and NGOs are also involved in knowledge and information sharing about climate change. One such initiative is a permanent interactive exhibition on the science of mitigation and adaptation to climate change at the Rajiv Gandhi Science Centre. Others include the dissemination of information on

environment and climate change to the general public through mass media such as the press, radio and television, especially during the celebration of international environmental events such as the World Environment Day and Earth Day.

Similarly, the media report regularly on national and international events and highlight the cause and consequences of climate change. The emphasis is often on actions at individual and community levels. The radio and TV broadcasts are accessible to everyone as they are in English, French, Creole and some Asian languages. Wider availability of high speed internet connectivity is also facilitating access to information on climate change. Students can now easily obtain such information as Government has taken the initiative of providing those at secondary level with laptops and those at primary level with tablets.

10.3 Data sharing facilities to enhance reporting requirement

In order to structure and improve the organization of data collection, storage and access, several projects have been implemented. A few of the facilities include:

(i) The MUELEX web-based, searchable database system hosts the National Legal Databases for capacity-building and for stakeholders' involvement in sharing data and information for reporting and policy making purposes

(ii) A High Performance Computing (HPC) Server is operational at the University of Mauritius. It provides, among others, storage space and encourages data access and networking for research and modelling

(iii) Statistics Mauritius (SM) has established a Statistical Environment Unit at the MoESDDBM for the collection of environmental data including climate change elements

(iv) The Ministry of Health and Quality of Life (MoHQL) has established its own Statistics Unit. The Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island (MoEMRFSOI) has developed its own statistical system with the assistance of SM to facilitate the identification of linkages between climate, and health and the marine environment, respectively.

10.4 Information technologies for data exchange and storage

In the past, several attempts were made to centralise environmental data collection and storage using ICT. Some of the facilities described in Section 10.3 were considered for this purpose. As information systems

Figure 10.2 Schematic representation of (left) cloud computing and storage and (right) Big Data Networking and Sharing

form an important part of GHG inventories, mitigation analysis, and vulnerability and adaptation assessment in National Communications, it is envisaged to institutionalise a more integrated system for data management and sharing under the existing CCIC (Box 10.1).

Box 10.1 Recommendations for CCIC to play a growing role in networking and information sharing

CCIC as a platform for knowledge and information sharing

- Ensure easy access to all key stakeholders to populate the database with their data
- Set up a data and information management team of technicians and experts
- Use of data sharing platform for the exchange od data. An Info-Highway platform has been set up by the Ministry of <Technology, Communication and Innovation for for the purpose of sharing data/information
- Explore emerging technologies to address issues related to Big Data (Figure 10.2), analytics and High Performance Computing to exploit opportunities for further research by stakeholders
- Promote an Open Data policy to encourage information sharing among stakeholders. In particular, Mobile Apps developers could develop customized applications based on available data and the products to be made available publicly in line with the Open Data initiative of the Government
- Promote a legal policy regarding the sharing of climate change data which fall under the responsibility of other institutions. MoUs could be used to formalize data sharing arrangements
- Establish a GHG Data Coordinating and Management Committee entrusted with the preparation of NCs and BURs activities
- Facilitate data access to organisations and institutions and to the general public through a login and password-protected system. Data could be categorized at various levels, having different levels of access, depending on the nature of the data

Source: MoESDDBM

10.5 The CCIC – a national repository of all climate change-related data

In view of increasing reporting requirements of RoM with regard to the Climate Change Convention including the Biennial Update Reports every two years and the National Communication every four years there is growing need for a multipurpose platform that would facilitate continuous interaction with all stakeholders. Currently, CCIC is serving as a platform for efficient networking (Box 8.4). It is proposed to consolidate this function and reinforce its facilities so that CCIC could also serve as centre of excellence (Box 8.7) and a repository of all information on climate change (Box 10.1).

Box 10.2 Functions of the CCIC Committee

Functions of the Climate Change Information Centre Committee

a) To identify, discuss and agree on climate change indicators for Mauritius
b) To provide information to the Centre based on climate change indicators identified
c) To recommend the posting of relevant general information on climate change on the website of the CCIC for use by the public
d) To ensure the quality of the information prior to its posting on the CCIC website
e) To discuss and agree on any reports prepared by the Centre prior to their dissemination

Source: MoESDDBM

Stakeholders including Ministries, public and private sector organisations, academia and NGOs can submit their data to the Centre and access all other available information. The Centre has identified 44 environmental indicators for reporting purposes. It has collected data on 15 of them and is actively pursuing its efforts to obtain data on the remaining indicators from stakeholders.

A CCIC Committee has been set up to serve as a forum for various stakeholders to discuss ways of improving awareness raising and information sharing on climate change and coordinate and strengthen networking among them. The Committee's main functions are briefly described in Box 10.2.

The Centre will soon move to Rose Hill where more space and facilities will be available. Discussion with regional partners has already been initiated to develop it into a regional Climate Change Information Hub for the Eastern African Region. To this end, several recommendations have been made (Box 8.4 and Box 10.1).

10.6 Climate Change Bill and CCIC Committee

In its determination to accelerate climate change-related actions and provide a suitable framework for policy making, a Climate Change Bill will soon be finalised. The aim of the Bill is to consolidate the legal framework and mechanism for making Mauritius climate change-resilient and achieve a low carbon emission economy in line with the overarching Government objective of achieving a greener economy.

The Climate Change Bill would also make provision for the establishment of a Rodrigues Climate Change Committee (RCCC) to coordinate and strengthen networking among stakeholders in Rodrigues as well as advise on climate change issues for Rodrigues.

CHAPTER ELEVEN

CHAPTER 11 CONSTRAINTS AND GAPS AND FINANCIAL AND TECHNICAL NEEDS

Further to intensive consultations with relevant stakeholders and several training sessions organised in the context of the TNC process, various constraints and gaps and the related financial, technical and capacity needs were identified. The most pressing ones pertain to GHG inventory, climate change scenarios, vulnerability assessment and adaptation, and mitigation assessment. These are discussed in the following sections.

11.1 Constraints, gaps and related technical and capacity needs

Several actions are proposed to address the gaps and needs in a few key areas are applicable to both Mauritius and Rodrigues and, to some extent, are relevant to the other outer islands. Table 11.1 summarises the constraints, gaps and related technical and capacity needs that have been identified.

11.1.1 Gonstraints and gaps for Rodrigues

Consultative meetings and intensive discussions were held with all stakeholders in Rodrigues during the TNC implementation process. Proposals to address several additional gaps and needs applicable to the particular circumstances of Rodrigues in few important sectors such as biodiversity, fisheries, health and infrastructure sectors are summarised in Annex to Chapter11/Rodrigues.

Constraints on data collection in a few key sectors including livestock, forest cover and fuel consumption from fishing vessels and pleasure boats have been important barriers for more accurate GHG Inventory. Stakeholders have proposed that a Climate Change Technical Committee be established to discuss and take appropriate action to address the issue. It has been proposed that the mandate of Statistical Office be broadened to include data collection relevant for the compilation of GHG emissions and sinks. To this end, capacity building and support from MOESDDBM will be required

11.2 Financial needs

The Government has indicated in its INDC that "*The Republic of Mauritius imperatively needs international technical and financial support to enable it to abate its GHG emissions by 30%, by the year 2030, relative to the Business as Usual scenario of 7M* tCO_{2e}". To this end, it will require international support in its efforts to transition towards a low-carbon development path through greater utilisation of renewable sources of energy and to adapt to the negative impacts of climate change that affect several sectors of the economy. To fully realise its INDC, it will need international financial support:

(i) To supplement its own financing and investment in the form of grant/concessional financing
(ii) For technology development and transfer, through both South-South and North-South cooperation
(iii) For capacity development that will include strengthening of both institutional capabilities and human resource

The funding needs are indicated in Section 11.2.4.1

Table 11.1 Summary of constraints, gaps and related technical and capacity needs in key sectors

Sector	Key areas where gaps have been identified	Proposed actions/ technical and capacity needs	Potential source of financial/ technical support
Climate change scenarios	• Development of climate change scenarios is quite complex and requires specialized expertise • Acquisition of meteorological data to test and validate climate change models	There is a need to develop expertise at national level in concerned institutions for the application of appropriate climate change models and scenarios for determination of climate change impact assessment at sectoral level	Bilateral
GHG inventory	• Lack of disaggregated activity data and local and country specific emission and sink factors for more refined GHG calculation to higher Tiers	Enhanced CB of scientists and better laboratory facilities to conduct studies on determination of local and country specific EF for emission and sinks	Local training UNFCCC Bilateral
Energy	Insufficient energy auditors and enforcement of regulations under the EE Act	Training of energy auditors and on enforcement; and training of trainers on energy saving and EE	Local training UNFCCC Bilateral
Transport	Absence of EE mass transportation systems based on hybrid technologies and cleaner energies	Policy development, institutional CB and technology transfer.	UNFCCC Bilateral
IPPU	Lack of CB and resources to leapfrog to low global warming potential refrigerants. Data on sectors – metal, minerals	Human and institutional CB for a new generation of appliances and installations (AC/chillers etc.)	Montreal Protocol Bilateral
Forest	Lack of data on privately-owned forests, trees along rivers, roadside; on natural forests (type of trees, age distribution class, annual increment)	Refinement of inventory system and capturing data on trees outside forest area and ground truthing on private land Further training in remote sensing for land use change. Acquisition of high resolution satellite imagery with near infrared band for Mauritius for the accurate calculation of carbon sink for RoM.	RCMRD UNFCCC Bilateral
Waste	Limited development in integrated waste management including waste to energy and record of waste types and EFs development	Technology transfer for project development and calculation of emissions from waste; and CB on waste-to-energy technology	ADB UNDP Multilateral Bilateral
Liquid waste	• Lack of data on emissions at treatment plants and records of population connected; and industries to develop EFs • Absence of a real time flow monitoring system for sewers to obtain real time data and take remedial measures upfront • Use of renewable sources of energy has not been explored for the operation of wastewater treatment plants and pumping stations	Capacity building on development of EFs Secure funding for implementation of projects	UNFCCC
Agriculture	• Limited development in integrated pest and disease management; bio-farming; research to develop local EFs; and sustainable land use planning practices;	Integrated pest and disease management and bio-farming technologies; Ways to introduce revenue-generation mechanisms; other technologies (GIS, agro-meteorological stations)	FAO IITA CGIAR Multilateral;

	• Lack of trained staff on climate modeling to understand and predict the impact of climate change on the agricultural sector. • Lack of trained staff on techniques for mitigation analysis and scenario building. • Lack of a systematic observation framework to study how CC is impacting on the agricultural sector. • Lack of data pertaining to livestock sector, in particular deer and horses	• Integrate CC gaps into current agricultural policies and strategies • Improve technology transfer and capacity building • Increase funding and investment in climate change-related adaptation and mitigation technologies	
Coastal areas and Tourism	Limited coastal protection works - coastal vegetation; beach nourishment / dune replenishment; coastal wetland protection/ restoration; lagoon management and coral rehabilitation	Coastal protection works - site investigation/source identification; planting of native vegetation; re-establishment of marshes; mangroves/seagrass restoration; coral nursery	GEF, JICA, AFD, GIZ REDD+ Multilateral Bilateral
Water	Limited forecasting and integrated water resources management; limited water use efficiency and water storage capacity ; limited monitoring and data analysis	Development and use of hydrological models; Reduce losses in water distribution system; Promote soil and water conservation techniques; Increase water storage capacity; Modernize data acquisition and management system	UNDP, USAID EC Multilateral; Bilateral
Biodiversity	Limited restoration of native forests and reintroduction of native plants in planted forest; limited expansion and improvement of protected areas and protection of Environmentally Sensitive Areas	R&D on impacts of CC on native forests; maintenance of replanted forest; removal of invasive alien species. Improving the resilience of marine/terrestrial biodiversity to CC	GEF; REDD+
Fisheries	Limited rehabilitation and expansion of coastal and marine habitat; limited development in sustainable aquaculture; limited improvement in monitoring of coastal areas and absence of a harmonized monitoring methodology	Promote sustainable aquaculture; coral nursery; seagrass restoration; mangrove propagation; create a centralized knowledge repository; Enhance fishers sensitization and training programme	EU, AFD, FAO; Multilateral Bilateral
Health	• Limited surveillance/monitoring/control of vectors, diseases and environmental hazards • Limited health promotion through education/communication/dissemination on preventive strategies • Absence of policies to make projections for hotspots	Policy formulation; Consolidation of data for mapping purposes; implementation of Early Warning System of surveillance to monitor trend of vectors, environmental hazards and climate-sensitive disease and conditions. Create a Unit for vector borne and climate-sensitive diseases	WHO WB Multilateral Bilateral
Infrastructure	Limited use of topographic, hydrology and climate-related data in infrastructure planning (e.g. elevated roads and buildings); and absence of real time warning system for infrastructure failure	CB of institutions on the use of climate related data for infrastructure planning; use of climate resilient materials and techniques in flood prone areas; CB on restoration of landscape integrity and technology deployment	AFD; Multilateral Bilateral;
Gender	Lack of expertise to address gender implications of CC	Capacity Building Programmes of Officers and Gender Focal Points on: • Gender and its implications on CC • Adopting a gender lens while planning, implementing and evaluating projects and programmes	Bilateral

Source: MoESDDBM

11.2.1 Domestic public finance for climate change activities

The estimation of domestic public finance for mitigation and adaptation expenditures, according to the Mauritius Public Environment Expenditure Review 2011-2014, is given in Table 11.2 The percentage of climate change expenditures is in the range of 7 to 7.9 % of the total government expenditure and is about 2% of the GDP for the period 2011-2014. The share of adaptation expenditures is generally about77%, while that of mitigation is about 24%, which is quite typical of SIDS. The major part of the mitigation-related expenditure are from (i) solid waste sector (ii) local authorities, where the bulk (over 87%) is related to waste management, and (iii) livestock production.

Table 11.2 Breakdown of expenditures for different ministries

	2011		2012		2013		2014	
Total expenditure	**Actual Expenditure (MUR m)**		**Actual Expenditure (MUR m)**		**Actual Expenditure (MUR m)**		**Actual Expenditure (MUR m)**	
	Adaptation	**Mitigation**	**Adaptation**	**Mitigation**	**Adaptation**	**Mitigation**	**Adaptation**	**Mitigation**
MOESDDBM	465.7	576.2	682.4	557.2	637.6	587.4	584.3	654.1
MOAIFS	928.4	301.9	956.7	285.8	1 123.4	340.5	1 098.8	339.8
MOEBRFSOI	171.7	-	125.1	-	159.9	-	224.9	-
RRA	126.7	-	130.5	-	105.9	-	208.1	-
PMO	874.8	-	583.5	-	1 587.6	1.6	754.4	2.8
MEPU	2 674.3	11.4	2 455.2	41.1	2 899.5	50.8	3 646.0	57.3
MOLG	-	502.0	-	538.2	-	698.4	-	726.1
Climate Change	5 014.8	1 391.4	4 802.9	1 422.3	6 408.0	1 678.5	6 308.4	1 780.0
% Breakdown	78	22	77	23	79	21	78	22
Government Climate Change (TGCCE)	6 406		6 222		8 081		8 081	
Total Government (TGE)	87 812		89 102		102 924		106 693	
% TGCCE/ TGE	7.3		7.0		7.9		7.6	
% TGCCE/ GDP	2.0		1.8		2.2		2.1	

Source: Adapted from RoM Public Environment Expenditure Review (PEER) 2011-2014 (UNDP, 2016)

11.2.2 Private sector finance

An estimate of private sector finance for key sectors is indicated in Table 11.3.

