



Inside front cover

Mauritius Environment Outlook Report 2011



Environment - Mauritius

Ministry of Environment and Sustainable Development

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Foreword



I am privileged to present this Mauritius Environment Outlook report, which is the first of its kind in the history of environmental reporting in Mauritius. This report analyses the environmental trends for the past twenty years, assesses the present state of the environment and looks into the prospects for shaping a better future for individuals, society, industries, organisations and coming generations.

The Mauritius Environment Outlook report has been published at a point in time when the world is preparing for the United Nations Conference on Sustainable Development (RIO + 20) in 2012 to renew their commitment to sustainable development. At the local level, this commitment has been given a new impetus through the “Maurice Ile Durable’ (Mauritius a sustainable island) concept. And to vehicle this concept, the mandate of my Ministry has been broadened to include sustainable development.

It is high time we realise that environment is a pre-requisite for development and our well-being. Our natural environment is fundamental in providing resources to produce goods and services, to support the nation, industries and tourism.

This report which highlights the policy choices before us will definitely contribute in paving the way to make environmental sustainability an integral part of all national development planning. To achieve this, we need to move from words to actions. This will require the appropriate mix of measures including the regulatory and institutional set up, strengthening decision-making and identifying the priorities for action. The report will guide our future endeavours so that we can all work together to make ‘Maurice Ile Durable’ a reality at all levels, from grassroots to the highest political instance.

I wish to thank all the organizations and individuals who contributed in the realisation of this report and look forward to their equal full participation and collaborative effort in the implementation phase.

Hon. Devanand Virahsawmy, G.O.S.K, F.C.C.A

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- ~ Mauritius Sugar Industry Research Institute
- ~ Central Water Authority
- ~ Outer Island Development Corporation
- ~ Central Statistics Office
- ~ Mauritian Wildlife Foundation
- ~ Rodrigues Regional Assembly

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Acronyms & Units

ACP	Africa Caribbean Pacific
AHRIM	Association des Hôteliers et Restaurateurs de l'Île Maurice
AR4	4th Assessment Report on climate change
BPO	Business Process Outsourcing
CBD	Convention on Biological Diversity
CEB	Central Electricity Board
CFC	Chlorofluorocarbon
CFL	Compact Fluorescent Lamp
CSO	Central Statistics Office
CWA	Central Water Authority
DCCA	Dangerous Chemicals Control Act
DDT	Dichlorodiphenyltrichloroethane
DOE	Department of Environment
DPSIR	Driver Pressure State Impact Response
ECC	Environment Coordination Committee
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environment Protection Act
ESA	Environmentally Sensitive Areas
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GMO	Genetically Modified Organism
GWh	Giga Watt Hour
ha	Hectares
HCFC	Hydrochlorofluorocarbon
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IOC	Indian Ocean Commission
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRS	Integrated Resort Scheme
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
kt CO₂	Kilo tonne carbon dioxide
kW	Kilo Watt
LAVIMS	Land Administration, Valuation and Information Management System
LPG	Liquefied Petroleum Gas
MDGs	Millennium Development Goals
MEA	Multilateral Environmental Agreement
MEO	Mauritius Environment Outlook Report

mg/l	Milligram per litre
MID	Maurice Ile Durable
MIDF	Maurice Ile Durable Fund
Mm³	Million Cubic metres
MPA	Marine Protected Areas
MRL	Maximum Residue Limits
MSDS	Material Safety Data Sheet
MSIRI	Mauritius Sugar Industry Research Institute
MW	Mega Watt
NCCAP	National Climate Change Action Plan
NDS	National Development Strategy
NDU	National Development Unit
NEC	National Environment Commission
NEL	National Environmental Laboratory
NEP	National Environment Policy
NES	National Environmental Strategies
NGO	Non-Governmental Organisation
NMVOC	Non-methane volatile organic compounds
NNSD	National Network for Sustainable Development
NPCS	National Parks and Conservation Service
NTA	National Transport Authority
ODS	Ozone Depleting Substances
OIDC	Outer Islands Development Corporation
PCB	Polychlorinated Biphenyls
PER	Preliminary Environmental Report
PET	Polyethylene Terephthalate
POPs	Persistent Organic Pollutants
PPG	Planning Policy Guidance
ppm	Parts per million
R&D	Research and Development
RECOMAP	Regional Programme of the IOC for the Sustainable Management of the Coastal Zones of the Indian Ocean Countries
RES	Real Estates Scheme
RRA	Rodrigues Regional Assembly
SAICM	Strategic Approach to International Chemicals Management
SCP	Sustainable Consumption and Production
SEA-MAAS	Strategic Environment Assessment for the Multi-Annual Adaptation Strategy for the sugar cane cluster
SIDS	Small Island Developing State
SIPP	Small Independent Power Producer
SWIO	South West Indian Ocean
toe	Tonne of oil equivalent
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMA	Wastewater Management Authority
µg	Micro gram

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Introduction

Background

Since 1990, environment and sustainable development have been positioned high on the world's agenda. The global community has become increasingly conscious of its fundamental dependency on ecosystems and its simultaneous impacts on these same ecosystems through the pressures of population growth, resource consumption and the discharge of waste and pollutants to air, land and water.

The outcome of the various conferences held, from Agenda 21 (1992), through the Barbados Plan of Action (1994) and the Johannesburg Plan of Implementation (2002) to the Mauritius Strategy (2005) have all successively recognised that access to information on the

environment is one of the catalyst for the implementation of the policies contained in these reports. It is this awareness and commitments taken by States to foster sustainable development that have driven the emergence of environmental reporting in an effort to improve understanding of the environment, monitor its health and serve as a tool to ensure its protection.

The Mauritius Environment Outlook Report (MEO) is the first report of its kind published by the Government of Mauritius, which reflects a firmly based and growing recognition of the importance attached to environmental issues as an integral part in the pursuit of sustainable development.

Evolution of Environmental Reporting in Mauritius 1991 - 2010

1991

First State of the Environment Report: set out a frank assessment of environmental decline, prospects and action required.

1997

Agenda 21 Mauritius National Report: presented an agenda of action for the 21st century for sustainable development in line with the international policy framework agreed at the 1992 United Nations Conference on Environment and Development held in Rio de Janeiro.

2002

Meeting the Challenges of Sustainable Development: prepared for the World Summit on Sustainable Development; it gave a picture of the constraints, challenges, opportunities and achievements since the 1992 Rio Conference.

2005

Mauritius Staking Out the Future: Partnership for Sustainable Development: prepared for the 2005 United Nations Conference on Small Island Developing States; it gave an overview of the actions taken to implement the 1994 Barbados Plan of Action, challenges in each sector, progress made and the way ahead.

2010

Mauritius Strategy for Implementation National Assessment Report: A five-year review of the progress and challenges in the implementation of policies in the 18 thematic areas in the Mauritius Strategy. This report was prepared as part of an ongoing United Nations process.

This report has been prepared by the Ministry of Environment and Sustainable Development and various stakeholders with support from the United Nations Environment Programme (UNEP) and the Indian Ocean Commission. Thus, MEO is the result of an integrated process of participatory assessment exploring the opportunities for achieving sustainable development, reducing vulnerability and making best use of environmental resources to improve human wellbeing.

This assessment builds on an evolution of environmental reporting through a range of previous reports, which have contributed to alert policy makers, community leaders and the public at large on the importance of environmental protection.

MEO Process and Methodology

The MEO process has involved gathering of information from participating bodies across the public sector, parastatal bodies and NGOs. The choice of chapters was made after consultation with various stakeholders in the light of priorities in Mauritius and the Outer Islands. The report has been developed in accordance with UNEP's methodology of Integrated Environmental Assessment and Reporting based on the 'Drivers-Pressures-State-Impacts-Response' (DPSIR) Framework, as shown in Figure 1 and to some extent on the Opportunities Framework through the following key questions:



A template for chapters has been broadly followed covering for each theme the challenges, progress and prospects. Each chapter includes a Best Case Scenario of the prospects for 2030 assuming optimum development and implementation of policies and strategies. In two chapters, namely: 'Freshwater' and 'Climate change', three contrasting scenarios: the Worst Case Scenario, Business as Usual Scenario and Best Case Scenario have been developed depicting the prospects for 2030. In these two chapters, the Worst Case Scenario describes a situation where control in Mauritius is relaxed, adverse trends continue, policies are neglected and programmes fail to be well developed or implemented.