Table 11.3 Estimate of private sector finance in key sectors

Name of Project	Implementing Organisation	Key benefits of project	Amount of funds disbursed	Start date	End date	Status of project (On-going or completed)
La Ferme – Bambous 15 MW solar power farm	SARAKO PVP Co. Ltd and as strategic partner, TAUBER-SOLAR	(i) 222 260 tCO_{2e} abated over 10 years (fixed) (ii) Improve energy self-sufficiency (iii) Creation of 300 jobs (iv) Transfer of technology.	M.€35.7	2014	2034 (Lifetime of project is estimated over 20 years)	Solar power farm is operational and CDM process is on-going. Letter of approval from Designated National Authority obtained in June 2016.
EOLE Plaine des Roches	Joint Venture local companies : Sugar Investment Trust and Aerowatt Mauritius Ltd	i) Imports substituted by local production ii) Renewable energy development, with CO_2 avoided and improve towards energy self-sufficiency iii) Jobs creation iv) Forestry sustainability with a tree replant programme	Total Investment by Capital Expenditure USD 18.4 M (Equity USD 3.9 M, and Debt USD 14.5 M) BPCE/Banque des Mascareignes	Commercial Operation date: Mars 2016.	20 years of operation scheduled	Completed
Sweet Power: Using cane trash as a source of energy for power production	Terragen	i) Decrease of coal consumption ii) Reduction of burning of sugarcane before harvesting iii) Social and economic benefits in the country iv) sustainability of cane industry v) creation of jobs	MUR100 M	2015	2020	On-going
Sweet Paper: Recyclable paper (shredded) as source for power production	Terragen	i) Decrease of coal consumption: ii) • Enhance recycling of paper	MUR10M	2016	2020	On-going
Bioethanol Distillery	Omnicane Ethanol Production Limited	i) Annual bioethanol production capacity of 24 million litres/year ii) Use of Concentrated Molasses Stillage to produce bio-fertilizers iii) Reduction in CO2 emission by capturing and using it in beverage industry	USD29M	2012	2014	Completed
Small Energy Plant	Omnicane Heat and Power Services Ltd/Omnicane Thermal Energy Operations (La Baraque) Limited	i) Less reliance on grid for electricity ii) 3.8 MW power plant using both woodchips and coal to produce steam and electricity for the cluster only.	USD17M	April 2013	June 2014	Completed

Carbon Burn Out	Thermal Valorisation Co. Ltd./Omnicane Thermal Energy Operations (La Baraque) Ltd.	i) Reduced CO2 by 29,000 tonnes yearly from avoided production of cement ii) Eliminate need for landfilling of ash, hence no dependency on land availability iii) Recommendations for re-use of fly ash in cement by the Strategic Environmental Assessment of MAAS in 2007 iv) & Technical Advisory Committee on Coal Ash Management in 2009	USD22M	June 2015	Nov 2016	On-going
Landfill Gas to energy	Sotravic Ltée	i) Renewable energy generation with contribution to the electricity needs of the country at an average of 22 GWh per year which is equivalent to nearly 1% of the total consumption. ii) CDM registration as an emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO_2.On average, it is estimated that an average of 70 000 tCO2e has been reduced annually since operation.	Disbursement of MUR 200 million since 2010 with additional investment of MUR 150 million foreseen in 2017	2011	Negotiations concerning a renewal of the project is ongoing with the Central Electricity Board and MoESDDBM	On-going with renewal expected up to an until the harmful landfill gases are no longer a threat to the environment
Applications (DOWA)	Urban Cooling Ltd	i) The project will aim at the reduction of about 25000 tons of CO2. ii) There will be reduction of electricity consumption and consequently fossil fuel imports equivalent to 15MW which is the electricity consumption of the 22 targeted buildings. The proposed SWAC system can cool the buildings in Phase 1 using only 1.5MW of electricity.	Amount spent on development cost as at 31st of Dec 2015 amount to approximately MUR 60 million for an anticipated project cost of MUR 2.1 billion excluding downstream opportunities.			On-going project with concession agreement signed on 23 Dec 2015 and project implementation underway

Source: MoESDDBM

11.2.3 GEF, Annex II Parties, multilateral and bilateral contributions

Most of the financial resources come from government funding as well as donor countries. Some funding is also accessed from the Global Environment Facility and Adaptation Fund Board. The Ministry of Finance and Economic Development is responsible for coordinating all the funding received and this is eventually reflected in the National Accounting in a spirit of transparency and good governance.

Table 11.4 provides information on climate finance from international funding agencies.

Table 11.4 Information on climate finance from international donors

Name of project	Implementing organisation	Amount of funds received	Source of Funding (Funding Agency)	Type of funding (Grant/Loan/ Technical Co-operation)	Type of cooperation (bilateral/multi-lateral)	Start date	End date	Status of project
Nationally Appropriate Mitigation Actions	MoESDDBM	USD 1.462M	GEF	Grant	Bilateral	Jan 2017	Dec 2020	Project starts in Jan 2017
Land Degradation Neutrality Target Setting Programme	Forestry Service (Focal Point)	USD 35 000 so far	Global Mechanism	Grant	Multilateral	October 2016		Start Oct 2016
Support to forest code revision and institutional reform in Mauritius	Forestry Service	USD 298 000	FAO	Grant	Bilateral	31 August 2016	July 2018	MOU signed on 31/08/16
Support to climate smart agriculture for small holders	Ministry of Agro Industry and Food Security	EUR300 000	GCCA	Grant	Bilateral	2016	2018	Started in 2016
Climate Change Adaptation in the Coastal Zone	MoESDDBM	USD 9.12 M	Adaptation Fund Board	Grant	Bilateral	August 2012	August 2018	Ongoing
Biennial Update Report	MoESDDBM	USD 352 000	GEF	Grant	Bilateral	Jan 2016	Dec 2017	Ongoing
Enhancing the observation, forecasting and warning capabilities of Mauritius Meteorological Services	MMS	USD 0.98 M	JICA	Technical Cooperation	Bilateral	2014	2016	Ongoing
Improvement of the Meteorological Radar System	MMS	USD 13.8 M	JICA	Grant	Bilateral	August 2016	March 2018	Ongoing
Expanding coverage and strengthening management effectiveness of the protected area network on the island of Mauritius (PAN Project)	NPCS	USD 4M	GEF/UNDP	Grant		2010	April 2018	Ongoing
National Biodiversity Planning to support the implementation	NPCS	USD 220 000	GEF/UNDP	Grant		2016	2016	Ongoing

of the CBD 2011-2020 Strategic Plan in Mauritius (NBSAP Project)								
Africa Adaptation Programme	MoESDDBM	USD 3 M	Government of Japan under its Cool Earth Partnership for Africa	Grant	Multilateral	2010	2012	Complete
Technology Needs Assessment	MoESDDBM	USD 120 000	GEF	Grant	Bilateral	2011	2013	Complete
Capacity Development on Coastal Protection and Rehabilitation	MoESDDBM	USD 5.15 M	JICA	Technical Cooperation	Bilateral	May 2012	June 2015	Complete
Mauritius 2050 Pathways Calculator	MoESDDBM	£ 20 000	UK Foreign and Commonwealth Office	Grant	Bilateral	August 2014	June 2015	Complete
Landslide Management	MPI&LT	USD 3.38 M	JICA	Technical Cooperation	Bilateral	May 2012	March 2015	Complete
Training of Trainers Programme on "Gendered Impacts of Climate Change" and campaigns on the same issue	MGECDFW	USD 5 715 (MUR 200 000)	MoESDDBM through the Government of Japan under the AAP on Adaptation to Climate Change	Grant	Bilateral Cooperation	April 2012	October 2012	Complete
Production of an interactive DVD entitled "Women and Climate Change" (in Creole language) Capacity Building Programme of Officers on the DVD Awareness raising on the DVD at the level of Women Centres, Social Welfare Divisions, Community Centres, Women's Associations and Secondary Schools	MGECDFW	USD 2 800 (MUR 97 900)	Commonwealth of Learning	Grant	Bilateral Cooperation	July 2013	Decembe r 2015	Complete

Source: MoESDDBM

11.2.4 Proposed projects for financing

11.2.4.1 Proposed projects under INDC

The financial resource requirements to achieve the target of 30% reduction in GHG emissions by 2030 are estimated at $ 5.5 billion, with $ 4.0 billion allocated for adaptation and the remaining $ 1.5 billion allocated for mitigation activities during the period 2015-2030. Table11.5 gives the financial requirements for climate change adaptation and Table 11.6 for mitigation options, both identified under INDC.

Table 11.5 Financial requirements for climate change adaptation options identified under INDC

Vulnerability	Climate change adaptation options	Indicative cost estimates (USD)
Critical and Coastal infrastructure	Enhancing protection of critical public infrastructure and ecosystems	2 032.9 M
	Enhancing protection of coastal zone	116.5 M
Water security	Increase water storage with construction of eight dams	580M
	Promote rainwater harvesting	109.3M
	Reduction of water losses in distribution system	677M
	Improve water resources management	0.5M
Food Security	Promote integrated pest and disease management	3.3M
	Develop efficient irrigation techniques	15.1M
	Promote climate-smart agricultural practices	160.6M
	Promote climate-smart fisheries practices	55.8M
Health	Improving resilience to climate change impacts in the health sector	15 M
Biodiversity	Improving protection and resilience in biodiversity sector	71.7M
Rodrigues	Improve resilience of Rodrigues to climate change	600M
Total		**4 437.7 M**

Table 11.6 Financial requirements for climate change mitigation options identified under INDC

Mitigation action types identified in the INDC	International support type	Example of support type	Estimated support to 2030 (USD)
Expansion in solar, wind and biomass energy production and other renewable energy sources.	All types, including grants, technology transfer, capacity building, as well as subsidised loans, risk guarantees, and potentially existing carbon market and/or new market mechanisms.	Grant finance for capacity building and policy design for Small Scale rooftop distributed solar generation, combined with access to 'green loans' credit lines from ADF through commercial banks.	600M
Gradual shift towards the use of cleaner energy technologies, such as LNG, among others.	Grants for capacity building and policy development, and grant financing, risk guarantees and subsidised loans for large scale investments.	Grant financed consultancy services for best practice competitive tendering for PPP development, with subsidised loan, and possibly sovereign risk guarantee for large scale financing of LNG terminal.	600M

Modernisation of the national electricity grid through the use of smart technologies, which is a prerequisite to accelerate the uptake of renewable energy.	Grants for capacity building and policy development. Technology transfer for key smart grid software and battery hardware; grant for large scale implementation of grid storage and upgrades.	Introduction of automated software for grid despatch, combined with 'smart-meters' for DSM energy efficiency measures.	60M
Efficient use of energy through the deployment of appropriate technologies in all sectors of the economy, including an eco-friendly manufacturing sector, and awareness raising on energy conservation.	Grants for capacity building and pilots, some technology transfer pilots, and capacity building for regulatory changes and enforcement.	Energy efficiency testing and labelling of appliances, such as refrigerators and washing machines; advocacy and outreach campaigns to educate market participants; pilot and demonstration projects for technology transfer.	50M
Sustainable transportation, including promotion of energy efficient mass transportation systems based on hybrid technologies and cleaner energy sources.	Grants for institutional capacity building in transport and infrastructure management and policy development, technology transfer, technology risk guarantees and grants to meet the incremental cost to shift to clean energy for large scale implementation.	Grants to provide subsidies for purchase of hybrid-diesel buses to spur the market shift toward cleaner transport, in conjunction with public transport improvement policies.	50M
Climate smart agriculture including bio-farming.	Capacity building to help build and expand a nascent industry.	Exchange of information and best practice to raise awareness and demand for bio-products in Mauritius and for export.	5M
Sustainable and integrated waste management, including waste to energy.	Grants for capacity building and policy development, technology transfer, technology risk guarantees and grants and subsidised loans for large scale investments.	Grant support services to develop best practice competitive tendering for the most appropriate waste-to-energy technology, as well as technology transfer for project development, with subsidised loan, and technology risk guarantees for financing of facilities.	100M
Sustained tree planting programme within the context of the cleaner, greener and safer initiative.	Grants for knowledge capture and sharing.	Public education and outreach regarding uptake and respect for trees and green corridors, as well as to develop methodologies to incorporate the carbon impact of plantings into National Communications.	10M
Leapfrog to low global warming potential refrigerants.	Grants for capacity building and pilots, technology transfer, technology risk guarantees; and grants and subsidised loans for programmatic implementation.	Grant support to build human and institutional capacity for a new generation of appliances and installations (AC, chillers, etc.), as well as grant support for technology transfer for project development, with access to subsidised finance for widespread programme uptake.	20M

Smart use of marine resources, sustainable consumption and production in all sectors of the economy.	Grants for research, advocacy and capacity building.	Identify, develop and elucidate links between marine resources and possible mitigation options.	5M
Total			**1 500M**

11.2.4.2 Project proposals for Rodrigues

The proposed projects for funding under the INDC as given in Tables 11.5 and 11.6 apply to both Mauritius and Rodrigues. Some project ideas on Mitigation and Technology Transfer and Development for Mauritius are given as Project G and some others on biodiversity, fisheries, health and infrastructure, appropriate for the specificities of Rodrigues that have been identified under the TNC are given as Project H.

11.2.4.3 Additional project proposals for funding

Some additional project proposals have been identified during the implementation of TNC. These are given in the Annex to Chapter 11 as Projects B to F.

Annex to Chapter 11/Rodrigues

A. Project Proposal on Constraints, gaps and technical and capacity needs related to Rodrigues[1]

Table A.1 –Rodrigues Project Proposal

Sector	Constraints/Gaps	Financial, Technical and Capacity needs
Biodiversity	1. Invasive species and lack of research on strategies to eliminate them 2. Insufficient knowledge and documentation on biodiversity 3. Limited capacity on collection of data and data archival 4. Uncontrolled grazing animal causing further propagation of invasive species	1. Assistance and support from experts e.g UOM for research and as themes for student projects 2. Training on keeping records and documentation 3. CB on collection of appropriate data and development of an archival system 4. Enforcement of existing law
Fisheries	1. Insufficient training in management of coastal and marine resources 2. Insufficient incentives as well as training of fishers for fishing outside lagoon and bank fishing 3. Limited advanced training on aquaculture 4. Inadequate knowledge on deep sea prawns around Rodrigues	1. Training by experts including on propagation\rehabilitation of mangroves and coral reefs 2. More training, additional incentive and appropriate equipment 3. CB by experts, training of trainers and fishermen and research on various culture such as edible Oysters, sea cucumbers, Clams and Hippocampus 4. Conduct exploration survey for deep sea prawn to diversify fishing activities
Health	1. Limited training of health personnel conversant in management of Climate Change related diseases 2. Not enough dissemination of information on impacts of climate change on Health	1. Enhance CB on management of diseases caused by climate change 2. Enhance Education and sensitization as from grass roots level for proactive measures to keep healthy.
Infrastructure	1. Port Mathurin and sea port barely 1 m AMSL and vulnerable to extreme weather conditions and SLR 2. Waste water effluents and no water recycling 3. Coastal roads vulnerable to heavy waves and flooding 4. At household level, use of sand laden with salt, steel reinforce not covered enough with cement and insufficient knowledge and knowhow on construction	1. Major infrastructure scheme to address this major issue 2. Individual and communal collection and preliminary treatment 3. Elevated coastal roads and propagation of mangroves for protection 4. Awareness, Technical empowerment and capacity building for remedial action.