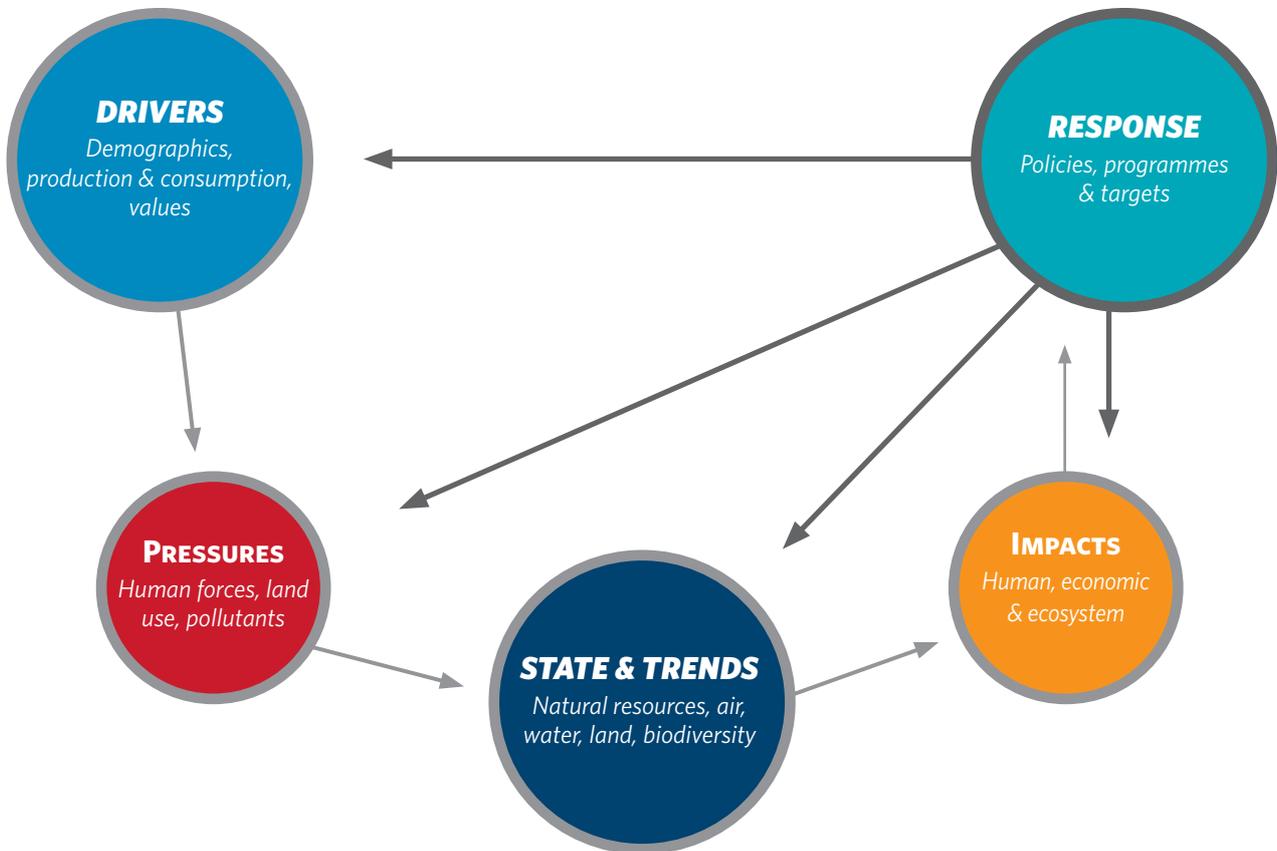
The Business as Usual Scenario shows that some progress is made with the implementation of current policies but the country fails to respond to new drivers, changing pressures and adverse trends through lack of active leadership and integrated policy development and evidence based action.

The scenarios were mainly qualitative as it was not possible to develop quantitative scenarios for various reasons including unavailability of modelling tools, unavailability of historical data and capacity constraints. However, efforts have been made to widen the data covered in this report and to include the most recent updates, though authors were faced with a critical lack of data in some sectors.

The Best Case Scenario

- ▶ *The Best Case Scenario in each chapter depicts a situation where Mauritius has developed and successfully put in place policies and actions to achieve sustainable development.*
- ▶ *It highlights the present and future requirements in terms of institutional structure, legislative strengthening, capacity building, policies and actions to achieve environmental sustainability that will eventually contribute to the sustainable development of the country.*

Figure 1: The DPSIR framework (Adapted from UNEP (2002) AEO, Earthscan for UNEP)



MEO Scope and Content

MEO is a frank assessment of the environment and underlines the importance of the perspective of environment for development. It analyses past environmental trends, assesses the present state and looks into the future to 2030. It highlights where good practices have been established and where policies are not working well, where adverse trends are overwhelming natural resources and where damaging practices remain a continuing threat to the natural resources and wealth of the country.

The report provides a series of actions for making progress towards a sustainable future and uses scenarios to highlight how policy makers can enhance the contribution of the environment to the country's wealth and prospects.

The analysis on which the report is based gives rise to a series of underlying questions about the environment. These are being addressed and need to be resolved as an integral part in the pursuit of sustainable development.

KEY QUESTIONS ARISING FROM MEO

- ▶ *How is the environment important for social and economic development and how can we make better use of the value of our environmental resources?*
- ▶ *How is the environment changing and what threats and opportunities does that pose for progress?*
- ▶ *What can be done to reduce the operation of adverse drivers and pressures on natural resources and enhance the potential of the environment by improving prevention, adaptation and rehabilitation?*
- ▶ *What special hotspots need immediate attention to halt disasters or irremediable damage?*
- ▶ *How will fresh policies and better implementation enhance opportunities and promote better results and what resources are required?*
- ▶ *What must be done now and in the next twenty years to ensure that by 2030 social and economic development is secured and environmental quality enhanced?*

MEO brings into sharp focus environmental themes that have become increasingly important and critical for a sustainable future. It sets out opportunities for action to improve social and economic welfare of people and the enhanced use and care of the rich but fragile natural environment of Mauritius.

Geographically, the report covers mainland Mauritius, together with the Outer Islands Rodrigues, Agalega and St. Brandon, thus leading to the development of the 14 chapters as follows:

- **Chapter 1: Drivers of environmental change**
- **Chapter 2: Air**
- **Chapter 3: Freshwater**
- **Chapter 4: Land**
- **Chapter 5: Solid waste management**
- **Chapter 6: Coastal and marine resources**
- **Chapter 7: Inland biodiversity**
- **Chapter 8: Energy**
- **Chapter 9: Climate change**
- **Chapter 10: Offshore islets**
- **Chapter 11: Tourism and environment**
- **Chapter 12: Chemicals and hazardous waste**
- **Chapter 13: Rodrigues**
- **Chapter 14: Agalega and St. Brandon**

The chapters conclude with outlines of programmes and their expected results by 2030 and also highlight the need for fresh policies and programmes.

The Summary for Decision Makers, which is separate from this main report, summarises the salient environmental issues brought out in the chapters and highlights the policy options to support decision-making in the context of sustainable development.

Importance of MEO

The report will serve as a monitoring and evaluation tool for the implementation of policies, programmes, strategies and activities contained in the National Environment Policy, National Environmental Strategies, the targets of the Millennium Development Goals, the Mauritius Strategy, the forthcoming 'Maurice Ile Durable' Policy and Strategy and any other future policies and strategies.

The report aims at providing access to information on environmental conditions to different user groups including the public, Government, industry, academics, community groups and Non-Governmental Organisations. Unrestricted access to information will undoubtedly improve understanding of the environment, inculcate in people environmental and ethical awareness, values and attitudes that will ultimately cultivate a sense of personal environmental responsibility and greater motivation and commitment towards sustainable development.

MEO is not only a tool for environmental education and awareness but is also an instrument for decision-makers for effective environmental management.

At regional and global levels, the report provides a further contribution to the United Nations Environment Programme processes for mapping the environment outlook through the development of the forthcoming Africa Environment Outlook 3 and Global Environment Outlook 5.

Drivers of Environmental Change and Policy Responses

Environment is one of the essential aspects of sustainable development together with economy and society. Similarly, natural resources are the foundation of the country's future but have been often ignored or undervalued in the drive for social and economic development and these have put pressures on the environment. The linkages between economy, environment and society are intricate and diverse. Our decisions, policies and actions influence the environment we live in and yet human wellbeing depends on the quality and capacity of environmental services such as clean water, land, fresh air and biodiversity.

● 1.1 ENVIRONMENTAL CHANGE & SOCIO-ECONOMIC FACTORS

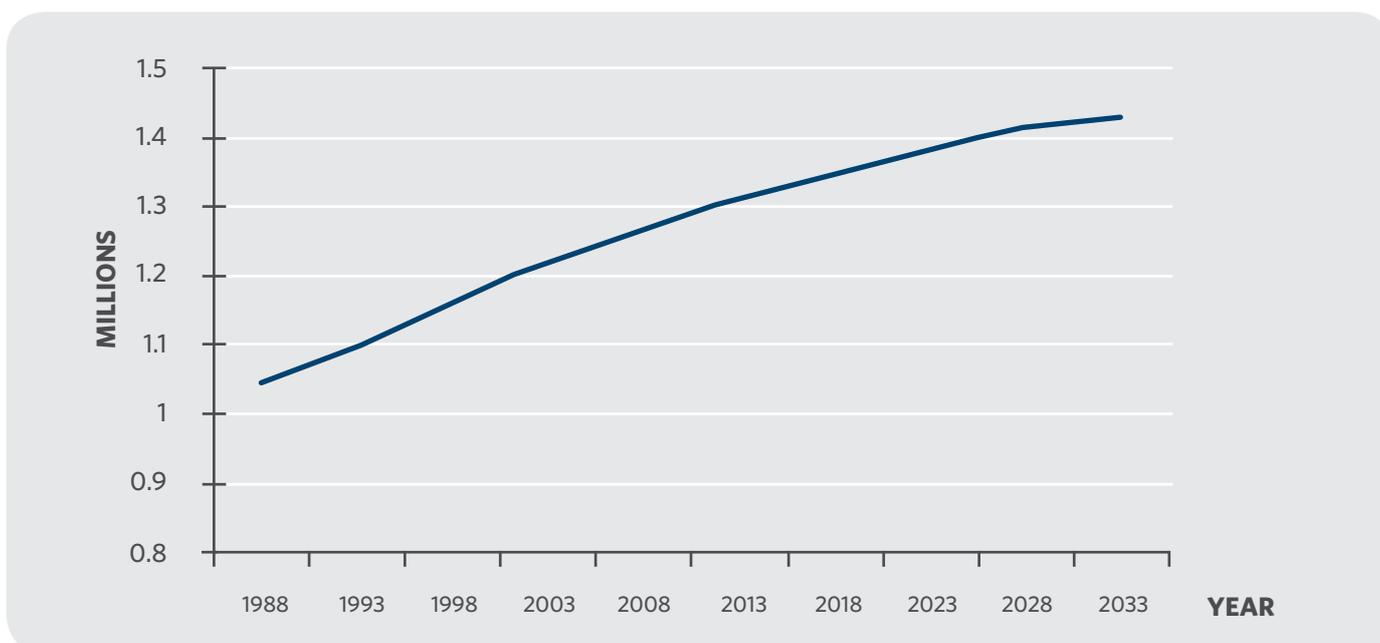
◎ 1.1.1 Population Growth

The drivers of environmental change are many and complex. Population growth is one of the principal factors affecting the environment and the economy. The population for the Republic of Mauritius in 1988 was about one million and grew steadily to about 1.3 million by 2010. The Central Statistics Office projects that the population will reach around 1.4 million by 2033, as shown in Figure 1.1.

Rising population puts pressure on space for housing and food production, creates demand for more energy and potable water. Social development and higher living standards bring increasing road traffic, congestion, more and larger homes and higher domestic consumption. Economic development in its various sectors creates pressure on natural resources. Likewise, agricultural development can trigger heavier use of chemicals entailing higher risks of water and air pollution.

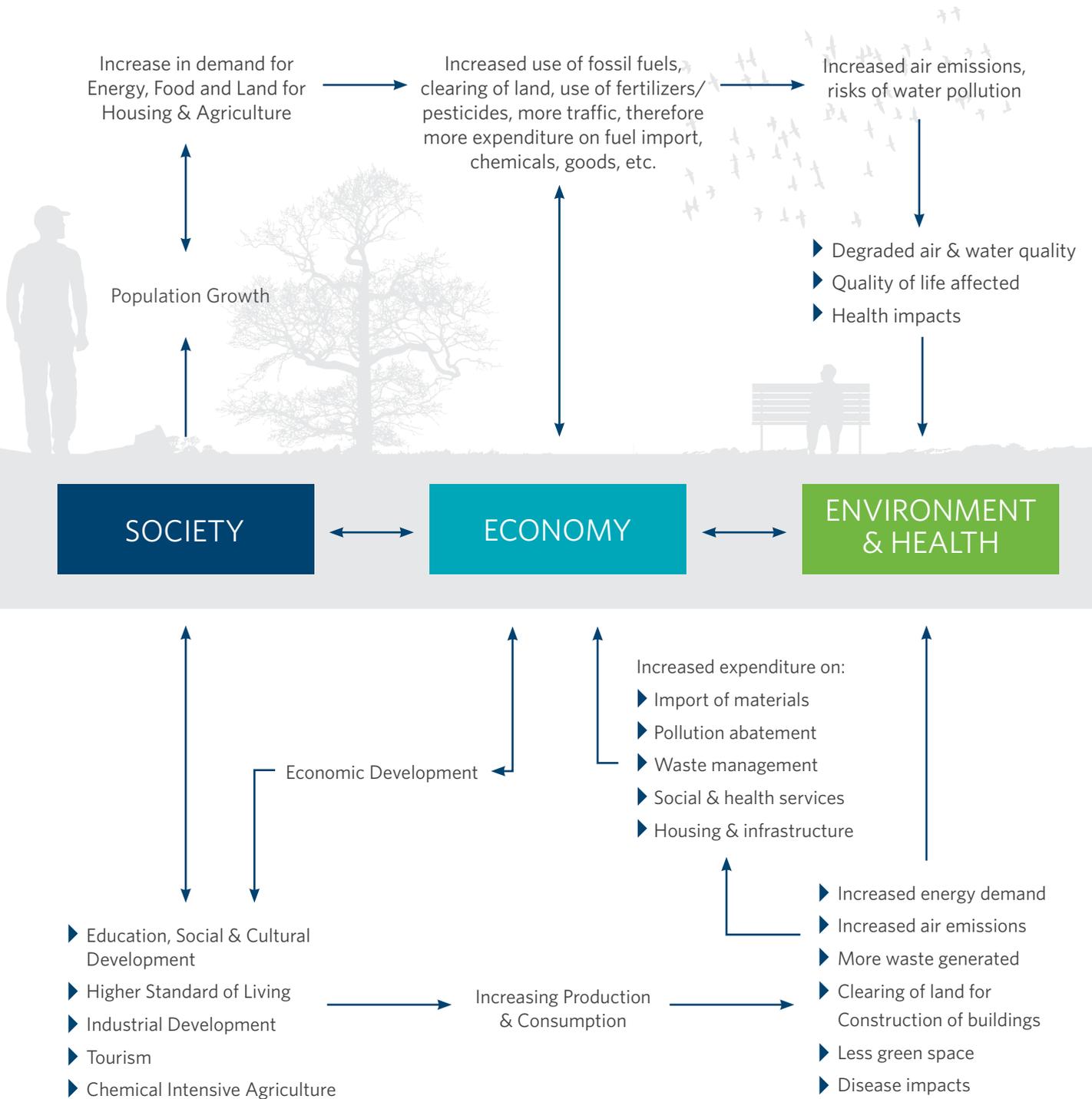
Industrial development takes space, increases traffic and generates waste giving rise to air and water pollution. Tourism development puts pressure on the sensitive ecology of littoral land, beaches and lagoons. On a wider scale, the burning of fossil fuels adds to the emissions of greenhouse gases, which contribute to air pollution and long-term global climate change. A diagrammatic representation of the inter-linkages between society, economy and the environment is shown in Figure 1.2.

Figure 1.1: Population growth (1988-2009) & projected growth (2011 - 2033) for the Republic of Mauritius



Source: CSO - Digest of Demographic Statistics, 2009

Figure 1.2: The three elements of development and their interaction



1.1.2 Economic Development

The economy has progressed significantly over the past decades. Indeed, Mauritius has gone up the scale from a least developed country to a developing country status with a Gross Domestic Product (GDP) per capita around US\$6,700. This has been possible due to sustained increase in the national income led mainly by tourism, financial services, construction and manufacturing sectors. From 1999 to 2009, GDP in real terms grew on average by 4.7% per annum. However, growth rate for 2009 was 3.1% lower than the 5.1% growth registered in 2008, largely due to the global economic crisis. The economy expanded by around 4.1% in 2010, with positive growth in all sectors. This is expected to go up slightly to 4.2% in 2011.

The ongoing economic reform programme in Mauritius aims at putting the economy on a higher growth trajectory by moving from a model based on trade preferences to that based on global competitiveness and a wider range of employment opportunities. With the same vision, Government also embarked on a four plank reform programme, namely: fiscal consolidation, improving public sector efficiency, trade competitiveness and investment opportunities as well as democratising¹ the economy. With further diversification of the economic base, new regional and international service sectors are emerging. These include the Information and Communication Technology (ICT), Business Process Outsourcing (BPO) and seafood sectors, real estate, energy industries as well as health and education hubs. The ICT/BPO sector has been growing at around 14.2 % on average annually over the past three years. It is now contributing more than 6% to GDP compared to less than 1% in 2005. The share of the services sector in the economy was nearly 67% in 2008 and grew to 69% in 2009.

Investment rate rose from about 21% in 2005 to about 26% in 2009, while Foreign Direct Investment rose from around Rs. 2.8 billion in 2005 to more than Rs. 11 billion in 2008. In spite of the global economic crisis, Foreign Direct Investment remained close to Rs. 9 billion in 2009. Private sector investment increased mostly in such areas as tourism, the Integrated Resort Scheme (IRS) and finance. Moreover, the Jin Fei project² is one of the largest Foreign Direct Investment in the history of Mauritius with an investment of Rs. 25 billion over eight years, starting 2009. In 2011, the target will be to position Mauritius as the preferred gateway for investment into Africa, particularly from India and China.

Focus is now being increasingly put on sustainable development with the introduction of the 'Maurice Ile Durable' concept, which integrates environmental, economic and social concerns across different sectors. Locally, environmental concerns are being mainstreamed in policy development and expenditure programmes.

The effectiveness of reforms and the robustness of the financial system have helped to build the resilience of the economy against the energy crisis and economic and financial crisis. The Public Sector Investment Programme outlines key projects, programmes under implementation or in the pipeline in the various sectors of the economy. The major forthcoming areas of development in Mauritius are shown in Table 1.1.

¹ Democratisation is being undertaken through reform on income tax to remove burden from lower income group by promoting increased employability through the Empowerment Programme, promotion of the Small and Medium Enterprise sector and poverty alleviation schemes.

² The Mauritius Jinfei Economic and Trade Cooperation Zone project is being developed on 211 ha of land at Riche Terre. The economic zone comprises the following components: manufacturing & processing, logistics & trade, information & business and hospitality. The project will be developed in two phases over an eight-year period. Opportunities exist for investors both from China and other countries to set up their projects in the Jinfei Zone, which can provide industrial/commercial/office space or serviced land. Investment can be in the different areas mentioned above and include activities such as: high-tech manufacturing, engineering, ICT operations, data centre operations, business continuity planning, disaster recovery operations, offshore and financial services, education (from pre-primary to tertiary levels), private health services, clinical research operations, logistics services, commercial activities for high-end shopping, regional headquarters operations, seafood and food processing amongst others.