Note[1] on data availability

Constraints on data collection in some key sectors including on livestock, forest cover and fuel consumption from fishing vessels and pleasure boats have been important barriers for more accurate GHG Inventory. Stakeholders have proposed that a Climate Change Technical Committee be established to discuss and take appropriate action to address the issue. It has been proposed that the mandate of Statistical Office be broadened to include data collection relevant for the compilation of GHG emissions and sinks. To this end, capacity building and support from MOESDDBM will be required

B. Project Proposal on mangrove propagation

1. Project idea

Enhancement of the mangrove propagation programme in Mauritius

2. Rationale and justification

In the past, mangroves were quite widespread around Mauritius. They were considered as wasteland and were thus cleared in favour of settlements and coastal development. In the 1980's, the coverage dwindled down to 45 ha. In order to restore these precious ecosystems, a reforestation programme, initiated by the then Ministry of Fisheries started in the 1980s. During the implementation of the propagation programme of the Ministry (1995-2008), around 220 000 mangrove seedlings were successfully planted on an area of more than 13 hectares of the coastal strip and with a survival rate exceeding 80%. The total mangrove cover around the island has significantly increased and presently stands at 18 ha (Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island). Mangroves are now a protected species under the Fisheries and Marine Resources Act 2007.

Mangroves are better known as an effective measure in climate change adaptation as they protect beaches from heavy waves and increasing coastal erosion and serve as a habitat for fingerlings providing them protection from predators. They also contribute to fighting climate change. Mangroves are among the most carbon-rich ecosystems in the world (Adam et al., 2015; Ajonina et al., 2014) and can absorb as much as 10 times the carbon of a similarly sized patch of terrestrial forest. Studies have showed that undisturbed mangroves contain 1520.2±163.9 t/ha (Ajonina et al., 2014). They may also help fight coral bleaching.

3. Project description

An island-wide survey was conducted in 2013 (ADD, 2013) to identify potential sites (Table). In the process, the 2008/2009 aerial photograph of the island was analysed using Arcview 10 GIS. Field surveys were then conducted to obtain ground truth evidence. Around 72 ha of potential sites were identified as suitable for mangroves plantation. The 10 best sites are:

Table B.1. Potential sites and areas available for mangrove plantation

Locality	Extent (m²)
Petite Case Noyale	83 767
Vieux Grand Port	53 035
Case Noyale	38 220
Anse Jonchée	35 571
Rivière des Créoles	32 248
Bambous Virieux	30 498
Pte Lascar	30 424
Pte Régate	25 670

Pte Jérôme	24 651
Petite Rivière Noire	22 243

Since then, 30 000 seedlings have been planted at Case Noyale/ Petite Rivière Noire on the basis of the survey.

The mangrove propagation programme is being implemented by many NGOs in partnership with Local Government authorities and local communities. However, lack of funding has been the main barrier to continue the propagation programme.

Overall goals and objectives

The overall goal is to increase GHG sink through the plantation of mangroves seedlings in the areas identified. The objective is to plant about 40 000 seedlings every year over a 10-year period. This will be done in partnership with local villagers involving the most vulnerable communities in the selected villages especially during the planting phase.

4. Development context

In INDC and TNA, dune and vegetation restoration has been recommended as a priority to protect coastal ecosystems and resources and to adapt to climate change. The mangroves will protect the coastal zone and beaches, which are the main assets attracting local and international tourists. They will also contribute to fishery resources to address dwindling fish stock. They will further contribute to carbon sequestration in addition to providing other goods and services.

5. Duration

The project will span over 10 years

6. Financial resources

The conservative cost of the project is about US$ 60 000 on the basis of planting 40 000 seedlings per annum. The cost estimate includes labour cost, some equipment and local travel cost.

7 Stakeholders

Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island, Private sectors through CSR fund, NGOs involved in mangrove planting, Village and District Councils and National World Heritage Fund for the Le Morne region.

C. Project Proposal on Impacts of sea level on Agalega

1. Project idea

Pilot study on the impact assessment of accelerated sea level rise (ASLR) on coastal and water resources, and agriculture

2. Rationale and justification

It has been observed from analysis of sea level data from Mauritius and Rodrigues (Ragoonaden et al., 2015) that sea level rise has been accelerating and recent measurements indicate a rise of of 5.9 mm/yr. This has also been observed at global level. Such a rise might be occurring in the region of Agalega but no long term observation is available. A sea level gauge was installed in 2008.

Agalega is barely a couple of metres above the mean sea level. With the projected accelerated sea level rise which is predicted to be about 1m before the end of the century, and with the advent of more intense tropical cyclones, the impacts on the island's vegetation, and water and coastal resources may be higher. The inundation of coastal land and enhanced coastal encroachment and erosion may have far reaching impact. Salt water intrusion in aquifers may reduce freshwater resources potential. Mangroves, which protect the coastal region from high seas and coconut trees, may also be damaged. These transformations will seriously affect the welfare of the inhabitants. A preliminary assessment of the vulnerability of Agalega is a prerequisite for further studies in order to develop proactive and precautionary measures to mitigate and adapt to the impacts well in time.

As a low lying island Agalega could have the same fate as other coral atolls such as Maldives and many Pacific and Caribbean islands which are threatened with their population becoming climate refugees. Agalega as an inhabited island remains an example of vulnerability to climate change in the South-West Indian Ocean. A comprehensive report on Agalega with focus on impacts of climate change may provide further evidence of the fragility of Agalega and call for urgent action.

Under the Africa Adaptation Programme (2010 – 2012), some studies were conducted on the impacts of sea level rise on the coastal zone of Agalega using a Digital Elevation Model (DEM) with a horizontal resolution of 90m and a vertical resolution of 1m. It emerges that a high percentage of its surface will be at potential risk. More than 50 % of the land can be potentially inundated in all the investigated scenarios. However, no development and implementation of a coastal line management plan to mitigate areas prone to very high and high inundation risk in developed areas has been developed as was the case with Mauritius (DRR, 2013).

However, this coarse resolution poses substantial limits to a comprehensive analysis of exposure and risk. More refined resolution is needed to understand better the impacts of sea level rise on the island.

3. Overall goals and objectives

The goals of this proposal are to assess the vulnerability and adaptive capacity of Agalega to the impacts of climate change and sea level rise on key socio-economic sectors and propose policy options on adaptation and mitigation to address them in the short- and long-term.

The main objectives are to

(i) Conduct a comprehensive survey of Agalega with the participation and involvement of various stakeholders concerned with climate change issues
(ii) Prepare contour maps at 0.5 m interval up to 2 m to estimate loss of coastal area due to different sea level rise scenarios

(iii) Identify key sectors including water, agriculture and coastal zone that are most vulnerable to climate change and sea level rise
(iv) Sensitise the local communities on climate change and sea level rise and prepare materials or adapt available materials for follow up activities
(v) Prepare a comprehensive report on climate change and socio-economic impacts and make recommendations on policy options to address climate change issues.

4. Development context

There will be considerable benefits and impacts on the daily life of the inhabitants. The findings will contribute towards better management and governance of resources and more effective planning for sustainable development. The project will permit the determination of safe set back distance for the development of major infrastructure.

Delaying adaptation and mitigation measures and enhanced sensitisation may leave Agalega poorly prepared to deal with adverse changes and may increase the possibility of irreversible or very costly consequences. Options for adapting to change or mitigating change will make society more flexible or resilient to anticipated adverse effects of climate change and SLR.

5. Duration

The survey will be conducted by two teams of surveyors comprising a surveyor and 3 assistants in each team. Two experts in coastal and agriculture will also participate. The study will be carried during the 4 to 5 day visit of the supply ship to the island. The analysis and preparation of report will take about 10 days.

6. Financial resources

A conservation cost of the project is about MUR 350 000 (US$10 000) comprising ship tickets, accommodation and disturbance allowances.

7. Stakeholders

Many Ministries and institutions will be involved in the implementation of the project. Some will have to travel to Agalega for onsite activities. These include:

- Ministry of Environment, Sustainable Development, and Disaster & Beach Management
- Ministry of Housing and Lands
- Ministry of Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Island
- Ministry of Agro Industry and Food Security
- Meteorological Services
- Mauritius Oceanography Institute
- Water Resources Unit

D. The use of natural refrigerants for large scale commercial installations

1. Project idea

Replacement of HFCs having a high global warming potential with natural refrigerants such as CO_2 in large scale commercial refrigeration systems.

2. Rationale and justification

RoM is a party to the Montreal Protocol and the Paris Agreement, which will enter into force on 4 November 2016, Kyoto Protocol and has to contribute to the protection of the ozone layer and mitigation of climate change. Hence the choice of refrigerants to be adopted is crucial. It has been using HCFCs and HFCs as transfer technologies to CFCs and is now undertaking the next phase of adopting environment-friendly refrigerants. In view of the damaging impacts of synthetic refrigerants, a new generation of natural refrigerants is recommended as replacement. Carbon dioxide, ammonia and hydrocarbons are all potential substitutes which are being used in different countries. However, countries like Mauritius experience both technical and economic limitations.

Since 2011, RoM has embarked on the implementation of a hydrochlorofluorocarbons phase-out management plan (HPMP). HFCs are ozone-friendly but have highly global warming potentials.

RoM aims to leapfrog to natural refrigerants, which are ozone-friendly, have low global warming potential and are energy efficient. However, the penetration of these technologies on the local market is presently very low and the project aims to address this issue. To date, almost all supermarket refrigeration systems in Mauritius, both for medium and low temperature have been charged with HFC-404A. Commercial refrigeration is the sector which uses the refrigerant with the highest GWP and the replacement of HCFC22 by HFC-404A will result in a 100 % rise in direct GHG emissions if equal leakage rate is to be considered.

The use of natural refrigerant is now widely adopted in developed countries and in countries such as South Africa, Australia and New Zealand in the Southern Hemisphere. The large scale adoption of natural refrigerant in large commercial and industrial enterprises in RoM will contribute, though to a modest extent, to a decrease in local GHG emission.

Research is ongoing at the Université des Mascareignes (UDM) on the use of CO_2 as a refrigerant with potential use in large scale commercial refrigeration such as supermarkets and hypermarkets. A transfer of technology is ongoing at UDM and a research and training platform on natural refrigerants, with special focus on the examination of the potential use of CO_2 as refrigerant for the commercial and industrial sectors, has been installed at its Faculty of Sustainable Development and Engineering. However, to facilitate and support commercial enterprises including supermarkets in adopting this green cooling technology, the following incentives to commercial entities are proposed:

- financial incentives to stakeholders to adopt the technology through some form of subsidies, for adopting the technology
- tax rebate on equipment to enable a leapfrog to HFC's and adopt natural refrigerants in future installations
- capacity building for concerned stakeholders (including technicians and personnel of training institutions)

Figure C.1 Equipment at UDM for a pilot study

3. Overall goal and objectives

The overall goal of this proposal is to promote the use of natural refrigerants, initially in new large scale commercial installations and gradually replace HCFs by natural refrigerants in existing installations through Government incentives. The objectives are:

i) Gather information of all new proposals to install large scale refrigerant system and the refrigerant that will be used

ii) Make a survey of all existing large scale refrigerant system and determine GHG emission reduction in case of replacement by natural refrigerants

iii) Explore the possibility whether a large scale shift from high HCFs GWP refrigerant to natural refrigerant is entitled to CDM fund

4. Development context

The use of natural refrigerant in commercial refrigeration such as supermarkets and hypermarkets is non-existent in RoM compared to other countries particularly in developed countries especially in Europe where it is being widely adopted. The replacement of HCF high GWP by natural refrigerant will reduce GHG emission and could be entitled to CDM fund.

5. Duration

It will be a gradual process and could take several years. A pilot project proposal could be formulated for submission to explore the possibility of obtaining incremental funding under the CDM scheme.

6. Financial resources

UNDP has submitted a project to GEF entitled "Realising energy savings and climate benefits of implementing mandatory energy auditing in coordination with HCFC phase-out and HFC avoidance," covering a large range of sectors in collaboration with EEMO.

To initiate the process, this project proposal is targeting mainly large commercial companies such as supermarkets and hypermarkets which are contemplating the adoption of natural refrigerants in their current and future businesses. The switch to the use of a natural refrigerant in large commercial refrigeration systems would entail additional cost compared to the baseline HFC6404A installation. A subsidy to compensate for the additional cost and other facilities such as tax rebate on equipment will encourage companies to participate in the Government obligation under the Paris Agreement to reduce GHG emission (Section 2, above). A carbon dioxide cascade system installed under the HPMP at the UDM to the tune of USD 117 000 can be used as a co-financing component for the project. Capacity building of Engineers and Technicians should also be considered.

7. Stakeholders

A partnership between public and private sectors engaged in large scale refrigeration systems for a win-win situation.

E. Project Proposal on Emission Factor from energy sector

1. Project idea

Determination of the emission factor from the combustion of fuels from both heat and power generation in Mauritius

2. Rationale and justification

SIDS are contributing the least amount of GHG compared to developed countries, yet they are more vulnerable to the effect of climate change and are likely to suffer the most. Most of them rely heavily on fossil fuels to meet their energy needs. Mauritius is required to report on its GHG emission on a regular basis. The highest amount of GHG is released from the energy sector namely transport and power generation. In order to facilitate reporting, it important to determine the emission factor for each fossil fuel. In this context, this project will determine the national emission factor for Mauritius.

The impact of GHG on the environment has to be assessed in order to take appropriate mitigation measures. The project will consist of collecting data on different energy conversion systems like engines, boilers and combustion chambers. The different technologies will be studied and data on the amount of fossil fuel burned for each technology will be gathered. Tests like calorific value and carbon content on each fuel will be conducted in order to determine the emission factor.

3. Overall goal and objectives

The overall goal is to use local/country emission/sink factors to calculate more accurately GHG emission/sink.

The specific objectives are as follows:

i) Study the energy sector in Mauritius and the different energy conversion technologies
ii) Determine the different fossil fuels use in Mauritius
iii) Characterise the fuels in terms of energy content, proximate and ultimate analysis
iv) Determine the emission factor of each fuel from each conversion technology
v) Calculate the amount of GHG released from each fossil fuel

4. Development context

In national communications, inventories of GHG emissions from the energy sector both for power generation or heat production were reported. However, in most of the reports, the default emission factors were taken. In order to achieve a better and more accurate amount of GHG emission, Mauritius could use the national emission factor instead of default emission factor. In this context, this study will enable Mauritius to be among the few SIDS to come up with its own emission factor.

5. Duration

The project will span over 15 months.

6. Financial resources

The conservative cost of the project is about US$ 20 000 which will consist mainly of recruitment of researcher and all the experimental costs.

7. Stakeholders

MoESDDBM, the Ministry of Energy and Public Utilities, the Ministry of Industry and Commerce, the State Trading Cooperation, and the Central Electricity Board.