Table 1.1: Development in the key economic sectors of Mauritius

Tourism	<ul style="list-style-type: none"> • Declared policy of attaining 2 million tourists by 2015 • Branding of Mauritius to attract more tourists • Implementation of the duty-free paradise vision by 2015
Infrastructure	<ul style="list-style-type: none"> • Extension, improvement and creation of new road networks • Modernisation and expansion of the port and airport • Deepening of sea bed in the port to meet growing traffic and attract larger vessels • Expansion of container terminal berth by 2012 • Opening of a cruise terminal to encourage cruise ships to stop in Port Louis • Construction of more hotels and IRS / RES (Real Estate Schemes) • Extension of wastewater services • Initiation of new housing schemes
Health	<ul style="list-style-type: none"> • Vision of health hub (a centre of activity for health services) • Setting up of new health care facilities
Industrial Development	<ul style="list-style-type: none"> • Setting up more industrial areas • Inventory of vacant industrial space • Boosting up of the Small and Medium Enterprise sector
Energy	<ul style="list-style-type: none"> • Increasing energy supply capacity: capacity of the Fort Victoria generation plant will be raised by 30 MW • Construction of 2 hydro power plants • Setting up of wind parks • Promotion of solar energy
Agro Industry	<ul style="list-style-type: none"> • Increasing animal production and reproduction farms • Accelerating the food security project • Increasing milk production capacity to 10 million litres of milk per year as from 2010 and 12 million litres by 2011 • Attaining self-sufficiency in various food crops • Diversification of cane cultivation from sugar production to alcohol production and other value-added products • Promotion of cross-border investment initiatives (local entrepreneurs are investing in Madagascar and Mozambique)
Land Based Oceanic Industry	<ul style="list-style-type: none"> • Setting up of the first Land Based Oceanic Park over 56 hectares at Flic en Flac. The park will include use of sea water for cooling, aquaculture, desalination and bottling & exploitation of pharmaceutical products amongst others.
Fisheries	<ul style="list-style-type: none"> • Further development of the sea food hub • Promoting aquaculture • Encouraging off-lagoon fishing
Increasing Productivity	<ul style="list-style-type: none"> • Enhancing land productivity for employment and wealth creation • Promoting use of marine resources for economic activities • Improving the environment for doing business

1.1.3 Production and Consumption Patterns

Gross Domestic Product (GDP), which measures the total value of production, increased in nominal terms by about 145%, from about Rs. 108 million in 1999 to Rs. 274 million in 2009. The share of agriculture in GDP fell from 6.1% in 1999 to 4.3% in 2009; that of manufacturing decreased from 23.9% to 19.5%, while that of financial and business services increased from 8.4% to 11.7%. With an annual growth of 0.5% in the population and 4.6% in GDP at market prices, GDP per capita³ grew by 9.8% per annum during the period 1990 to 2009.

Annual energy consumption per capita has increased from 0.55 toe⁴ in 1990 to 0.63 toe in 2009. From 1990, the transport sector has remained the largest consumer of energy followed by the manufacturing sector. In 2009, the transport and manufacturing sectors accounted for 48% and 28% of the total energy consumption respectively. Household consumption accounted for 14% of total energy consumption and the commercial sector 9%.

Over the years, electricity generation has remained the principal source of carbon dioxide (CO₂) emissions in the atmosphere. It contributed around 59.3% of the emissions, with 1,997 thousand tonnes CO₂ in 2009. It was followed by the transport sector, which contributed around 25.1% of the total emissions and manufacturing industries with 10.4%. Carbon dioxide emission resulting from fuel combustion went up from 1,737 thousand tonnes in 1995 to 3,365 thousand tonnes in 2009, a rise of 94% with an annual increase of about 5.5%.

During the period 1990 to 2009, domestic per capita consumption of water rose from 153 litres/day to 162 litres/day. From 2005 to 2006, there has been a slight decrease in Domestic Material Consumption⁵ from 11.5 to 11.3. A positive trend towards decoupling⁶ of economic growth from the use of resources was therefore observed.

Industrialization, continuous economic growth and higher standard of living have led to a rapid increase in transport services over the recent years. The vehicular fleet has been growing at an average annual rate of around 5.97%. From 1990 to 2009, the total number of vehicles has gone up from 123,545 to 366,520 representing a rise of 196.7% with an annual increase of about 5.89%. Traffic congestion is a serious problem and the total cost to the economy of congestion is estimated to be around 1.3% of GDP (SCP Indicators, 2010). The density of vehicles has been considerably increasing and reached 177 vehicles per km of road in 2009 from 69 vehicles per km of road in 1990. This expansion in the number of vehicles has also been accompanied by a corresponding growth in energy consumption and carbon dioxide emission (SCP Indicators, 2010). The consumption and production trends in key sectors are shown in Figure 1.3.

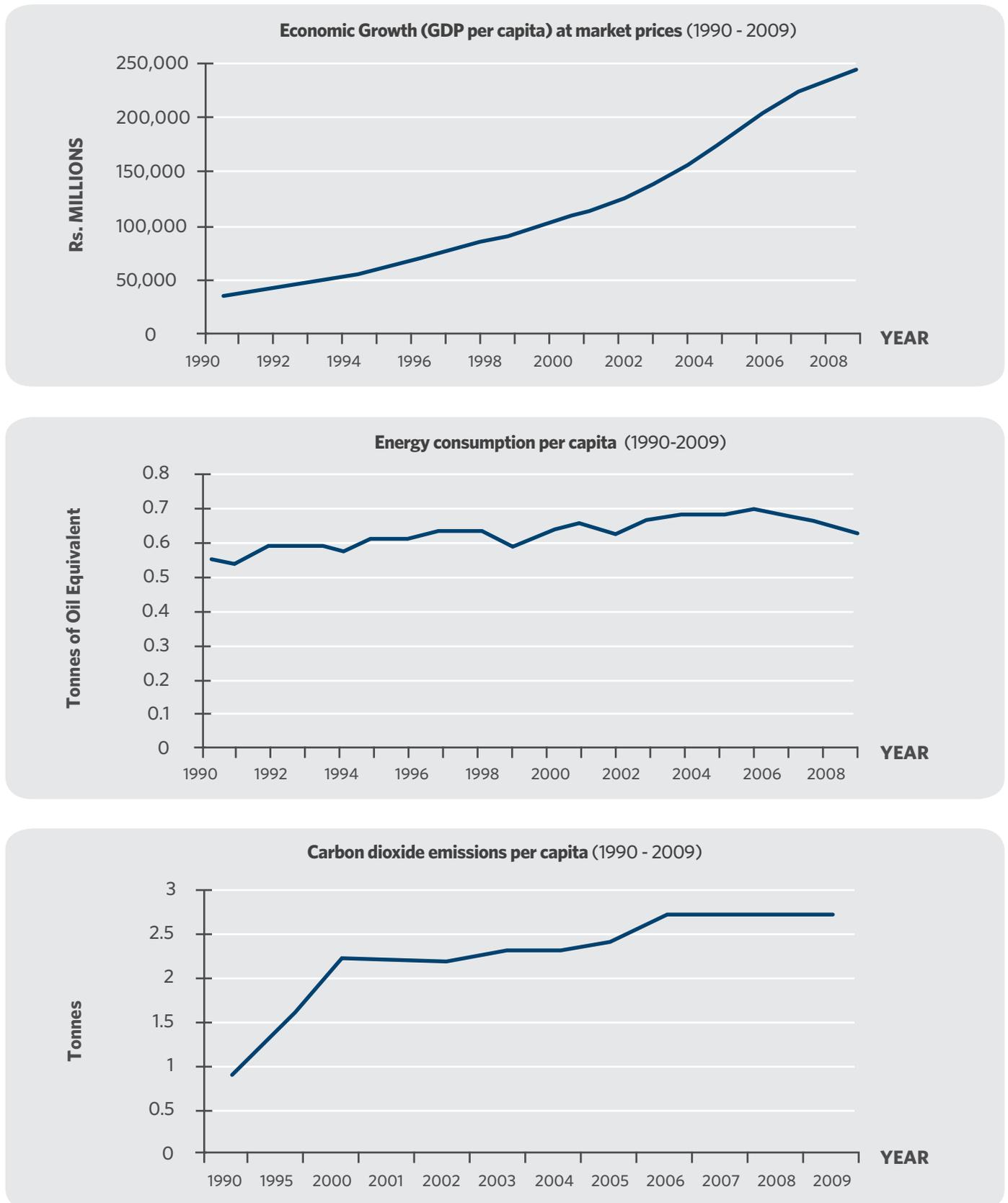
³ GDP per capita at market prices is used as an indicator of the standard of living of the population.

⁴ Tonne of oil equivalent.

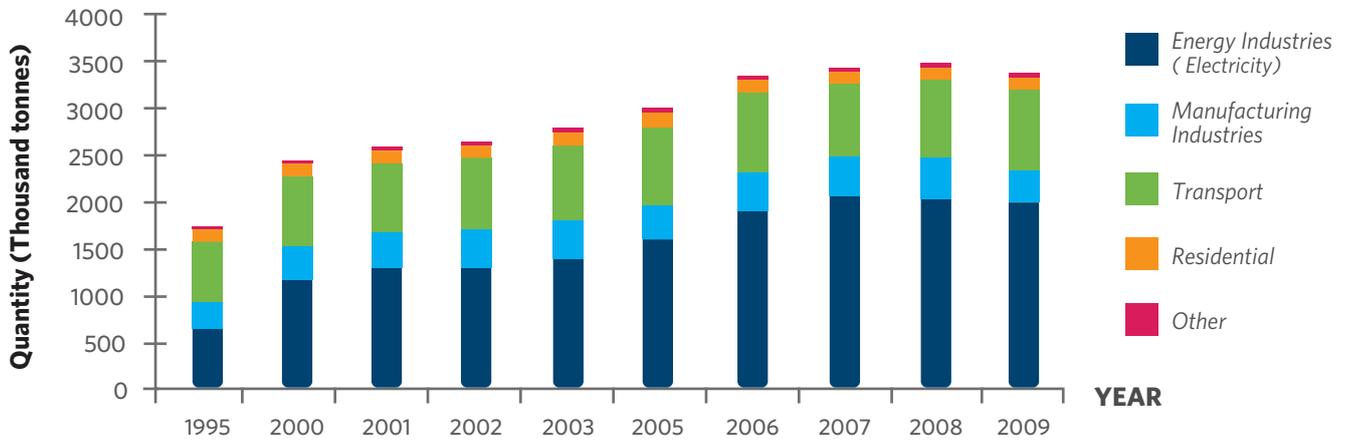
⁵ Domestic Material Consumption accounts for all materials directly consumed by the economy in a country and is defined as all materials entering directly the national economy (domestic extraction plus imports), less the materials that are exported.

⁶ Decoupling refers to the ability of an economy to grow without putting additional pressures on the environment.

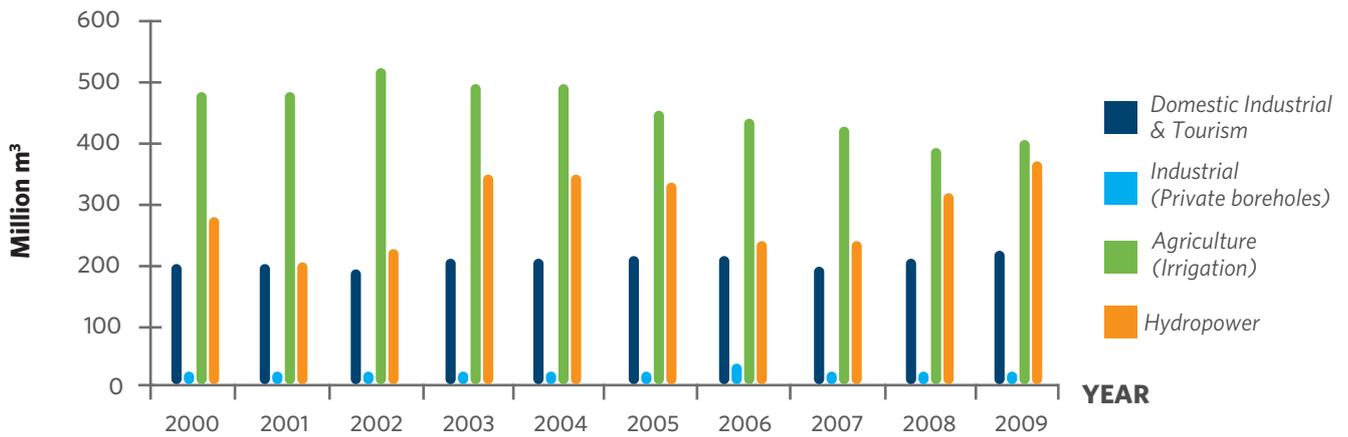
Figure 1.3: Production and consumption trends in Mauritius



Carbon dioxide emissions from fossil fuel by sector (2000 - 2009)



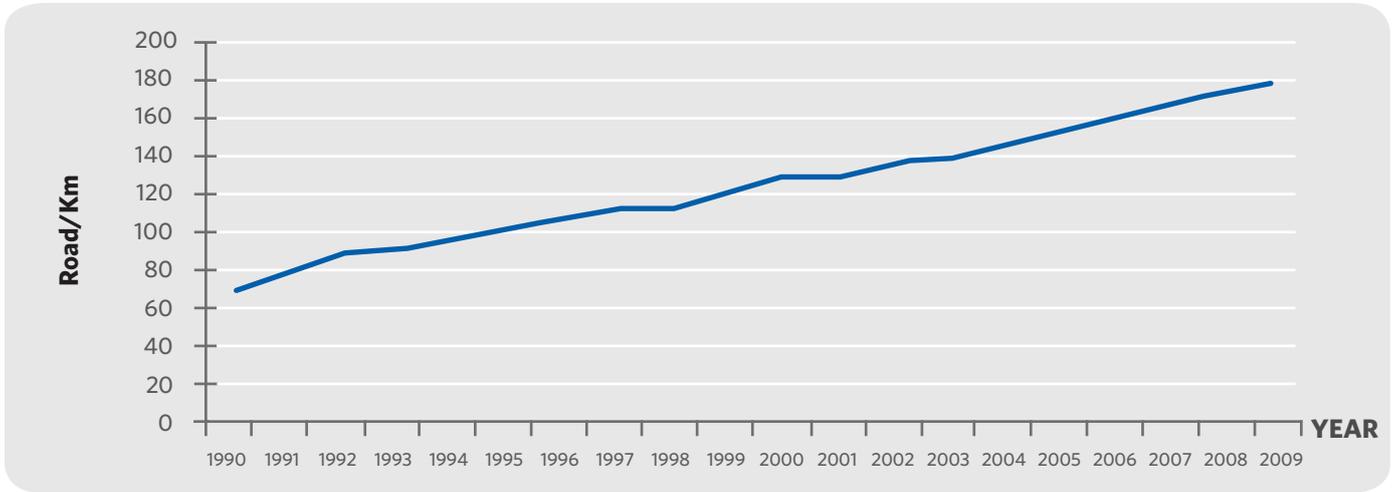
Water utilisation by sector (2000-2009)



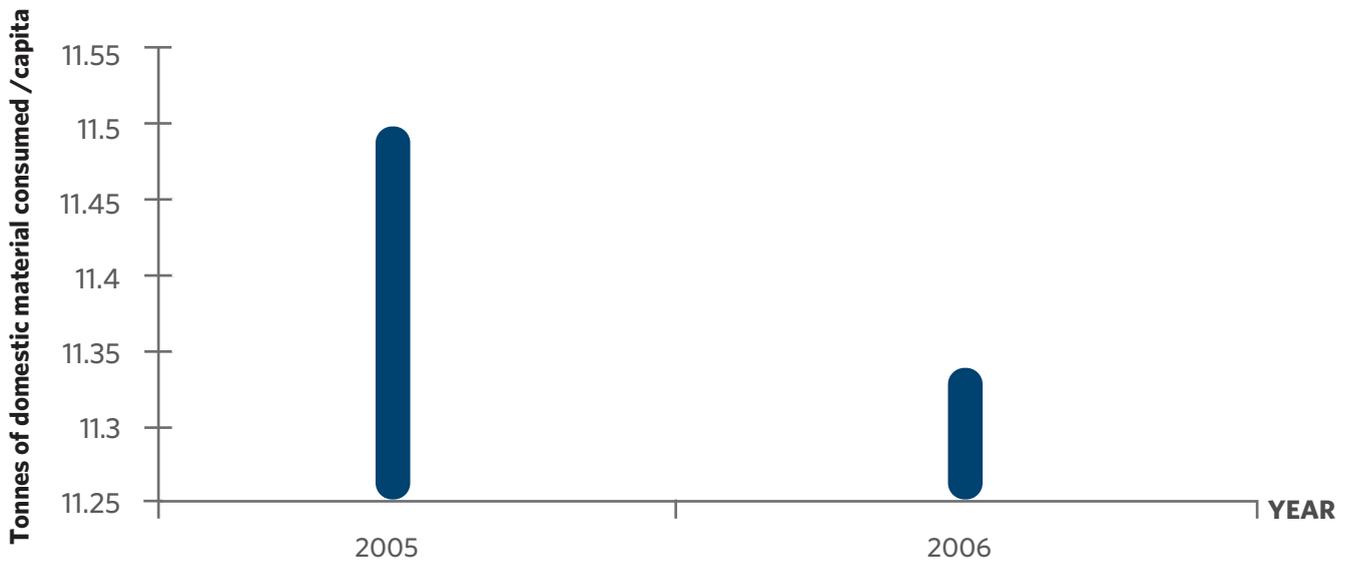
Domestic per capita water consumption (1990 - 2009)



Number of vehicles per kilometer of road (1990 - 2009)



Domestic material consumption per capita



Source: SCP Indicators, 2010 and Central Statistics Office

● 1.2 IMPLICATIONS OF THE ENVIRONMENT

Economic growth as well as changing patterns of production, consumption and service delivery put pressure on the environment. Indeed, more resources will be required to sustain both a growing population and to achieve the great strides in economic growth. Concurrently, more funds will have to be allocated to meet the demands

of the Mauritian population in terms of health services, education, energy, food, sanitation and transport. While this will contribute to a dynamic economy, undue additional pressures on the environment will also arise.