F. Project proposal on CCIC further development and strengthening to coordinate and enhance ETPA activities

1. **Project idea**

Setting up of a permanent interactive exhibition and demonstration corner on climate change issues at the Climate Change Information Centre (CCIC) in Rose Hill

2. Rationale and justification

One of the most durable solutions to enhance understanding and strengthen resilience against climate change is climate change literacy. In this respect, the National Climate Change Adaptation Policy Framework for Mauritius (2012) recommends that society at all levels and in all segments be adequately informed on climate change and its implications.

The CCIC aims to contribute to make Mauritius a climate resilient country by enhancing awareness and understanding necessary to instill a climate risks mitigation and adaptive management mindset for the public at large.

In order to ensure greater accessibility and to further strengthen the actions of the CCIC MoESDDBM is proposing to relocate the CCIC at Rose Hill in the Ex-Survey office building. The Ministry has initiated necessary rehabilitation works to the existing building and peripherals.

The CCIC is also aiming at becoming a Regional Observatory on Climate Change with the collaboration of the international agencies such as UNECA and IOC. The establishment of the Permanent Interactive Exhibition will thus enhance the capacity of the CCIC to play its role as a Centre of Excellence to disseminate climate change information.

3. Overall goal and objectives

The three main strategic objectives of the CCIC with regard to climate change with relation to the public are to enhance:

- access to information awareness raising and education
- participation and engagement in related issues

4. Development context

ROM is already experiencing the detrimental effects of climate change such as sea-level rise, ocean acidification, decline in agricultural production and extreme weather events. Education and public awareness are prerequisite to better preparedness, to take concrete measures adapt to the impacts of climate change, and to contribute at individual level through effective actions to mitigate climate change. To this end, the permanent interactive exhibition will display models to demonstrate simple actions including rain harvesting, use of solar PV, waste segregation bins and composting that can be undertaken at home and in the office to save energy, and to reduce carbon footprint in additional to economic saving.

5. Duration

The project will span over 15 months.

6. Finance resources

7. The conservative cost of the project is about US$ 50 000 which will include the design and display of the exhibit and the acquisition of related materials.

8. Stakeholders

MoESDDBM, MIE and Rajiv Gandhi Science Centre.

G. Project ideas: Mitigation, technology transfer and development

Energy Efficiency

- Capacity building to develop the technical capacity of end users to identify EE measures, including auditing, prioritising interventions and cost-benefit analysis

Wind energy (onshore)

- Invest in energy storage for renewable energies of intermittent sources
- develop a zoning plan for the implementation of wind energy

Transport

- Training programme to skill personnel manning the examination stations

Agriculture

- R&D for the comparative analysis of compost or chemical fertiliser on crop productivity, impact
- Carry out a feasibility study to establish the market potential for composting animal waste

Waste

- Enhanced LFG capture for either flaring or electricity generation
- To develop and implement ISWM

Waste to energy

- Feasibility study concerning appropriateness of alternative WTE options in Mauritius

H. Project ideas for Rodrigues

(i) Biodiversity

1. **Project idea**: Restoration of the mainland reserves, of Grande Montagne, Anse Quitor and valleys initially of Cascade Mourouk and Saint Louis as well as maintenance weeding for 10 years

   Duration: Five years with restoration of 6 ha of mainland reserves and 6 ha of valleys annually and maintenance weeding for 10 years

   Total Cost of project: MRU 20 M

2. **Project idea**: Restoration of the islets of Coco, Sables, Crabes and Hermitage

   Duration: Five years for restoration and 10 years for maintenance weeding
   Total Cost of project: MRU 7 M

3. **Project idea:** Restoration of slopes of mountains and terracing to reduce soil erosion
   Duration: 10 years
   Total cost: MRU 2 500 000

(ii) Fisheries and Marine Biodiversity

1. **Project idea**: Capacity building in the effective management of Marine Resources in strengthening relevant institutions responsible for the management of Marine Resources and Marine Protected Areas (MPAs) with the view to improve governance and enforcement of the existing MPAs

   Duration: At least 7 years would be required.
   Total Cost of project: MUR 25 Million (app: US $ 700 000)

2. **Project idea**: Rehabilitation and expansion of Sensitive Habitats such as corals reefs including coral farming, seagrass beds and mangrove areas.

   Duration: 5 Years
   Total Cost of project: MRU 25 Million (US$ 700 000)

3. **Project idea**: Promotion of Aquaculture of highly marketable species such as edible Oysters, sea cucumbers, bivalves such as Clams and Hippocampus with proper training in the farming and commercialisation of the products.

   Duration: 5 years
   Total Cost of Project: MUR 30 Million (US$ 900 000)

4. **Project Idea**: Promotion of offshore and Bank fishing by providing incentives to fishers such as the purchase of materials and equipment, including proper boats, nets and traps through a combination of bank fishery and deep sea prawns and crabs.

   Duration: 5 year
   Total Cost of Project: MUR 100 Million (US$ 3 M)

(iii) Health

1. **Project idea**: Management of climate-sensitive diseases by capacity building of health care workers

   Duration: 12 months

   Total Cost of project: MRU 0.5 M

2. **Project idea**: Estimate of environmental disease burden

   Duration: 3 years

   Total Cost of project: MRU 1.0 M

(iv) Infrastructure

1. **Project idea:** Land drainage
   Improve land drainage, particularly within built-up areas on mountain slopes. Thus the drainage of the township of Rivière Cocos which is subject to frequent land slips, rock falls, soil erosion and blockage of existing drains by transported soil, should be reviewed

   Duration: one year for capital works and regular maintenance thereafter
   Total Cost of project: MUR 80 M

2. **Project idea** Land drainage
   Port Mathurin is sited almost at sea level and hydraulic flow within roadside drains is mostly tidal. Efforts to alleviate localised flood problems are at best palliative in nature and do not resolve the global problem in a holistic manner and the problems are likely to exacerbate with climate change.
   It is proposed to implement a major infrastructure scheme for this capital township which could include relocation of numerous residences to higher grounds and resort to pumping to lower ground water.
   Duration Five years
   Total Cost of project MUR 300 M

3. **Project idea** Upgrading of bridges
   Many bridges and submerged crossings (radiers) along coastal roads are subject to frequent submergence during rainfall events and have to be upgraded / raised. These include bridges at Camp du Roi, Anse Ali and the « radiers" at Port Sud Est, l'Union, Ile Michel, Latanier, Pistaches and La Fourche Mangues.
   Duration Progressive over three years
   Total Cost of project MUR 150 M

4. **Project idea** Water supply
   Rodrigues is a water scarce country with an output of only 3,000 m^3/day during the dry season for a population of 42,000 besides having a defective distribution system. The water supply network needsto be upgraded to optimise an equitable water supply distribution.
   Duration: Over five years
   Total Cost of project: MUR 200 M

5. **Project idea:** Road Untarred roads which are rendered impractical during events have to be upgraded.

   Duration: Over 3 years
   Total Cost of project: MUR 200 M

Annexes

National Greenhouse Gas Inventory of anthropogenic emissions by sources and removals by sinks of all GHGs

Inventory Year: 2006 - Table 1

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)	CO Gg	NOx (Gg)	NMVOCs (Gg)	SOx (Gg)
Total National Emissions and Removals	2956.93	72.54	0.47	0.00	0.00	0.00	0.00
1 - Energy	3440.57	0.35	0.08	0.00	0.00	0.00	0.00
1A - Fuel Combustion Activities	3440.57	0.35	0.08	0.00	0.00	0.00	0.00
1A1 - Energy Industries	1555.99	0.04	0.02	0.00	0.00	0.00	0.00
1A2 - Manufacturing Industries and Construction (ISIC)	380.12	0.10	0.00	0.00	0.00	0.00	0.00
1A3 - Transport	1281.44	0.11	0.05	0.00	0.00	0.00	0.00
1A4 - Other Sectors	223.03	0.10	0.00	0.00	0.00	0.00	0.00
1A5 - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B - Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B1 - Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B2 - Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 - Industrial Processes	42.04	0.00	0.00	0.00	0.00	0.00	0.00
2A - Mineral Products	1.54	0.00	0.00	0.00	0.00	0.00	0.00
2B - Chemical Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2C - Metal Production	40.50	0.00	0.00	0.00	0.00	0.00	0.00
2D - Other Production	0.00	0.00		0.00	0.00	0.00	0.00
2E - Production of Halocarbons and Sulphur Hexafluoride				0.00	0.00	0.00	0.00
2F - Consumption of Halocarbons and Sulphur Hexafluoride				0.00	0.00	0.00	0.00
2G - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 - Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - Agriculture		0.84	0.08	0.00	0.00	0.00	0.00
4A - Enteric Fermentation		0.70		0.00	0.00	0.00	0.00
4B - Manure Management		0.14	0.03	0.00	0.00	0.00	0.00
4C - Rice Cultivation		0.00		0.00	0.00	0.00	0.00
4D - Agricultural Soils			0.06	0.00	0.00	0.00	0.00
4E - Prescribed Burning of Savannas		0.00	0.00	0.00	0.00	0.00	0.00
4F - Field Burning of Agricultural Residues		0.00	0.00	0.00	0.00	0.00	0.00

4G - Other (please specify)				0.00	0.00	0.00	0.00
5 - Land-Use Change & Forestry	-525.68	0.12	0.24	0.00	0.00	0.00	0.00
5A - Changes in Forest and Other Woody Biomass Stocks	-525.65			0.00	0.00	0.00	0.00
5B - Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C - Abandonment of Managed Lands	0.00			0.00	0.00	0.00	0.00
5D - CO2 Emissions and Removals from Soil	0.00		0.00	0.00	0.00	0.00	0.00
5E - Other (please specify)	-0.04	0.12	0.24	0.00	0.00	0.00	0.00
6 - Waste	0.00	71.23	0.07	0.00	0.00	0.00	0.00
6A - Solid Waste Disposal on Land		37.98		0.00	0.00	0.00	0.00
6B - Wastewater Handling		33.26	0.07	0.00	0.00	0.00	0.00
6C - Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6D - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items							
International Bunkers	764.58	0.00	0.02	0.00	0.00	0.00	0.00
1A3a1 - International Aviation	764.58	0.00	0.02	0.00	0.00	0.00	0.00
1A3d1 - International Marine (Bunkers)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Multilateral operations	0.00	0.00	0.00				
CO2 emissions from biomass	34.72						

Inventory Year: 2006 – Table 2

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO2)	SF6 (Gg)
Total National Emissions and Removals	0.03516	0	1.71392	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							

1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.03516	0	1.71392	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.03516	0	1.71392	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							
5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Inventory Year: 2013 – Table 1

Greenhouse gas source and sink categories	Net CO2 (Gg)	CH4 (Gg)	N2O (Gg)	CO Gg	NOx (Gg)	NMVOCs (Gg)	SOx (Gg)
Total National Emissions and Removals	3759.47	73.62	0.53	0.00	0.00	0.00	0.00
1 - Energy	4212.64	0.49	0.09	0.00	0.00	0.00	0.00
1A - Fuel Combustion Activities	4212.64	0.49	0.09	0.00	0.00	0.00	0.00
1A1 - Energy Industries	2380.09	0.04	0.03	0.00	0.00	0.00	0.00
1A2 - Manufacturing Industries and Construction (ISIC)	306.64	0.11	0.00	0.00	0.00	0.00	0.00
1A3 - Transport	1340.00	0.24	0.06	0.00	0.00	0.00	0.00
1A4 - Other Sectors	185.92	0.09	0.00	0.00	0.00	0.00	0.00
1A5 - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B - Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B1 - Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1B2 - Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 - Industrial Processes	37.54	0.00	0.00	0.00	0.00	0.00	0.00
2A - Mineral Products	1.49	0.00	0.00	0.00	0.00	0.00	0.00
2B - Chemical Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2C - Metal Production	36.05	0.00	0.00	0.00	0.00	0.00	0.00
2D - Other Production	0.00	0.00		0.00	0.00	0.00	0.00
2E - Production of Halocarbons and Sulphur Hexafluoride				0.00	0.00	0.00	0.00
2F - Consumption of Halocarbons and Sulphur Hexafluoride				0.00	0.00	0.00	0.00
2G - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 - Solvent and Other Product Use	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 - Agriculture		1.04	0.09	0.00	0.00	0.00	0.00
4A - Enteric Fermentation		0.80		0.00	0.00	0.00	0.00
4B - Manure Management		0.16	0.02	0.00	0.00	0.00	0.00
4C - Rice Cultivation		0.00		0.00	0.00	0.00	0.00
4D - Agricultural Soils			0.07	0.00	0.00	0.00	0.00
4E - Prescribed Burning of Savannas		0.00	0.00	0.00	0.00	0.00	0.00
4F - Field Burning of Agricultural Residues		0.08	0.00	0.00	0.00	0.00	0.00
4G - Other (please specify)				0.00	0.00	0.00	0.00
5 - Land-Use Change & Forestry	-490.71	0.00	0.27	0.00	0.00	0.00	0.00
5A - Changes in Forest and Other Woody Biomass Stocks	-490.67			0.00	0.00	0.00	0.00
5B - Forest and Grassland Conversion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5C - Abandonment of Managed Lands	0.00			0.00	0.00	0.00	0.00

5D - CO2 Emissions and Removals from Soil	0.00		0.00	0.00	0.00	0.00	0.00
5E - Other (please specify)	-0.04	0.00	0.27	0.00	0.00	0.00	0.00
6 - Waste	0.00	72.09	0.07	0.00	0.00	0.00	0.00
6A - Solid Waste Disposal on Land		43.73		0.00	0.00	0.00	0.00
6B - Wastewater Handling		28.36	0.07	0.00	0.00	0.00	0.00
6C - Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6D - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7 - Other (please specify)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items							
International Bunkers	732.62	0.00	0.02	0.00	0.00	0.00	0.00
1A3a1 - International Aviation	732.62	0.00	0.02	0.00	0.00	0.00	0.00
1A3d1 - International Marine (Bunkers)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Multilateral operations	0.00	0.00	0.00				
CO2 emissions from biomass	31.04						

Inventory Year: 2013 – Table 2

	HFC			PFC			SF6
Greenhouse gas source and sink categories	HFC-23 (Gg)	HFC-134 (Gg)	Other (Gg-CO2)	CF4 (Gg)	C2F6 (Gg)	Other (Gg-CO2)	SF6 (Gg)
Total National Emissions and Removals	0.06082	0	6.173136	0	0	0	0
1 - Energy							
1A - Fuel Combustion Activities							
1A1 - Energy Industries							
1A2 - Manufacturing Industries and Construction (ISIC)							
1A3 - Transport							
1A4 - Other Sectors							
1A5 - Other							
1B - Fugitive Emissions from Fuels							
1B1 - Solid Fuels							
1B2 - Oil and Natural Gas							
2 - Industrial Processes	0.06082	0	6.173136	0	0	0	0
2A - Mineral Products							
2B - Chemical Industry							
2C - Metal Production	0	0	0	0	0	0	0
2D - Other Production							
2E - Production of Halocarbons and Sulphur Hexafluoride	0	0	0	0	0	0	0
2F - Consumption of Halocarbons and Sulphur Hexafluoride	0.06082	0	6.173136	0	0	0	0
2G - Other (please specify)							
3 - Solvent and Other Product Use							
4 - Agriculture							
4A - Enteric Fermentation							
4B - Manure Management							
4C - Rice Cultivation							
4D - Agricultural Soils							
4E - Prescribed Burning of Savannas							
4F - Field Burning of Agricultural Residues							
4G - Other (please specify)							
5 - Land-Use Change & Forestry							

5A - Changes in Forest and Other Woody Biomass Stocks							
5B - Forest and Grassland Conversion							
5C - Abandonment of Managed Lands							
5D - CO2 Emissions and Removals from Soil							
5E - Other (please specify)							
6 - Waste							
6A - Solid Waste Disposal on Land							
6B - Wastewater Handling							
6C - Waste Incineration							
6D - Other (please specify)							
7 - Other (please specify)							

Agriculture - *Transforming challenges into opportunities* (Mauritius) **Annex 2**

Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
A1	Water Supply and Conservation Support	**A1.1.** Water conservation incentives **A1.2.** Dissemination of micro irrigation systems for efficient water use and management **A1.3.** Floodplain Easements, to maintain agricultural production that is compatible with flood conveyance	*H:* co-financing *G:* incentives, capital investment for infrastructure *P:* co-financing	*H:* water shortages *G:* water supply, flood damage *P:* reduced yield and revenue, water costs	*H:* food security, employment *G:* tax revenue *P:* revenues and income
A2	Preventing, preparing for, and responding to agricultural invaders, pests and diseases	**A2.1.** Development and up-scaling of locally proven IPDM (integrated pest and disease management) technologies for control of pests and diseases **A2.2.** Decentralised rapid pest and disease diagnosis service (plant clinic)and introduction of insurance	*H:* O&M cost *G:* incentives, policy development *P:* capital and O&M cost	*H:* N/A *G:* food imports *P:* reduced yield and revenue	*H:* food security and health *G:* tax revenue from increases production *P:* revenues and income
A3	Sustainable land use planning practices	**A3.1.** Encourage community land use (urban and peri-urban farming) against land conversion to urbanization **A3.2.** Explore ways of introducing revenue-generation mechanisms (e.g. carbon trading, certifications)	*H:* time (agriculture practices) *G:* awareness raising *P:* capital investment	*H:* food expenditure *G:* food imports *P:* N/A	*H:* food security & quality *G:* carbon revenues, emission reductions *P:* revenues
A4	Promote working landscapes with ecosystem services to improve agro-biodiversity	**A4.1.** Technical and financial assistance for the reallocation of agriculture to less critical areas **A4.2.** Promotion and development of sustainable agriculture practices **A4.3.** Promotion of composting and support the use of compost as a substitute to traditional fertilizers	*H:* composting *G:* incentives, capital investment for infrastructure, R&D *P:* co-financing for capital investment, research	*H:* food expenditure *G:* food imports *P:* reduced yield and revenue	*H:* food security, employment *G:* national food security *P:* revenues and income
A5	Building and sustaining institutional support	**A5.1.** Define a capacity-building framework that will build the capacity of institutions, train their human resources and those of local communities on sustainable agriculture	*H:* capacity building *G:* capacity building *P:* co-financing, capacity building	*H:* N/A *G:* policy effectiveness *P:* reduced yield	*H:* knowledge and skills *G:* knowledge and skills *P:* improved services from staff
A6	Research, innovation and technology development for bio-farming and communication	**A6.1.** Support biofarming; bring together technologies with agriculture management practices (e.g. through the use of GIS, agro-meteorological stations) **A6.2.** Support the development of appropriate models for communication to transfer and disseminate information on new techniques and technologies including those that address climate change.	*H:* higher food expenditure *G:* research-based policy *P:* co-financing	*H:* water shortage *G:* natural resource mgmt. costs *P:* reduced yield	*H:* food security *G:* budget surplus *P:* revenues and income

Coastal areas and Tourism - *Transforming challenges into opportunities* (Mauritius)
Strategies (T1etc.) and corresponding actions (T1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
T1	Restoration of coastal vegetation	**T1.1.** Removal of exotic plants that are proven to damage coastal areas. **T1.2.** Planting of native vegetation species	*H:* time, voluntary actions *G:* labour, transport, equipment, herbicides, training *P:* training, co-financing	*H:* property value, injuries *G:* coastal erosion, public spending (coastal infrastructure, health) *P:* property value, insurance	*H:* employment, well-being *G:* carbon sequestration, mitigation of ocean acidification *P:* N/A
T2	Promoting beach nourishment and dune replenishment	**T2.1.** Suitability assessment **T2.2.** Site investigation and source identification **T2.3.**Structural interventions	*H:* N/A *G:* consultancy, contractors (equipment and labour) *P:* training	*H:* leisure opportunities *G:* beach loss *P:* tourism arrivals and revenue	*H:* cultural values and well-being *G:* reduced coastal vulnerability *P:* tourism arrivals and revenue
T3	Coastal wetland protection and restoration	**T3.1.** Re-establishment of salt marshes (vegetative transplant) **T3.2.** Mangroves and seagrass restoration **T3.3.** Improve governance of wetland areas	*H:* equipment and co-financing *G:* survey (site identification), labour, incentives *P:* equipment and infrastructure co-financing	*H:* property value, injuries *G:* coastal erosion, public spending (infrastructure, health) *P:* property value, catch and revenue, insurance	*H:* employment, well-being, leisure (biodiversity) *G:* tax revenue, carbon sequestration, mitigation of ocean acidification *P:* tourism arrivals and revenue
T4	Encouraging lagoon management and coral habitat rehabilitation	**T4.1.** Incentives for coral nursery **T4.2.** Improve regulation for sea-related tourism activities **T4.3.** Encourage sustainable fishing practices	*H:* time, voluntary actions *G:* survey (site identification), consultancy, nursery, propagation, software, labour *P:* training, survey	*H:* property value *G:* coastal erosion, public spending (coastal infrastructure) *P:* property value, catch and revenue, insurance	*H:* well-being, leisure (biodiversity) *G:* tax revenue *P:* tourism arrivals and revenue
T5	Increase resource efficiency	**T5.1.** Incentivise energy and water efficiency as well as water/waste recycle and reuse **T5.2.** Promote certification	*H:* co-financing *G:* incentives, consultancy *P:* training, co-financing, certification fees	*H:* water and energy cost *G:* water stress and water delivery (during droughts), waste landfilling *P:* water and energy cost	*H:* air quality, employment and income *G:* reduced public spending, energy import, emissions *P:* competiveness, resilience
T6	Incentivise eco-tourism, with the valorisation of natural capital	**T6.1.** Branding **T6.2.** Awareness raising **T6.3.** Capacity building	*H:* N/A *G:* consultancy, training package, media strategy *P:* training	*H:* N/A *G:* habitat loss, public spending *P:* attractiveness, competitiveness	*H:* employment and income *G:* tax revenue *P:* tourism arrivals and revenue

Annex 4

Water resources sector - *Transforming challenges into opportunities* (Mauritius)
Strategies (W1etc.) and corresponding actions (W1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
W1	Fully develop the potential of integrated water resources management	**W1.1.** Develop hydrological models **W1.2.** Further enhance forecasting, management, protection and quality of water resources **W1.3**. Modernise data acquisition and management system	*H:* N/A *G:* consultancy, software, training, coordination, data management *P:* data collection and sharing	*H:* water scarcity *G:* water delivery, emergency interventions *P:* water scarcity	*H:* water availability and security, employment *G:* tax revenue *P:* revenues and income
W2	Increase water use efficiency	**W2.1.** Reduce losses in water distribution system **W2.2.** Invest in water infrastructure to support irrigation projects and development of a policy framework to enhance access to, and productive use of, water in the agricultural sector **W2.3.** Promote soil and water conservation techniques (rainwater harvesting, waste water recycling, waste management strategy)	*H:* co-financing *G:* incentives, capital investment in infrastructure, O&M costs *P:* capital and O&M cost, co-financing	*H:* water expenditure *G:* water losses, delivery and cost *P:* loss of productivity and revenue	*H:* water security (supply and access), employment *G:* tax revenue, food security *P:* revenues and income
W3	Enhance and sustain ecosystems	**W3.1.**-Safeguard and protect the ecosystem along water courses **W3.2.** Protect and restore water catchment areas and reduce soil erosion **W3.3.** Awareness campaigns to save water and protect water resources from pollution	*H:* waste disposal for reducing water contamination *G:* labour, transport, equipment; herbicides; compensation; training *P:* training, re-investment in community safety	*H:* water scarcity, food security/expenditure *G:* water delivery, food import, water purification, social tension *P:* water scarcity and cost	*H:* fresh water supply, food security, employment *G:* enhanced ecosystems, water quality and supply, tax revenue *P:* water supply, soil quality, tourism
W4	Expand water storage	**W4.1.** Build new dams and upgrade existing dams to increase water storage capacity **W4.2.** Expand rain water harvesting capacity at household and community level	*H:* co-financing *G:* consultancy, constructor, labour, incentives *P:* co-financing	*H:* water expenditure *G:* water delivery, food import, social tension *P:* loss of productivity and revenue	*H:* water supply, food security, employment *G:* water supply, tax revenue *P:* water supply
W5	Preserve, upgrade and increase monitoring and data analysis	**W5.1.** Incentivise the collection and use of data to understand the mechanisms underlying atmospheric processes that lead to seasonal and geographic distribution of precipitation	*H:* N/A *G:* incentives, labour and training, R&D, data management *P:* training, co-financing, data collections	*H:* water scarcity *G:* malpractice *P:* water scarcity	*H:* employment, human capital *G:* labour productivity *P:* skilled workforce

Biodiversity - *Transforming challenges into opportunities* (Mauritius)
Strategies (B1etc.) and corresponding actions (B1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
B1	Catchment areas (mountains and rivers): eradication of invasive species	**B1.1.** Weeding and replanting (proper species) **B1.2.** Maintenance of replanted forest **B1.3.** Relocation of activities	*H:* relocation costs *G:* labour, transport, equipment; herbicides; compensation; training *P:* relocation costs, foregone revenue; training	*H:* water scarcity, food security/expenditure *G:* water distribution, food import, water purification, social tension *P:* water scarcity and cost, fertilizer and pesticides	*H:* fresh water supply, food security, health, employment and income, leisure *G:* water quality and supply, tax revenue *P:* water supply, soil conservation and quality, tourism
B2	Reintroduction of native plants in planted forest	**B2.1.** Propagation of native plants **B2.2.** Gradual clearing and replacement **B2.3.** Maintenance of replanted forest	*H:* N/A *G:* collection of seeds, nursery, labour, equipment, transport *P:* collection of seeds, nursery	*H:* water scarcity, food security/expenditure *G:* ecosystem functions, food and habitat (wildlife), pests and diseases *P:* water scarcity and cost, forgone yield and revenue	*H:* leisure, water, soil and air quality *G:* reduced human/wildlife conflict (e.g. bats), carbon sequestration, resilience *P:* eco-tourism, land value (investment), resilience to cyclone, medicinal plants
B3	Restoration of native forests	**B3.1.** Removal of invasive alien species **B3.2.** Propagation and planting of native plants **B3.3.** Fencing of forest	H: N/A G: collection of seeds, nursery costs, labour, equipment, transport, materials P: collection of seeds, labour, equipment, transport	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value *G:* public health and welfare, green jobs, reduced human-bat conflict, respecting conventions and treaties, eco-tourism *P:* eco-tourism, resilience from cyclones, medicinal plants
B4	Expansion and improvement of protected areas	**B4.1.** Identification of suitable zones **B4.2.** Incentives for stewardship **B4.3.** Forest restoration	H: N/A G: survey costs, compensation, land swaps, conservation easement P: collection of seeds, nursery, fencing	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value *G:* public health and welfare, green jobs, reduced human-bat conflict, respecting conventions and treaties, tourism *P:* eco-tourism, resilience from cyclones, medicinal plants, land value
B5	Operationalize environment sensitive areas	**B5.1.** Harmonize and update spatial database **B5.2.** Enforcement of ESA categories **B5.3.** Mainstreaming of ESA	*H: N/A* *G:* GIS costs, technical labour, software and data, enforcement costs, review laws *P:N/A*	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value, health, flood reduction *G:* public welfare, green jobs, respecting conventions and treaties, eco-tourism *P:* eco-tourism, resilience from cyclones, medicinal plants, land value
B6	R&D on impacts of climate change and benefits of native forests	**B6.1.** Capacity building (institutions and citizens) **B6.2.** Research on climate change and biodiversity **B6.3.** Awareness raising on natural capital	*H:* citizen science *G:* workshops, training, advertising and communication *P:* CSR, use of media, technology development	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* community involvement *G:* public health and welfare, green jobs, land use planning, building resilience *P:* eco-tourism, resilience from cyclones, medicinal plants, land value, patenting

Fisheries - *Transforming challenges into opportunities* (Mauritius) **Annex 6**

Strategies (F1etc.) and corresponding actions (F1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
F1	Expand protected areas and improve governance and enforcement	**F1.1.** Implement management plan (MPAs) **F1.2.** Identify sensitive areas in light of future climate change impacts	*H:* N/A *G:* survey (biodiversity), consultancy, labour, enforcement *P:* survey (biodiversity)	*H:* fish cost *G:* public spending (rehabilitation) *P:* catch and revenue	*H:* employment and income, nutrition, leisure (biodiversity) *G:* health costs, tax revenue *P:* labour productivity, tourism (biodiversity)
F2	Rehabilitation and expansion of coastal and marine habitat	**F2.1.** Science-based and site specific coral nursery **F2.2.** Seagrass restoration **F2.3.** Mangrove propagation **F2.4.** release of fingerlings	*H:* N/A *G:* survey (site identification), consultancy, nursery, monitoring, propagation, software, labour *P:* training, survey	*H:* property value, injuries *G:* coastal erosion, public spending (coastal infrastructure, health) *P:* property value, catch and revenue, insurance	*H:* employment, well-being, leisure (biodiversity) *G:* tax revenue, carbon sequestration, mitigation of ocean acidification *P:* tourism arrivals and revenue
F3	Incentivise sustainable aquaculture	**F3.1.** Identify and review suitable sites **F3.2.** Incentives and capacity building for aquaculture entrepreneurship **F3.3.** Implement M&E	*H:* N/A *G:* survey (site identification), labour, incentives *P:* equipment and infrastructure co-financing	*H:* N/A *G:* fish import *P:* loss of productivity and income	*H:* employment and income, nutrition *G:* tax revenue *P:* revenues and profit
F4	Incentivise fishing outside of the lagoon	**F4.1.** Incentives to mitigate costs **F4.2.** Permitting	*H:* N/A *G:* incentive, certification (consultancy, labour) *P:* co-financing	*H:* N/A *G:* coastal and marine habitat loss, public spending (compensation) *P:* loss of productivity and income	*H:* employment and income *G:* tax revenue, climate resilience *P:* revenues and profit
F5	Sensitization of fishers	**F5.1.** Capacity building on the use of climate-related impacts (e.g. stock migration) **F5.2.** Awareness raising on the importance of coastal and marine ecosystem health **F5.3.** Capacity building on sustainable fishing techniques (lagoon and open sea)	*H:* N/A *G:* consultancy, training package, labour, campaigns *P:* fees (commercial), campaigns	*H:* N/A *G:* malpractice (overfishing, habitat loss), public spending (rehabilitation) *P:* productivity loss	*H:* well-being, employment and income (inclusiveness) *G:* human capital, tax revenue *P:* catch and revenue
F6	Improve the monitoring of coastal areas and harmonize monitoring methodology	**F6.1.** Ongoing capacity building **F6.2.** Facilitation of technology transfer **F6.3.** Create an open access and centralized knowledge repository **F6.4.** identification and monitoring of coral disease	*H:* N/A *G:* consultancy, labour, training materials, equipment *P:* labour, equipment	*H:* N/A *G:* public spending (duplication of efforts) *P:* labour cost	*H:* N/A *G:* human capital, information sharing *P:* human capital