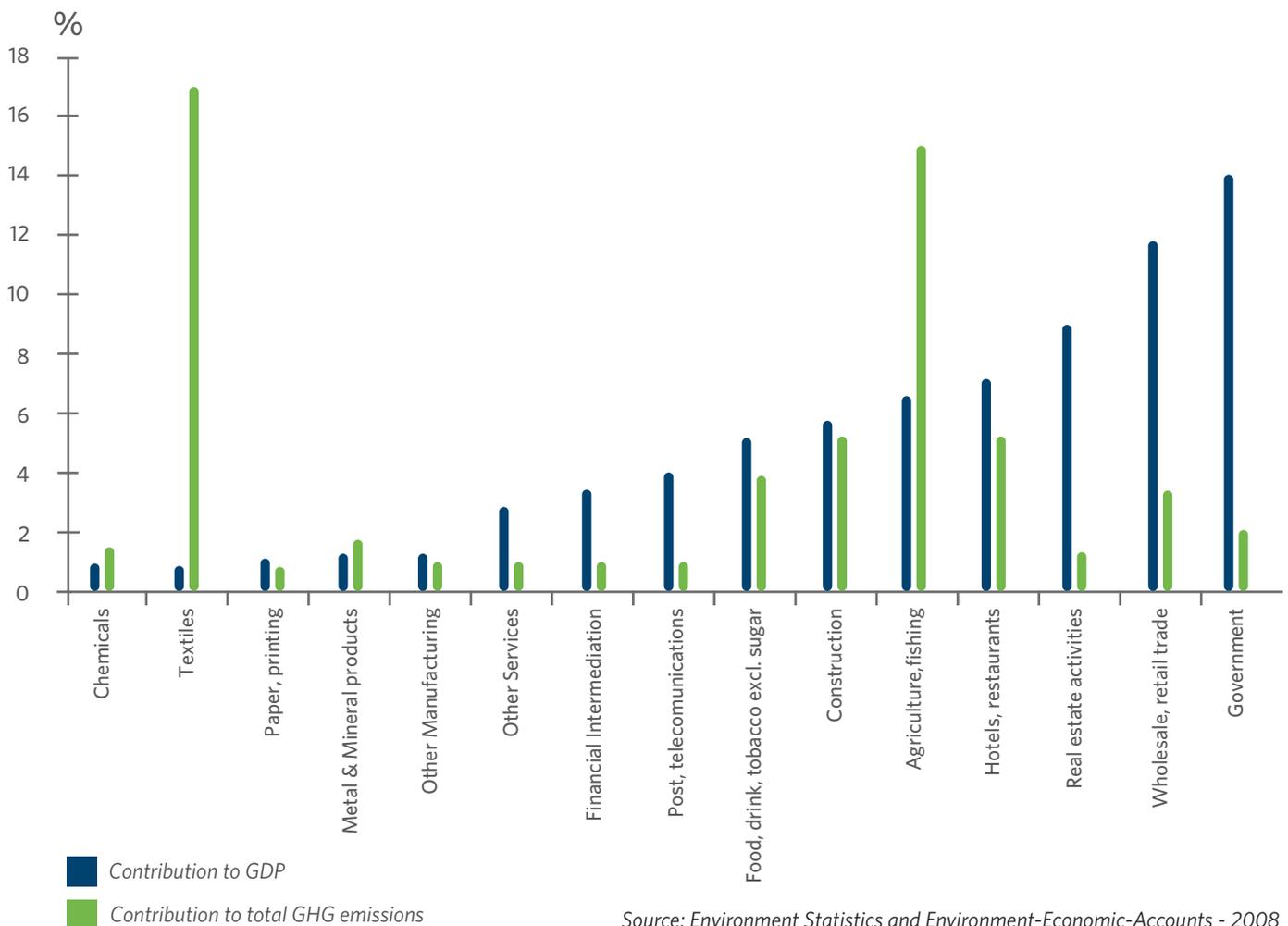
Furthermore, while some aspects of economic development and employment, such as Information and Communication Technologies and financial services, have lighter impacts on natural resources compared to manufacturing activities, their resulting impacts on income, consumption and transport contribute to put pressures on the environment. Population growth as well as social and economic development in Mauritius are all leading to an increase in the demand for land including in the coastal belt. Rising population implies more imports in food and increases in local production. However, to respond to the exigencies of consumers and maximise economic returns, agrochemicals are increasingly used in local food production.

Economic development entails tourism, industrial and agricultural expansion, infrastructural improvement and

emergence of new growth engines, which are all heavy consumers of water and energy as well as generators of waste. The increasing demand in energy results in the use of more fossil fuels for energy production, thereby releasing noxious gases into the atmosphere. Rapid technological improvement is leading to an increasing amount of electronic waste, which contain hazardous substances. Industrial development gives rise to environmental pressures through the release of harmful gases including greenhouse gases (GHG) and wastewater.

Figure 1.4 shows the sectoral emission of GHG in comparison with the contribution of the sector in GDP in 2002. The heavy emission of carbon dioxide from sectors like agriculture and fisheries can be noted, though these sectors have a low contribution to GDP.

Figure 1.4: Sectoral GHG emission as compared to contribution to GDP (2002)



Source: Environment Statistics and Environment-Economic-Accounts - 2008

The major development sectors in Mauritius, their expected social gains and possible environmental implications are outlined below:

ECONOMIC DEVELOPMENT	SOCIAL GAINS	ENVIRONMENTAL PRESSURES
<ul style="list-style-type: none"> ● RISE IN FOREIGN DIRECT INVESTMENT ● TOURISM DEVELOPMENT & RELATED INFRASTRUCTURES ● INFORMATION & COMMUNICATION TECHNOLOGY ● SEAFOOD SECTORS ● INTEGRATED RESORT SCHEME / REAL ESTATE SCHEME ● POWER PLANTS ● 360 KM OF NEW ROADS ● AGRICULTURAL DEVELOPMENT TO ADDRESS FOOD SECURITY ● AIRPORT CONSTRUCTION ● SEA PORT DEVELOPMENT INCLUDING DREDGING ● REFORM OF SUGAR CANE SECTOR ● LAND BASED OCEANIC PARK 	<ul style="list-style-type: none"> ● IMPROVED STANDARD OF LIVING ● CREATION OF JOBS ● INCREASED FOOD PRODUCTION ● BETTER ROAD NETWORK ● IMPROVEMENT IN CARGO HANDLING AND SEA TRANSPORT ● LAND BASED OCEANIC PARK WILL PROVIDE: ENERGY FOR AIR-CONDITIONING, DESALINATED MINERAL WATER, PHARMACEUTICALS FROM SEAWEEDS & OTHER TOURISM-RELATED FACILITIES 	<ul style="list-style-type: none"> ● INCREASED RISK OF WATER POLLUTION FROM USE OF AGROCHEMICALS ● NEW WASTE STREAMS & INCREASED WASTE AMOUNTS ● MORE EMISSION OF POLLUTANTS IN THE ATMOSPHERE ● INCREASED PRESSURE ON THE COASTAL ZONE ● INCREASE IN DEMAND FOR NATURAL RESOURCES: WATER AND LAND ESPECIALLY IN THE COASTAL REGIONS ● ENVIRONMENTAL PRESSURES FROM LAND BASED OCEANIC PARK (<i>RELEASE OF BRINE IN THE OCEAN FROM DESALINATION, DISTURBANCE OF MARINE ECOSYSTEMS DURING PIPE INSTALLATION AND SEAWEED HARVEST</i>)

● 1.3 THE NEED FOR SUSTAINABLE DEVELOPMENT AND GOVERNANCE

Economic development, social prosperity and human wellbeing all depend on a healthy environment. For economic development to take place, the country depends on natural resources. Land is required for construction of industries and hotels. Water is used for industrial processes, electricity production and agriculture. Healthy and aesthetically pleasing coastal ecosystems are the basis for tourism expansion and abundant biodiversity is essential for fisheries development. Rocks are needed for infrastructural development and the construction industry.

Social prosperity is closely linked to human wellbeing and good health, which in turn depend on the availability of basic needs like fresh air, clean water, nutritious food, clothing, shelter, energy, transport, communication and education. For national development to be meaningful and beneficial, there is a need to reconcile economic needs with environmental sustainability and human wellbeing.

Government has always shown strong commitment to develop policies and adopt programmes aimed towards sustainable development.

◎ 1.3.1 Maurice Ile Durable

In 2008, Maurice Ile Durable (MID) was announced as the new long term vision for achieving sustainable development and its main thrust was to make the Republic of Mauritius a world model of sustainable development, particularly for Small Island Developing States. The Maurice Ile Durable Fund was set up as a specialised fund to finance sustainable development projects. A national consultation process was launched in February 2010 to seek the views of the different sectors of society on the issue of MID. This consultation is the beginning of a policy process for shaping a national vision of a sustainable Mauritius. The next steps will include the development of a MID policy and strategy accompanied by the legislative and institutional changes to implement this vision.

1.3.2 The Millennium Development Goals

Progress with the Millennium Development Goals (MDGs) is one indication of our achievement towards sustainability as they encompass many social, economic and environmental considerations. Mauritius is doing well in various areas of the MDGs like poverty alleviation, universal primary education, some aspects of gender equality. It has eradicated malaria, is combating HIV/AIDS and also the prevalent problems of non-communicable diseases such as diabetes, heart and lung diseases and mental illness.