Strategies (H1etc.) and corresponding actions (H1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
H1	Infrastructure to monitor and control diseases and manage patients	**H1.1.**Upgrade capacity of health facilities to cope with surge of climate-sensitive diseases and conditions **H1.2.** Create an observatory fpr climate-related illnesses and a department for vector-borne and climate-sensitive diseases	*H:* Taxation *G:* equipment, labour *P:* Tax contribution	*H:* infections, death and health cost *G:* health costs(staff, medicines) *P:*productivity loss, insurance	*H:*well-being, life expectancy *G:*budget surplus (lower deficit), tax revenues *P:* revenues and profit
H2	Formulate climate-sensitive public health policy	**H2.1.** Formulate public health policy on health impacts of climate change **H2.2** Forge inter-ministerial collaboration through climate health panel **H2.3.**Develop and implement protocols to monitor performance indicators	*H:* N/A *G:* Labour and consultancies *P: time* (in-kind)	*H:*out of pocket expenses *G:*public spending *P:* health insurance (no increase)	*H:*social cohesion *G:*budget surplus (lower deficit) *P:*N/A
H3	Surveillance, monitoring and control of vectors, diseases and environmental hazards	**H3.1.I**mplement Early Warning System of surveillance to monitor trend of vectors, environmental hazards and climate-sensitive disease and conditions **H3.2.**Introduce new techniques for the control of mosquitoes	*H:* Cost of air conditioning and mosquito repellents *G:* research funding, media and communication *P: research* funding	*H:* reduced malpractice and health cost *G:*public spending *P:*health insurance (no increase)	*H:*well-being, life expectancy *G:*budget surplus (lower deficit), tax revenues *P:*N/A
H4	Health promotion for education and communication dissemination on preventive strategies	**H4.1.**Develop Information, Education and Communication plans to address perceptual and behavioural obstacles to climate change **H4.2.**Promote healthy life-style, nutrition habits and vector control strategies	*H: N/A* *G:* cost of designing, printing and dissemination *P:* advertising cost	*H:* infections, death and health cost *G:*public spending *P:*productivity loss, health insurance	*H:*well-being, healthy lifestyle, income *G:*tourism arrivals/revenues *P:* tourism arrivals, revenues and profit
H5	Train and dedicate staff for managing increase in disease burden attributable to climate change	**H5.1.**Develop curricula for life-long learning, in collaboration with academia **H5.2.** Train and dedicate workforce for managing climate-sensitive health conditions	*H: tuition* fee *G:*labour, expert/trainer, tuition fee/scholarship *P:* tuition fee	*H:* out of pocket expenses *G:* public spending on vulnerable groups *P:*insurance pay on vulnerable group	*H:*healthy family *G:*informed consumer *P:*healthy employees
H6	Stock piling of medicine and essential medical supplies	**H6.1.**maitain a stock of emergency medical supplies **H62.**Expand the range of vaccines	*H: N/A* *G*: cost of building recreation centers and nutritionist salaries *P: nutritionist* salaries	*H:*non communicable disease cost *G:*Public spending *P:*productivity loss, health insurance	*H:*reduce heart disease and obesity *G:*reduce health expenditure *P:*saving on insurance premium

Annex 8

Infrastructure - *Transforming challenges into opportunities* (Mauritius)
Strategies (IS1etc.) and corresponding actions (IS1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
IS1	Upgrade drains, frequent maintenance	IS1.1. Site investigation IS1.2. Topographical assessment IS1.3. Construction work	H: N/A G: consultancy, contractors (equipment and labour), compensation (during work) P: N/A	H: injuries, property value G: compensation (extreme events), public spending P: productivity, property value	H: mobility, well-being, employment G: health (reduced vector-borne diseases) P: mobility, revenue
IS2	Use of climate resilient materials and techniques (e.g. water-draining road pavement)	IS2.1. Suitability assessment IS2.2. Site investigation IS2.3. Construction work	H: N/A G: consultancy, contractors (equipment and labour), training, awareness raising P: training, marketing	H: injuries (roads) G: public spending (maintenance and health) P: N/A	H: mobility, well-being, property value G: tax revenue P: property value, productivity (roads)
IS3	Improve landscape management (e.g. slow water time of travel)	IS3.1. Restore landscape integrity (native plant species) IS3.2. Enforce river/creek buffer requirements IS3.3. Public awareness and voluntary reporting (empowering force vive)	H: weeding and planting trees G: weeding and planting trees, public outreach, labour (enforcement) P: weeding and planting trees	H: injuries, property value G: compensation (extreme events), public spending P: productivity, property value	H: well-being, employment G: carbon sequestration, branding P: tourism, revenue
IS4	Collection and use of topographic, hydrology and climate-related data in infrastructure planning (e.g. elevated roads and buildings)	IS4.1. Collection of data IS4.2. Capacity building for the use of data IS4.3. Topography/hydrology-based zoning/planning	H: construction G: consultancy (data and site investigation), contractors (equipment and labour), training P: training	H: injuries, property value G: compensation (extreme events), public spending P: productivity, property value	H: mobility, well-being, employment G: tax revenue P: mobility, revenue
IS5	Real time warning system for infrastructure failure	IS5.1. Technology deployment IS5.2. Identification of hotspots and “escape routes” IS5.3. Awareness raising	H: N/A G: consultancy, contractors (equipment and labour), training, awareness raising P: training	H: injuries (possibly congestion, energy cost), insurance G: public spending (health cost) P: insurance, (possibly congestion, energy cost, productivity)	H: well-being G: public safety, labour productivity P: profits
IS6	Improvement of institutional capacity	IS6.1. Capacity building planning and implementation IS6.2. Quality control unit (monitoring and evaluation) IS6.3. Law enforcement	H: N/A G: training, labour P: training	H: N/A G: public spending (avoided malpractice) P: N/A	H: employment and income, human capital G: skilled workforce, tax revenue P: revenue

Agriculture - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
A1	Water Supply and Conservation Support	**A1.1.** Water conservation incentives **A1.2.** Dissemination of micro irrigation systems (and expand rainwater harvesting) for efficient water use and management **A1.3.** Floodplain Easements, to maintain agricultural production that is compatible with flood conveyance	*H:* N/A *G:* incentives, capital investment for infrastructure *P:* co-financing for capital investment	*H:* water shortages *G:* water supply, flood damage *P:* reduced yield and revenue, water costs	*H:* food security, employment *G:* tax revenue *P:* revenues and income
A2	Preventing, preparing for, and responding to agricultural invaders, pests and diseases	**A2.1.** Develop policy for imports and (maintaining) local production **A2.2.** Implement integrated pest and disease management	*H:* N/A *G:* incentives, policy development *P:* capital and O&M cost	*H:* N/A *G:* food imports *P:* reduced yield and revenue	*H:* food security *G:* tax revenue *P:* revenues and income
A3	Sustainable land use planning (zoning)	**A3.1.** Design law for sustainable land use planning and zoning **A3.2.** Enforce abidance to law and avoid land encroachment **A3.2.** Education and awareness raising	*H:* N/A *G:* awareness raising *P:* N/A	*H:* land use conflicts *G:* integration of agriculture and pasture *P:* N/A	*H:* food security & quality, well-being *G:* water quality, social cohesion *P:* N/A
A4	Promote working landscapes with ecosystem services to improve agro-biodiversity	**A4.1.** Technical and financial assistance for maintaining traditional production (e.g. honey, lemon) **A4.2.** Identification, development and breeding of crop varieties capable of adapting to climate change **A4.3.** Formalize certification for bio production, increasing reliance on tradition fertilizers (e.g. composting) and pesticides	*H:* composting *G:* incentives, capital investment for infrastructure, certification *P:* co-financing for capital investment, certification	*H:* food expenditure *G:* food imports *P:* reduced yield and revenue	*H:* food security, employment, traditional production *G:* tax revenue (higher production and access to new markets) *P:* revenues and income
A5	Building and sustaining institutional support	**A5.1.** Define a capacity-building framework that will build the capacity of institutions, train their human resources as well as those of local communities on sustainable agriculture	*H:* N/A *G: capacity building* *P:* N/A	*H:* N/A *G: policy effectiveness* *P:* reduced yield	*H:* knowledge and skills *G: N/A* *P:* knowledge and skills
A6	Research, market development for bio-farming and communication	**A6.1.** Support the development of a bio market (export) for ag products; through awareness raising and facilitating access to market **A6.2.** Support the development of appropriate models for communication to transfer and disseminate information on climate change. **A6.3**. Survey on carrying capacity of cattle	*H:* N/A *G:* research and policy *P:* data collection and analysis	*H:* water shortage *G:* natural resource mgmt. costs *P:* reduced yield, conflict agriculture-cattle	*H:* food security, employment, traditional production *G:* water quality, social cohesion *P:* revenues and income

Annex 10

Coastal areas and Tourism - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
T1	Restoration of coastal vegetation	**T1.1.** Removal of exotic plants **T1.2.** Planting of native vegetation species	*H:* N/A *G:* labour, transport, equipment, training *P:* training, co-financing	*H:* property value, injuries *G:* coastal erosion, public spending (coastal infrastructure, health) *P:* property value, insurance	*H:* employment, well-being *G:* carbon sequestration, mitigation of ocean acidification *P:* N/A
T2	Promoting the creation of natural parks	**T2.1.** Site investigation **T2.2.** Establishment of parks **T2.3.**Monitoring for management, compliance	*H:* N/A *G:* consultancy, contractors (equipment and labour) *P:* training	*H:* leisure opportunities *G:* vegetation and biodiversity *P:* landscape fragmentation	*H:* cultural values and well-being *G:* ecosystem integrity *P:* tourism arrivals and revenue
T3	Protection and restoration of ESA	**T3.1.** Mapping of ESAs **T3.2.** Improve governance of ESAs **T3.3.** Mangroves plantation	*H:* N/A *G:* survey (site identification), labour, incentives *P:* equipment and infrastructure co-financing	*H:* property value, injuries *G:* coastal erosion, public spending (infrastructure, health) *P:* property value, catch and revenue, insurance	*H:* employment, well-being, leisure (biodiversity) *G:* tax revenue, carbon sequestration, mitigation of ocean acidification *P:* tourism arrivals and revenue
T4	Encouraging coral nursery and growth of coral reefs	**T4.1.** Incentives for coral nursery **T4.3.** Encourage sustainable fishing practices	*H:* N/A *G:* survey (site identification), consultancy, nursery, propagation, software, labour *P:* training, survey	*H:* property value *G:* coastal erosion, public spending (coastal infrastructure) *P:* property value, catch and revenue, insurance	*H:* well-being, leisure (biodiversity) *G:* tax revenue *P:* fish catch and revenues
T5	Promote best practices (water, energy, etc.)	**T5.1.** Incentivise energy and water efficiency as well as water/waste recycle and reuse **T5.2.** Promote certification	*H:* co-financing *G:* incentives, consultancy *P:* training, co-financing, certification fees	*H:* water and energy cost *G:* water stress and water delivery (during droughts), waste landfilling *P:* water and energy cost	*H:* air quality, employment and income *G:* reduced public spending, energy import, emissions *P:* competiveness, resilience
T6	Incentivise eco-tourism, with the valorisation of natural capital	**T6.1.** Branding **T6.2.** Awareness raising **T6.3.** Capacity building	*H:* N/A *G:* consultancy, training package, media strategy *P:* training	*H:* N/A *G:* habitat loss, public spending *P:* attractiveness, competitiveness	*H:* employment and income *G:* tax revenue *P:* tourism arrivals and revenue

Water resources - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
W1	Practice and promote integrated flood management	**W1.1.** Reduce sedimentation, temporarily store floodwaters, recharge aquifers and restore environmental flows	*H:* N/A *G:* labour, equipment *P:* N/A	*H:* water scarcity, property damage *G:* water delivery, infrastructure damage, emergency interventions *P:* property damage	*H:* water availability, employment and income *G:* tax revenue *P:* production and profit
W2	Fully develop the potential of integrated water management	**W2.1.** Complete the Rodrigues Water Act **W2.2.** Improve the coordination of local groundwater storage and with other water supplies	*H:* N/A *G:* consultancy, software, training, coordination *P:* N/A	*H:* water scarcity *G:* water delivery, emergency interventions *P:* N/A	*H:* water availability, employment *G:* tax revenue *P:* revenues and income
W3	Increase water use and production efficiency	**W3.1.** Incentivise the reduction in water use **W3.2.** Support Efficient Water Management Practices in the agriculture sector **W3.3.** Stimulate the recycled and reuse of water	*H:* co-financing for technology *G:* incentives *P:* capital and O&M cost	*H:* water expenditure *G:* water delivery *P:* loss of productivity and revenue	*H:* water security, employment *G:* tax revenue *P:* revenues and income
W4	Enhance and sustain ecosystems	**W4.1.** Protect water catchment areas **W4.2.** Awareness campaigns (e.g. reduced litter and pollution)	*H:* N/A *G:* labour, transport, equipment; herbicides; compensation; training *P:* training	*H:* water scarcity, food security/expenditure *G:* water delivery, food import, social tension *P:* water scarcity and cost	*H:* fresh water supply, food security, employment *G:* water quality and supply, tax revenue *P:* water supply, soil quality, tourism
W5	Expand Water Storage	**W5.1.** Increase surface water storage capacity **W5.2.** Expand rain water harvesting capacity **W5.3.** Incentivise desalination, while taking into account ecosystem protection	*H:* co-financing *G:* consultancy, constructor, labour, incentives *P:* co-financing	*H:* water expenditure *G:* water delivery, food import, social tension *P:* loss of productivity and revenue	*H:* water supply, food security, employment *G:* water supply, tax revenue *P:* water supply
W6	Preserve, upgrade and increase monitoring and data analysis	**W6.1.** Incentivise the collection and use of data **W6.2.** Capacity building (technical empowerment)	*H:* N/A *G:* incentives, labour and training, R&D *P:* training	*H:* N/A *G:* malpractice *P:* N/A	*H:* employment, human capital *G:* labour productivity *P:* skilled workforce