It has a largely comprehensive system of access to safe drinking water and basic sanitation, but the country still needs to progress on reversing trends on emissions and loss of threatened animal and plant species. Moreover, there is a lack of essential data in key areas for making assessments and to adapt the international MDG system of indicators to the more specific requirements for small island states. A detailed status of achievements on MDG Goal 7: "Ensure Environmental Sustainability" is shown in Table 1.2:

Table 1.2: Status of MDG achievements in the environment sector

MDG TARGETS & INDICATORS	1990	LATEST DATA	TARGET	STATUS
Target 7A - Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources				
Proportion of land area covered by forest ⁷ (%)	19.2	25.3 (2008)	≥ 19.2	On track ■
Carbon dioxide emissions (CO ₂), thousand metric tonnes of CO ₂	1,463	3,264 (2008)	≤ 1,463	Off track ■
Carbon dioxide emissions (CO ₂), metric tonnes of CO ₂ per capita	1.4	2.7 (2008)	≤ 1.4	Off track ■
Carbon dioxide emissions (CO ₂), kg CO ₂ per \$1 GDP (Power-Purchase-Parity)	0.24	0.3 (2007)	≤ 0.24	Off track ■
Energy Use (kg oil equivalent) per \$ 1000 GDP	-	-	-	Missing data
Consumption of all Ozone Depleting Substances	Missing Data	8.6 (2007)	-	Missing data ⁸
Proportion of total water resources used, percentage	20.6	26.4 (2005)	≤ 20.6	Off track ■
Target 7B - Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss				
Terrestrial and marine areas protected to total territorial area, percentage	0.5	0.8 (2008)	≥ 0.5	Achieved ■
Terrestrial and marine areas protected, sq. km.	96	165 (2008)	≥ 96	Achieved ■
Terrestrial areas protected to total surface area, percentage	0.2	0.6 (2008)	≥ 0.2	Achieved ■
Terrestrial areas protected, sq. km.	45	113 (2008)	≥ 45	Achieved ■
Marine areas protected to territorial waters, percentage	0.3	0.3 (2008)	≥ 0.3	Achieved ■
Marine areas protected, sq. km.	50	52 (2008)	≥ 50	Achieved ■
Proportion of species threatened with extinction	-	-	-	Missing data

⁷ Forest cover includes National Parks, Islets National Parks, Nature Reserves on mainland and islets, plantations, grazing land on *pas géométriques*, scrubs, mountain and river reserves.

⁸ Chlorofluorocarbons have been phased out in 2005, five years ahead of the Montreal Protocol.

MDG TARGETS & INDICATORS	1990	LATEST DATA	TARGET	STATUS
Target 7C - Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation				
Proportion of population using an improved drinking water source, total, percentage	100	100 (2009)	100	Achieved ■
Proportion of population using an improved sanitation facility, total, percentage	94	94 (2006)	≥ 97	On track ■
Proportion of population using an improved sanitation facility, urban, percentage	95	95 (2006)	≥ 97.5	On track ■
Proportion of population using an improved sanitation facility, rural, percentage	94	94 (2006)	≥ 97	On track ■
Target 7D - By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers				
Slum Population as percentage of urban, percentage	-	-	-	N/A ■
Slum population in urban areas	-	-	-	N/A ■

Source: MDGs Addendum Report, 2010 and the official United Nations site for the MDG indicators (<http://mdgs.un.org/unsd/mdg/Data.aspx>)

1.3.3 Environmental Performance Index

Mauritius ranked 6th out of 163 countries (first in Africa) in the 2010 Environment Performance Index prepared by the Yale University and Columbia University, in collaboration with the World Economic Forum and the Joint Research Centre of the European Commission. Mauritius⁹ has scored a total of 80.6 out of 100 and is placed 6th after Iceland, Switzerland, Costa Rica, Sweden and Norway. In 2008, Mauritius ranked 59th.

The Environmental Performance Index focuses on two broad environmental protection objectives, namely: reducing environmental stresses on human health and protecting ecosystem vitality. It evaluates the performance of countries on 25 indicators tracked across ten policy categories¹⁰. The overall Environmental Performance Index rankings provide an indicative sense of which countries are doing best against the array of environmental pressures that every nation faces.

⁹ The profile and scores of Mauritius can be accessed at <http://epi.yale.edu/Countries/Mauritius>

¹⁰ The 10 policy categories are: environmental burden of disease, air pollution (effects on humans), air pollution (effects on ecosystem), water (effects on humans), water (effects on ecosystem), biodiversity and habitat, forestry, fisheries, agriculture and climate change.

1.3.4 Environmental Governance

1.3.4.1 Institutional Setup

The Department of Environment (DOE), which was established in 1989 as an institutional response to emerging environmental challenges, maintains the primary responsibility of ensuring environmental protection, planning, monitoring, coordination, enforcement and awareness-raising. Owing to the multi-disciplinary nature of environmental management, the task of environmental protection is assigned to various other departments, the Enforcing Agencies, with respect to specific environmental media and pollutants. The Maurice Ile Durable policy, which is presently being developed, will further address the issue of institutional set up for sustainable development.

○ Policies and Strategies

The environment policy framework for Mauritius is anchored in the concept of sustainable development and incorporates the relevant recommendations of the major international conferences. The first National Environmental Policy was developed in 1991. In view of emerging environmental challenges, a new National Environment Policy was adopted in 2007, based on a series of guiding principles, which include among others: placing humans at the centre of environmental sustainability, mainstreaming environmental concerns in economic and social development, precautionary principle, polluter pays principle, maintenance of ecological integrity as well as environmental stewardship. The National Environment Policy outlines a series of thematic policy objectives and strategies to address environmental challenges.

The first National Environmental Strategies, its National Environment Action Plan and Environment Investment Programme were also developed in 1988. Priority areas for environmental protection and management included: physical planning, water resources management, biodiversity conservation and restoration, solid waste management and sanitation, amongst others. Most of the projects were successful. As the economy of Mauritius grew and was faced with continuing environmental challenges, a second National Environmental Strategies, National Environment Action Plan and Environment Investment Programme for the decade 2000-2010 were developed. The main projects identified under National Environmental Strategies 2 included: monitoring of water resources, setting up of a cleaner production centre, a framework for Integrated Coastal Zone Management, the demarcation of Environmentally Sensitive Areas, Industrial Management and an Environment Information System, among others.

The second National Environmental Strategies was updated in 2008 and aimed at carrying forward and extending the substantive achievements of the National Environment Action Plan 2, while recommending corrective measures to overcome the constraints experienced. New measures to

address emerging economic issues and new developments in the environmental field at local, regional and international levels were also proposed. The updated strategies for environmental management aim at maintaining high standards of environmental health and quality of life, conserving the natural and built heritage and promoting individual responsibility towards environment. Six priority projects, which have been identified for immediate implementation, are:

- Integrated Air Quality Management Project
- Mauritius Industrial Pollution Prevention Project
- Quality & Ecological Assessment of Fresh Water Bodies
- Facilitation of Sustainable Environmental Practice
- Reforming the Environmental Management Framework in Mauritius & Capacity Building of Environmental Agencies
- Environmental Education Awareness & Community Empowerment.

Sectoral policies have also been developed across various thematic areas such as land, biodiversity, forests, wastewater, solid waste, coastal zone management, tourism and energy among others.

○ Legislative Framework

The Environment Protection Act (EPA) was first enacted in 1991 as the main legislation for the protection and management of the environmental assets of Mauritius and to foster harmony between quality of life, environmental protection and sustainable development. This was reviewed in 2002 and again amended in 2008 in response to emerging challenges. The EPA also sets out comprehensive enforcement procedures and development control mechanisms, provides for the promulgation of regulations and standards for environmental protection across all media and provides for the setting up of several statutory committees to ensure effective coordination among Enforcing Agencies.

○ **Environmental Education and Awareness**

Environmental stewardship is an integral component of the EPA, which stipulates that each and every citizen of Mauritius must preserve and enhance the quality of life by caring responsibly for the natural environment. The Ministry of Environment and Sustainable Development conducts continuous sensitisation in addition to publishing a wide range of communication materials on environmental issues aimed at all target groups.

○ **Enforcement Mechanism**

The enforcement mechanism is based on a sectoral approach involving the Police de l'Environnement and a number of Enforcing Agencies, including Local Authorities under the overall coordination of the DOE. A Prosecution Division has also been set up under the DOE to ensure that environmental offences are prosecuted.

Besides attending to environmental complaints, compliance to the conditions of Environment Impact Assessment (EIA) licences and Preliminary Environmental Report (PER) approvals is also monitored. Industrial waste auditing has been introduced through the Environment Protection (Industrial Waste Audit) Regulations in 2008 to ensure that industries closely monitor and mitigate their environmental impacts. A diagrammatic presentation of the legislative and institutional set up as well as the enforcement mechanism is shown in Figures 1.5, 1.6 and 1.7.

It was noticed that enforcement and coordination for the protection and management of the environment were spread under different statutes. As a result, 41 enactments or part of enactments were declared as environmental laws under the Environment Protection (Declaration of Environmental Laws) Regulations that were promulgated in May 2005 and amended in 2009. Enforcing Agencies are now able to make use of the more stringent enforcement mechanisms provided under the EPA thus enabling a synergistic approach to enforcement. However, lack of human resources, technical capacity and overlapping responsibilities sometimes cause impediments in enforcement both at the level of the DOE and the Enforcing Agencies.

○ **Internationally Agreed Goals and Multilateral Environmental Agreements**

The overall coordination of all conventions and treaties signed by Mauritius rests with the Ministry of Foreign Affairs, Regional Integration and International Trade. The latter acts as focal point among the key players, namely: UN agencies, Mauritius embassies and implementing ministries. Mauritius has signed several environment-related conventions and protocols, as shown in Box 1.1, which are legally binding. Actions have been taken by different stakeholders namely ministries, Non-Governmental Organisations among others for the implementation of these conventions. However, as at to-date, progress is limited to a few active conventions. A Multilateral Environment Agreement (MEAs) Coordination Committee has been instituted under the Environment Protection Act, with a view to coordinate and measure progress towards implementation of environment-related conventions.