Annex 12

Biodiversity - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
B1	Catchment areas: eradication of invasive species	**B1.1.** Weeding and replanting **B1.2.** Maintenance of replanted forest **B1.3.** Relocation of activities	*H:* relocation costs *G:* labour, transport, equipment; herbicides; compensation; training *P:* relocation costs, foregone revenue; training	*H:* water scarcity, food security/expenditure *G:* water distribution, food import, water purification, social tension *P:* water scarcity and cost, fertilizer and pesticides	*H:* fresh water supply, food security, health, employment and income, leisure *G:* water quality and supply, tax revenue *P:* water supply, soil conservation and quality, tourism
B2	Reintroduction of native plants in planted forest	**B2.1.** Propagation of native plants and fruit trees **B2.2.** Gradual clearing and replacement **B2.3.** Maintenance of replanted forest	*H:* N/A *G:* collection of seeds, nursery, labour, equipment, transport *P:* collection of seeds, nursery	*H:* water scarcity, food security/expenditure *G:* ecosystem functions, food and habitat (wildlife), pests and diseases *P:* water scarcity and cost, forgone yield and revenue	*H:* leisure, water, soil and air quality *G:* reduced human/wildlife conflict (e.g. bats), carbon sequestration, resilience *P:* eco-tourism, land value (investment), resilience to cyclone, medicinal plants
B3	Restoration of native forests	**B3.1.** Cut and carry strategy **B3.2.** Propagation and planting of native plants **B3.3.** Enforcement of legislation for stray animals	H: N/A G: collection of seeds, nursery costs, labour, equipment, transport, materials P: collection of seeds, labour, equipment, transport	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value *G:* public health and welfare, green jobs, reduced human-bat conflict, respecting conventions and treaties, eco-tourism *P:* eco-tourism, resilience from cyclones, medicinal plants
B4	Expansion and improvement of protected areas	**B4.1.** Identification of appropriate area delimitation, fast-track implementation **B4.2.** Incentives for stewardship **B4.3.** Forest restoration	H: N/A G: survey costs, compensation, land swaps, conservation easement P: collection of seeds, nursery, fencing	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value *G:* public health and welfare, green jobs, reduced human-bat conflict, respecting conventions and treaties, tourism *P:* eco-tourism, resilience from cyclones, medicinal plants, land value
B5	Operationalize the environment-tally sensitive areas	**B5.1.** Reactivate the Rodrigues Environment Committee **B5.2.** Harmonize env. laws **B5.3.** Amend EPA to form climate change unit	*H: N/A* *G:* GIS costs, technical labour, software and data, enforcement costs, review laws *P:N/A*	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* leisure, soil and air quality, aesthetic value, health, flood reduction *G:* public welfare, green jobs, respecting conventions and treaties, eco-tourism *P:* eco-tourism, resilience from cyclones, medicinal plants, land value
B6	R&D on impacts of climate change and benefits of native forests	**B6.1.** Capacity building (institutions and citizens) **B6.2.** Publication of research, improved access and awareness raising **B6.3.** Research on invasive species and entomology	*H:* citizen science *G:* workshops, training, advertising and communication (Agent de l'Environnement) *P:* CSR, use of media, technology development	*H:* water scarcity *G:* loss of ecosystem functions, food and habitat for wildlife *P:* loss of biodiversity, water scarcity and cost, food and habitat for wildlife	*H:* community involvement *G:* public health and welfare, green jobs, land use planning, building resilience *P:* eco-tourism, resilience from cyclones, medicinal plants, land value, patenting

Fisheries - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
F1	Expand protected areas and improve governance and enforcement	**F1.1.** Implement management plan (MPAs) **F1.2.** Identify sensitive areas in light of future climate change impacts	*H:* N/A *G:* survey (biodiversity), consultancy, labour, enforcement *P:* survey (biodiversity)	*H:* fish cost *G:* public spending (rehabilitation) *P:* catch and revenue	*H:* employment and income, nutrition, leisure (biodiversity) *G:* health costs, tax revenue *P:* labour productivity, tourism (biodiversity)
F2	Rehabilitation and expansion of coastal and marine habitat	**F2.1.** Science-based and site specific coral nursery **F2.2.** Seagrass restoration **F2.3.** Mangrove propagation **F2.4.** release of fingerlings	*H:* N/A *G:* survey (site identification), consultancy, nursery, monitoring, propagation, software, labour *P:* training, survey	*H:* property value, injuries *G:* coastal erosion, public spending (coastal infrastructure, health) *P:* property value, catch and revenue, insurance	*H:* employment, well-being, leisure (biodiversity) *G:* tax revenue, carbon sequestration, mitigation of ocean acidification *P:* tourism arrivals and revenue
F3	Identify and implement sustainable small scale aquaculture	**F3.1.** Identify and implement small scale aquaculture **F3.2.** Incentives and capacity building for aquaculture entrepreneurship **F3.3.** Implement M&E	*H:* N/A *G:* Study and survey (site identification), labour, incentives *P:* equipment and infrastructure co-financing	*H:* N/A *G:* fish import *P:* loss of productivity and income	*H:* employment and income, nutrition *G:* tax revenue *P:* revenues and profit
F4	Incentivise fishing outside of the lagoon	**F4.1.** Incentives to mitigate costs **F4.2.** Permitting	*H:* N/A *G:* incentive, certification (consultancy, labour) *P:* co-financing	*H:* N/A *G:* coastal and marine habitat loss, public spending (compensation) *P:* loss of productivity and income	*H:* employment and income *G:* tax revenue, climate resilience *P:* revenues and profit
F5	Sensitization of fishers	**F5.1.** Capacity building on the use of climate-related impacts (e.g. stock migration) **F5.2.** Awareness raising on the importance of coastal and marine ecosystem health **F5.3.** Capacity building on sustainable fishing techniques (lagoon and open sea)	*H:* N/A *G:* consultancy, training package, labour, campaigns *P:* fees (commercial), campaigns	*H:* N/A *G:* malpractice (overfishing, habitat loss), public spending (rehabilitation) *P:* productivity loss	*H:* well-being, employment and income (inclusiveness) *G:* human capital, tax revenue *P:* catch and revenue
F6	Improve the monitoring of coastal areas and harmonize monitoring methodology	**F6.1.** Ongoing capacity building **F6.2.** Facilitation of technology transfer **F6.3.** Create an open access and centralized knowledge repository **F6.4.** identification and monitoring of coral disease	*H:* N/A *G:* consultancy, labour, training materials, equipment *P:* labour, equipment	*H:* N/A *G:* public spending (duplication of efforts) *P:* labour cost	*H:* N/A *G:* human capital, information sharing *P:* human capital

Annex 14

Health - *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
H1	Infrastructure to monitor and control diseases and manage patients	**H1.1.**Upgrade capacity of health facilities to cope with surge of climate-sensitive diseases and conditions **H1.2.**Create department climate-sensitive diseases	*H:* Taxation *G:* equipment, labour *P:*Tax contribution	*H:* infections, death and health cost *G:* health costs(staff, medicines) *P:*productivity loss, insurance	*H:*well-being, life expectancy *G:*budget surplus (lower deficit), tax revenues *P:* revenues and profit
H2	Formulate climate-sensitive public health policy	**H2.1.**Formulate public health policy on health impacts of climate change **H2.2** Forge interministerial collaboration through climate health panel **H2.3.**Develop and implement protocols to monitor performance indicators	*H:* Taxation *G:*Labour and consultancies *P:* time (in-kind)	*H:*out of pocket expenses *G:*public spending *P:* health insurance (no increase)	*H:*social cohesion *G:*budget surplus (lower deficit) *P:*N/A
H3	Surveillance, monitoring and control of vectors, diseases and environmental hazards	**H3.1.I**mplement Early Warning System of surveillance to monitor trend of vectors, environmental hazards and climate-sensitive disease and conditions **H3.2.**Introduce new techniques for the control of mosquitoes	*H:* Cost of air conditioning and mosquito repellents *G:*research funding *P:* research funding	*H:*reduced malpractice and health cost *G:*public spending *P:*health insurance (no increase)	*H:*well-being, life expectancy *G:*budget surplus (lower deficit), tax revenues *P:*N/A
H4	Health promotion for education and communication dissemination on preventive strategies	**H4.1.**Develop Information, Education and Communication plans to address perceptual and behavioural obstacles to climate change **H4.2.**Promote healthy life-style, nutrition habits and vector control strategies	*H:* Community involvement *G:*cost of designing, printing and dissemination *P:*advertising cost	*H:*infections, death and health cost *G:*public spending *P:*productivity loss, health insurance	*H:*well-being, healthy lifestyle, income *G:*tourism arrivals/revenues *P:* tourism arrivals, revenues and profit
H5	Train and dedicate staff for managing increase in disease burden attributable to climate change	**H5.1.**Introduce Continued Medical Education, CME for life-long learning, **H5.2.** Train and dedicate workforce for managing climate-sensitive health conditions	*H:* tuition fee *G:*labour, expert/trainer, tuition fee/scholarship *P:* tuition fee	*H:*out of pocket expenses *G:*public spending on vulnerable groups *P:*insurance pay on vulnerable group	*H:*healthy family *G:*informed consumer *P:*healthy employees
H6	Stock piling of medicine, essential medical supplies and human resource deployment	**H6.2.**maitain a stock of emergency medical supplies **H6.3.**Expand the range of vaccines **H6.4**.Deployment of human resources	*H:* N/A *G*: cost of building recreation centers and nutritionist salaries *P:* Nutritionist salaries	*H:*non communicable disease cost *G:*Public spending *P:*productivity loss, health insurance	*H:*reduce heart disease and obesity *G:*reduce health expenditure *P:*saving on insurance premium

Infrastructure- *Transforming challenges into opportunities* (Rodrigues)
Strategies (A1etc.) and corresponding actions (A1.1 etc.) and investments from Households (*H*), Government (*G*) and Private sector (*P*) with resulting policy-induced avoided costs and added benefits

	Strategies	Action List	Investment	Avoided costs	Added benefits
I1	Upgrade drains, frequent maintenance	**I1.1.** Site investigation **I1.2.** Topographical assessment **I1.3.** Construction work	*H:* N/A *G:* consultancy, contractors (equipment and labour), compensation (during work) *P:* N/A	*H:* injuries, property value *G:* compensation (extreme events), public spending *P:* productivity, property value	*H:* mobility, well-being, employment *G:* health (reduced vector borne diseases) *P:* mobility, revenue
I2	Use of climate resilient materials and techniques (e.g. water-draining road pavement)	**I2.1.** Suitability assessment **I2.2.** Site investigation **I2.3.** Construction work	*H:* N/A *G:* consultancy, contractors (equipment and labour), training, awareness raising *P:* training, marketing	*H:* injuries (roads) *G:* public spending (maintenance and health) *P:* N/A	*H:* mobility, well-being, property value *G:* tax revenue *P:* property value, productivity (roads)
I3	Improve landscape management (e.g. reduce water accumulation and slow water time of travel)	**I3.1.** Restore landscape integrity (native plant species) **I3.2.** Enforce river/creek buffer requirements **I3.3.** Plan for emergency response for pumping operations	*H:* weeding and planting trees *G:* weeding and planting trees, public outreach, labour (enforcement) *P:* weeding and planting trees	*H:* injuries, property value *G:* compensation (extreme events), public spending *P:* productivity, property value	*H:* well-being, employment *G:* carbon sequestration, branding *P:* tourism, revenue
I4	Collection and use of topographic, hydrology and climate-related data in infrastructure planning (e.g. elevated roads and buildings)	**I4.1.** Raising or relocating machineries/buildings in flood prone areas **I4.2.** Capacity building for the use of data **I4.3.** Topography/hydrology-based zoning/planning	*H:* construction *G:* consultancy (data and site investigation), contractors (equipment and labour), training *P:* training	*H:* injuries, property value *G:* compensation (extreme events), public spending *P:* productivity, property value	*H:* mobility, well-being, employment *G:* tax revenue *P:* mobility, revenue
I5	Real time warning system for infrastructure failure	**I5.1.** Technology deployment **I5.2.** Identification of hotspots and "escape routes" **I5.3.** Awareness raising	*H:* N/A *G:* consultancy, contractors (equipment and labour), training, awareness raising *P:* training	*H:* injuries (possibly congestion, energy cost), insurance *G:* public spending (health cost) *P:* insurance, (possibly congestion, energy cost, productivity)	*H:* well-being *G:* public safety, labour productivity *P:* profits
I6	Improvement of institutional capacity	**I6.1.** Capacity building planning and implementation **I6.2.** Quality control unit (monitoring and evaluation) **I6.3.** Law enforcement	*H:* N/A *G:* training, labour *P:* training	*H:* N/A *G:* public spending (avoided malpractice) *P:* N/A	*H:* employment and income, human capital *G:* skilled workforce, tax revenue *P:* revenue

Results of Multi-Criteria Analysis

Annex 16/p1

ENERGY INDUSTRIES (Please see 'Annex 18a – MCA - energy industries – TNC Mauritius.xlsx' in e-version)

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
EE	10.7	7.5	10.2	11.3	4.1	3.0	1.3	10.0	**57.91**	**2**
Wind (utility scale)	14.4	3.8	25.0	7.5	10.0	1.3	1.3	2.4	**65.55**	**1**
Solar PV (utility scale)	14.4	6.0	0.7	4.5	0.3	3.5	1.3	0.0	**30.63**	**3**
WTE	0.0	9.0	0.3	10.5	0.1	4.0	2.5	0.3	**26.77**	**5**
Biomass	15.0	1.5	0.0	4.5	0.0	4.0	3.5	0.0	**28.54**	**4**

Source : TNC

ROAD TRANSPORT (Please see 'Annex 18b – MCA - road transport – TNC Mauritius.xlsx'. in e-version)

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
Improved fuel efficiency	15.0	15.0	5.1	0.8	2.0	1.3	2.5	5.2	**46.74**	**2**
Improved vehicle inspection	15.0	12.0	25.0	3.8	10.0	0.8	3.0	10.0	**79.46**	**1**
Ethanol blend	14.6	3.8	5.7	4.5	2.5	0.5	2.0	5.4	**39.07**	**4**
Hybrid cars	7.1	12.0	2.9	9.8	1.3	3.8	2.5	5.2	**44.51**	**3**
Eletric cars	7.7	7.5	0.0	7.5	0.0	4.5	1.5	5.2	**33.90**	**5**
Express Rail	0.0	1.5	8.2	12.0	3.2	0.3	4.3	0.0	**29.43**	**6**

Source : TNC

SOLID WASTE (Please see 'Annex 18c – MCA - solid waste – TNC Mauritius.xlsx' in e-version.)

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
LFG capture	15.0	12.8	12.6	1.5	1.9	0.5	0.8	0.0	**45.06**	**3**
Recycling of paper and textile	12.5	9.8	0.0	6.0	0.0	1.0	2.0	4.0	**35.21**	**4**
WTE	0.0	3.8	25.0	10.5	10.0	0.3	0.5	10.0	**60.00**	**1**
Composting	13.8	7.5	12.4	8.3	0.0	1.0	1.0	3.3	**47.27**	**2**

Source : TNC

AGRICULTURE (CROP) (Please see 'Annex 18d – MCA - agriculture_crop – TNC Mauritius.xlsx' in e-version.)

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
Crop burn	15.0	11.3	0.0	1.5	0.0	0.5	2.0	3.3	**33.58**	**3**
Compost in biofarming	0.0	11.3	3.3	4.5	0.0	1.0	4.0	10.0	**34.02**	**2**
Reducing chemical fertilisers	15.0	4.5	25.0	0.8	0.0	1.8	3.0	0.0	**49.97**	**1**

Agriculture (Livestock) (Please see 'Annex 18e – MCA - agriculture_livestock – TNC Mauritius.xlsx in e-version')

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
Biogas	0.0	1.0	0.4	1.5	10.0	1.3	4.0	15.0	**33.12**	**3**
Composting	19.9	8.0	0.0	3.3	0.0	3.5	0.8	0.0	**35.45**	**2**
Fertigation	20.0	1.0	30.0	0.3	0.0	0.3	0.3	11.2	**62.91**	**1**

Source : TNC

LULUCF (FORESTRY) (Please see 'Annex 18f – MCA - LULUCF – TNC Mauritius.xlsx' in e-version)

Since tree planting is a public good, the MCA indicator 'catalysing private investment' is set to zero. The indicator 'reduction in energy import bill' is also set to zero since there is no displacement of imported fossil fuel in the baseline.

	CRITERIA AND INDICATORS									
	Public Financing	Implementation Barriers	Climate	Economic			Social			
TECHNOLOGY	Direct cost	Ease of implementation	GHG reduction	catalysing private investment	Energy bill	replicability	Impact on health	Job creation	**TOTAL**	**RANK**
Tree Planting	15.0	12.0	0.0	0.0	0.0	3.0	3.0	0.0	**33.00**	**1**
Afforestation (1,000 ha)	0.0	3.0	25.0	0.0	0.0	0.5	4.0	0.0	**32.50**	**2**

Annex 17

Estimated cost of implementing mitigation measures for agricultural crops

Compost (from MWS) used in bio-.farming	Create a network of all stakeholders that is used to identify projects of national interests	MUR 1.5 million (~43,100 US$)[1]
	Invest in R&D for the comparative analysis of compost or chemical fertiliser on crop productivity, impact on health and the environment	MUR 18 million (~517,250 US$)
	• Develop awareness campaigns for promoting the benefits of sorting of waste at source • Establish incentives and disincentives to promote sorting of waste at source	MUR 12 million (~345,000 US$) MUR 100 million (~2.87 mUS$)
	Resources mobilization plan in place for making financing available for setting up the infrastructure needed to carry out sorting of waste at source and for the collection of the sorted waste	MUR 3 million (~86,200 US$) [resources that need to be mobilised estimated at MUR 300 million – i.e. ~8.62 mUS$]
Crop burning	• Invest more in mechanical harvesting • Develop self-thrashing cane varieties	MUR 50 million (~1.44 mUS$) MUR 25 million (~718,400 US$) over 15 years
	Institutional capacity building for enforcement	MUR 2.5 million (~72,000 US$)
	Make available the necessary resources to create awareness about the benefits of limiting crop burning	MUR 2 million (~57,500 US$)
Reducing the use of chemical fertilisers (Climate-Smart Agriculture)	Put in place a regulation for controlling the use of chemical fertilisers in crop production	MUR 3 million (~86,200 US$)
	Establish a regulatory body for overseeing the use of chemical fertilisers in crop production	MUR 10 million per year (~287,500 US$ per year) [can also empower existing body such as the Dangerous Chemicals Control Board to play the role of regulator for use of chemical fertilisers]
	Make available the necessary resources to create awareness about the benefits of limiting the use of chemical fertilisers (within the broader ambit of promoting bio-farming)	MUR 12 million (~344,800 US$)

Note[1] USD=MUR34.8

Annex 18

List of Annexes referred to in Chapter 4

These annexes will appear only in the e-version of the TNC report in view of their size, format and contents.

Annex 17a - Energy Industries - Mitigation Scenarios

Annex 17b - Land Transport - Mitigation Scenarios

Annex 17c - Solid Waste - Mitigation Scenarios

Annex 17 d - Solid Wastes - Mitigation Scenarios

Annex 17d - Wastewater - Mitgation Scenarios

Annex 17e - Crop and Livestock - Mitigation Scenarios

Annex 17f - LULUCF - Mitigation Scenarios

Annex 19

List of Annexes referred to in Annex 16

These annexes will appear only in the e-version of the TNC report in view of their size, format and contents.

Annex 18a - MCA - energy industries - TNC Mauritius

Annex 18b - MCA - road transport - TNC Mauritius

Annex 18c - MCA - solid waste - TNC Mauritius

Annex 18d - MCA – agricultural crop - TNC Mauritius

Annex 18e - MCA – agriculture livestock - TNC Mauritius

Annex 18f - MCA - LULUCF - TNC Mauritius

Annex 20

Parameters needed for mitigation scenarios MRV for the energy industries

Parameter	Units	Remarks
Grid Emission Factor		
Share of Low Cost Must Run (LCMR) power plants/units in the electricity system in the past 5 years	% of total generation	All the parameters are as defined in the CDM Methodological Tool 07, version 5 - "Tool to calculate the emission factor of an electricity system"(UNFCCC, CDM, PA Methodologies, 2016)
Annual data from each power plant/unit on power generation	MWh	Data should be measured using calibrated meters and collected using the Quality Assurance System (QAS) established by the CEB.
Annual data from each power plant/unit on fuel type		The fuel type determines the fuels for which emission factors and net calorific values (NCV) are needed (see NCV below).
Annual data from each power plant on fuel/unit consumption	t	Data are recorded using the QAS established by the CEB.
Net calorific value (NCV) of each type of fuel used in power plants/units	GJ/(tonne fuel)	Uses laboratory data from CEB for fuel oil and kerosene, and IPPs for coal.
Emission factor of each type of fuel used in power plants/units	tCO_2/GJ	Uses IPCC default values.
Annual electricity generated from renewable energy sources	MWh	Data should be measured using calibrated metres and collected using the Quality Assurance System (QAS) established by the CEB.
Avoided electricity through demand side management	MWh	• Reduction in electricity use against historical baseline • Surveys carried out by EEMO • Data collected during energy audits • At the project level, the parameters defined in CDM Approved Small-Scale methodologies, such as AMS-II.C; II.D; II.E; II.J; II.L; II.N; II.O; II.Q; II.R; II.S need to be measured (UNFCCC, CDM, SSC Methodologies, 2016)

Annex 21

Parameters needed for land transport mitigation scenarios MRV

Parameter	Units	Remarks
Passenger Mobility		
Average annual distance travelled by different types of passenger vehicles (e.g. two-wheelers, car, bus, DPV) and broken down by fuel type (e.g. LPG, gasoline, diesel, hybrid, electric)	km per year	This has to be carried out through sampling, and is a parameter that may be collected by the road worthiness test centres.
Average occupancy of different types of passenger vehicles and broken down by fuel type	Number of passengers	Data should be measured through surveys.
Average fuel consumption of different types of passenger vehicles and broken down by fuel type	L fuel per 100km travelled	Data should be measured through surveys using methodology adopted by the Global Fuel Economy Initiative (GFEI) project.
Number of registered passenger vehicles and broken down by fuel type	Number of passenger vehicles	Although these data are not used in the model, they can nevertheless be used to carry out cross verification of the model output.
Net calorific value (NCV) of each type of fuel used in vehicles	GJ/(tonne fuel)	Uses IPCC default values or can use laboratory data from national authorities (preferred).
Emission factor of each type of fuel used in passenger vehicles	tCO_2/GJ	Uses IPCC default values or can use Tier II factors when available.
Freight Mobility		
Average annual distance travelled by freight vehicles (diesel or gasoline)	km per year	This has to be carried out through sampling, and is a parameter that may be collected by the road worthiness test centres. Although not used in the model, it will be useful to collect data by categorising freight vehicles by tare or maximum load.
Average load of freight carried by vehicles	t	Data should be measured through surveys.
Average fuel consumption of freight vehicles	L fuel per 100km travelled	Data should be measured through surveys using methodology adopted by the Global Fuel Economy Initiative (GFEI) project. Data can also be collected for different types of freight vehicles classified by tare.
Number of registered freight vehicles by fuel type and size of vehicles (e.g. tare or maximum load)	Number of freight vehicles	Although these data are not used in the model, they can nevertheless be used to carry out cross verification of the model output.
Net calorific value (NCV) of each type of fuel used in vehicles	GJ/(tonne fuel)	Uses IPCC default values or can use laboratory data from national authorities (preferred).
Emission factor of each type of fuel used in passenger vehicles	tCO_2/GJ	Uses IPCC default values or can use Tier II factors when available.
Aggregate fuel statistics		
Quantity of total annual fuel consumed in land transport by fuel type	t per year	This data are already available at Statistics Mauritius. It is used in the model for carrying out the energy balance and for tracking overall national GHG emissions.

Annex 22

Parameters needed for solid waste mitigation scenarios MRV

Parameter	Units	Remarks
Population (annual)	Number of persons	Annual population is provided by SM.
Per capita waste generated	kg/person/yr	This value is calculated by dividing the total quantity of MSW generated (tonne) in a year by the population in that year. The quantity of total waste generated/collected is compiled by the Solid Waste Management Division, MoESDDBM.
Composition of waste	%	The total waste is disaggregated into its various components such as food, garden, paper, wood, inert, etc. These values can be obtained from waste characterisation at transfer stations. It should be measured periodically by the Solid Waste Management Division, MoESDDBM
Quantity of sludge	kg (or equivalent)	The quantity of sludge (e.g. from wastewater treatment) landfilled is recorded and available at the Solid Waste Management Division, MoESDDBM.
Quantity of industrial waste	kg (or equivalent)	The quantity of industrial waste landfilled is recorded and is available at the Solid Waste Management Division, MoESDDBM
Quantity of waste diverted from landfill for alternative uses (e.g. recycling, composting and waste-to-energy)	kg (or equivalent)	These quantities are recorded and are available at the Solid Waste Management Division, MoESDDBM.
LFG capture (either for flaring or electricity generation)	kg CH_4 (or equivalent units)	Data are recorded and available at the Solid Waste Division, MoESDDBM
Degradable Organic Carbon (DOC) in various types of solid waste	dimensionless	Uses IPCC default values.
Fraction of DOC (DOCf) dissimilated	dimensionless	Uses IPCC default values.

Annex 23

Parameters needed for agricultural crops mitigation scenarios MRV

Parameter	Units	Remarks
Crop burn		
Area of sugar cane on which agricultural residue is burnt	ha/year	This area is usually captured as a percentage of total area cultivated, and data are recorded and are available at the MCIA.
Mass of fuel available for combustion	t/ha	Uses IPCC default value for sugar cane post-harvest field burning (6.5 t/ha).
Emission factor	kg CH_4/(kg dm burnt)	Uses IPCC default value for agricultural residues (2.7 kg CH_4/(kg dm burnt))
Direct N_2O emissions from managed soils		
N input in the form of chemical fertiliser	kg N/yr	This data are obtained from chemical fertilisers used in sugar and non-sugar crop cultivation. They are estimated by MCIA and FAREI, respectively. Parameter is also used to calculate indirect N_2O emissions.
N input in the form of manure	kg N/yr	This data corresponds to livestock manure and is recorded by FAREI. Parameter is also used to calculate indirect N_2O emissions.
N input in the form of agricultural residues	kg N/yr	Data are recorded by MCIA (sugar cane residues) and FAREI (food crop residues), respectively. Parameter is also used to calculate indirect N_2O emissions.
Emission factor	kg N_2O-N/kg N	Uses IPCC default value (0.01 kg N_2O-N/kg N).
Direct N_2O emissions from managed soils–urine and dung inputs		
N input from pig, cattle and poultry excrement	kg N/yr	Data available from FAREI.
N input from sheep and other animals' excrement	kg N/yr	Data available from FAREI.
Emission factors	kg N_2O-N/kg N	Uses IPCC default values (0.02 kg N_2O-N/kg N for pig, poultry and cattle; 0.01 kg N_2O-N/kg N for sheep and other animals).
Indirect N_2O emissions from managed soils		
Fraction of synthetic fertiliser that volatilises	(kg NH3-N+NOx-N)/kg N	Uses IPCC default value [0.1 (kg NH3-N+NOx-N)/kg N].
Fraction of organic or dung inputs that volatilises	(kg NH3-N+NOx-N)/kg N	Uses IPCC default value [0.2 (kg NH3-N+NOx-N)/kg N].
Fraction N lost through leaching and/or runoff	kg N/kg of N additions	Uses IPCC default value [0.3 kg N/kg of N additions].
Emission factor for N_2O from leaching/runoff	kg N_2O-N/kg N leached	Uses IPCC default value [0.0075 kg N_2O-N/kg N leached].

Annex 24

Parameters needed for livestock management mitigation scenarios MRV

Parameter	Units	Remarks
Enteric fermentation		
Number of animal heads per year by livestock type	Number of heads	The livestock types covered in the analyses are: dairy cow, other cattle (calves, heifers, local and imported bulls), sheep, goats, horses, swine, poultry and deer). The data are recorded and are available from FAREI. Data are also used for the calculation of direct CH_4 and indirect N_2O emissions from livestock manure management.
Livestock type specific CH_4 emission factors for enteric fermentation	kg CH_4/(head yr)	Use IPCC default values. Each type of livestock has a specific emission factor as per details in Annex 17(f) of the e-version of TNC.
Direct CH_4 emissions from livestock manure management		
Number of animal heads per year by livestock type	Number of heads	Same as above.
Livestock type specific CH_4 emission factors for manure	kg CH_4/(head yr)	Use IPCC default values. Each type of livestock has a specific emission factor as per details in Annex 17(f) of the e-version of TNC.
Direct N_2O emissions from livestock manure management		
Number of animal heads per year by livestock type	Number of heads	Same as above.
Excretion rate for each livestock type	kg N/(1000 kg head/day)	Each type of livestock has a specific emission factor as per details in Annex 17(f) of the e-version of TNC. Data are available at FAREI.
Typical mass of each type of livestock and sub-category (e.g. heifer vs calf vs bull or piglet vs swine vs fattener)	kg	Each type of livestock has a specific emission factor as per details in Annex 17(f) of the e-version of TNC. Data are available at FAREI.
Fraction of N managed in Manure Management System (MMS) for each livestock type	dimensionless	FAREI has an inventory of the Manure Management System (MMS) categorisation for each livestock type.
Emission factors for direct N2O-N from MMS	kg N_2O-N/kg N in MMS	Uses IPCC default values.

Annex 25

Parameters needed for sequestration scenarios MRV

Parameter	Units	Remarks
Area of land planted/forested with trees by type (e.g. native vs exotic), and where necessary (such as pine) by age group	ha/yr	The areas are the effective areas – i.e. net of clear-felled areas and gaps. If demarcated forest areas are used, then replanting in clear-felled areas and gaps does not add to carbon stock. Forest areas are categorised as: Dry Lowland (DLL); Moist Forest; and Wet Upland (WUL). All native tree species are placed in one category – i.e. Natives, whereas exotic plants are categorised per species. The data are recorded and are available at the Forestry Services, Ministry of Agro-Industry and Food Security (MoAIFS).
Average annual above-ground biomass growth	tonne dm/ha/yr	The annual increase in biomass is needed for each tree species by forest type. The data are recorded and are available at the Forestry Services (MoAIFS)
Ratio of below-ground biomass to above-ground biomass	tonne dm below-ground/tonne dm above-ground (<1)	Data are needed for each tree species and by forest type. The data are recorded and are available at the Forestry Services (MoAIFS)
Wood removal	m^3/ yr	Volume of pine (WUL forest) and eucalyptus (DLL forest) removed annually for timber. The data are recorded and are available at the Forestry Services, (MoAIFS).
Fuelwood removal	m^3/ yr	Volume of pine (WUL forest) and eucalyptus (DLL forest) removed annually for thermal energy use. The data are recorded and are available at the Forestry Services, (MoAIFS)
Area affected by disturbance	ha / yr	Area of forest type and by type of tree species that is affected by disturbance. The data are recorded and are available at the Forestry Services, (MoAIFS)
Fraction of biomass lost in disturbance	number (<1)	The data are recorded and are available at the Forestry Services, (MoAIFS)
Average above-ground biomass of areas affected	tonne dm / ha	The data for above-ground biomass for each tree species by forest type are recorded and are available at the Forestry Services, (MoAIFS)
Carbon fraction of dry matter	(tonne C)/(tonne dm)	Constant at 0.47 (tonne C)/(tonne dm) for all tree species and forest type.

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