Box 1.1: LIST OF ENVIRONMENTAL CONVENTIONS AND PROTOCOLS SIGNED BY MAURITIUS**BIODIVERSITY-RELATED CONVENTIONS AND PROTOCOLS**

- 1 ~ African Convention for the Conservation of Nature and Natural Resources (*Algiers Convention 1968*)
- 2 ~ Convention in International Trade in Endangered Species of Wild Flora and Fauna (*CITES 1973*)
- 3 ~ Convention on Biological Diversity (*CBD 1992*)
- 4 ~ Bonn Convention on Migratory Species (*CMS*)
- 5 ~ United Nations Convention to Combat Desertification (*UNCCD 1994*)
- 6 ~ Cartagena Protocol on Biosafety
- 7 ~ International Plant Protection Convention (*1971*)
- 8 ~ Convention on Wetlands of International Importance especially as Waterfowl Habitat (*Ramsar 1971*)

MARINE-RELATED CONVENTIONS AND PROTOCOLS

- 9 ~ Convention on the High Seas (*1958*)
- 10 ~ International Convention on the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 (*MARPOL 73/78*)
- 11 ~ Convention on the Continental Shelf (*1958*)
- 12 ~ United Nations Convention on the Law of the Sea (*UNCLOS 1982*)
- 13 ~ Convention on the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region and related Protocols (*Nairobi Convention 1985*)
- 14 ~ Jakarta Mandate on Marine and Coastal Biological Diversity (*1995*)
- 15 ~ Convention for the Regulation of Whaling (*1996*)
- 16 ~ Convention on Fishing and Conservation of the Living Resources of the High Seas (*1958*)
- 17 ~ Convention on the Territorial Sea and Contiguous Zone (*1958*)
- 18 ~ International Convention on Civil Liability for Oil Pollution Damage (*CLC*) 1969 and Protocol of 1976 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969 (*CLC PROT 1976*)
- 19 ~ International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (*FUND*) 1971 and Protocol of 1976 amending the Convention on the Establishment of an international Fund for Compensation for Oil Pollution Damage, 1971 (*FUND PROT 1976*)
- 20 ~ Agreement on the Organisation for Indian Ocean Marine Affairs
- 21 ~ Agreement for the establishment of the Indian Ocean Tuna Commission adopted in 1983
- 22 ~ Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil thereof 1971

ATMOSPHERE-RELATED CONVENTIONS AND PROTOCOLS

- 23 ~ United Nations Framework Convention on Climate Change (*UNFCCC, 1992*)
- 24 ~ Kyoto Protocol (*1997*)
- 25 ~ Vienna Convention for the Protection of the Ozone Layer (*1985*) and Montreal Protocol on Substances that Deplete the Ozone Layer (*1987*)
- 26 ~ African Nuclear Weapons Free Zone Treaty (*Pelindaba treaty, 1996*)

CHEMICAL-RELATED CONVENTIONS AND PROTOCOLS

- 27 ~ Stockholm Convention on Persistent Organic Pollutants (POPs) 2001
- 28 ~ Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their disposal (1989) and Ban Amendment to the Basel Convention 2005
- 29 ~ Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- 30 ~ Bamako Convention on the ban of the import into Africa & the control of transboundary movement & management

Figure 1.5: Legislative framework for environmental management

PRIMARY ENVIRONMENTAL LEGISLATION	
Environment Protection Act 2002 (Amended in 2008)	
SUBSIDIARY ENVIRONMENTAL LEGISLATION	
Promulgated under the Environment Protection Act 2002 (Amended in 2008)	
<p>Environmental Standards</p> <ul style="list-style-type: none"> • Drinking Water Standards 1996 • Environment Standards for Noise 1997, amended in 2003 • Effluent Limitations for the Sugar Industry 1997 • Standards for Air 1998 • Standards for Hazardous Wastes 2001 • Standards for Effluent for use in Irrigation 2003 • Standards for Effluent Discharge 2003, amended in 2004 • Standards for Effluent Discharge into the Ocean 2003 	<p>Environmental Regulations</p> <ul style="list-style-type: none"> • PET Bottles Permit Regulations 2001 • Effluent Discharge Permit Regulations 2003, amended in 2004 • Plastic Carry Bags Regulations 2004 • Declaration of Environmental Laws 2005, amended in 2009 • Waste oil Regulations 2006 • Banning of Plastic Banners Regulations 2008 • Control of Noise Regulations 2008 • Affixing of Posters Regulations 2008 • Industrial Waste Audit Regulations 2008 • Environmental Protection (Designated National Authority) Regulations 2010 • Amendment of Schedule Regulations (2006, 2008, 2009, 2010)
DECLARED ENVIRONMENTAL LAWS	
Certain sections of legislation pertaining to the environment have been declared as environmental laws	
<ul style="list-style-type: none"> • Building Act and Building Regulations 1919 • Beach Authority (Use of Public Beach) Regulations 2004 • Central Water Authority Act and two of its subsidiary legislations • Criminal Code • Forests and Reserves Act • Fisheries and Marine Resources Act 2007 • Ground Water Act • Local Government Act 2003 • National Parks and Reserves Regulations 1996 • Pas Géométriques Act • Public Health Act 	<ul style="list-style-type: none"> • Public Health (Restrictions on Tobacco Products) Regulations 1999 • Rivers and Canals Act • Roads Act • Road Traffic (Control of Vehicle Emissions) Regulations 2002 • Stone Crusher and Block Making (Control) Regulations 1971 • State Lands Act • Wastewater Management Authority Act • Wastewater (Standards for Discharge of Industrial Effluents into a Wastewater System) Regulations 2004 • Local Government (Dumping and Waste Carriers) Regulations 2003 • Municipality of Port Louis Regulations 1908 • Various Local Authority Regulations pertaining to waste management

Figure 1.6: Institutional framework for environmental management

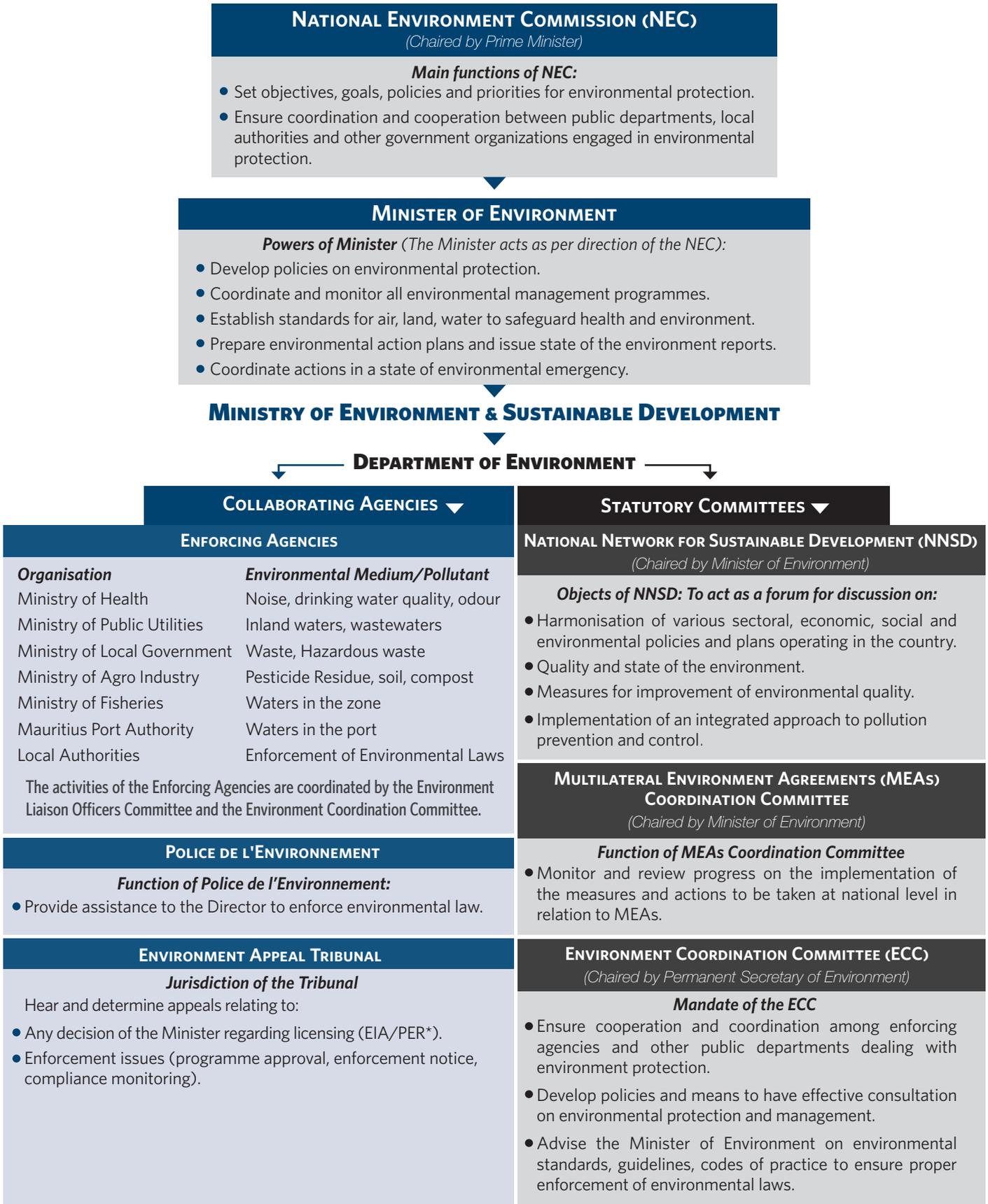
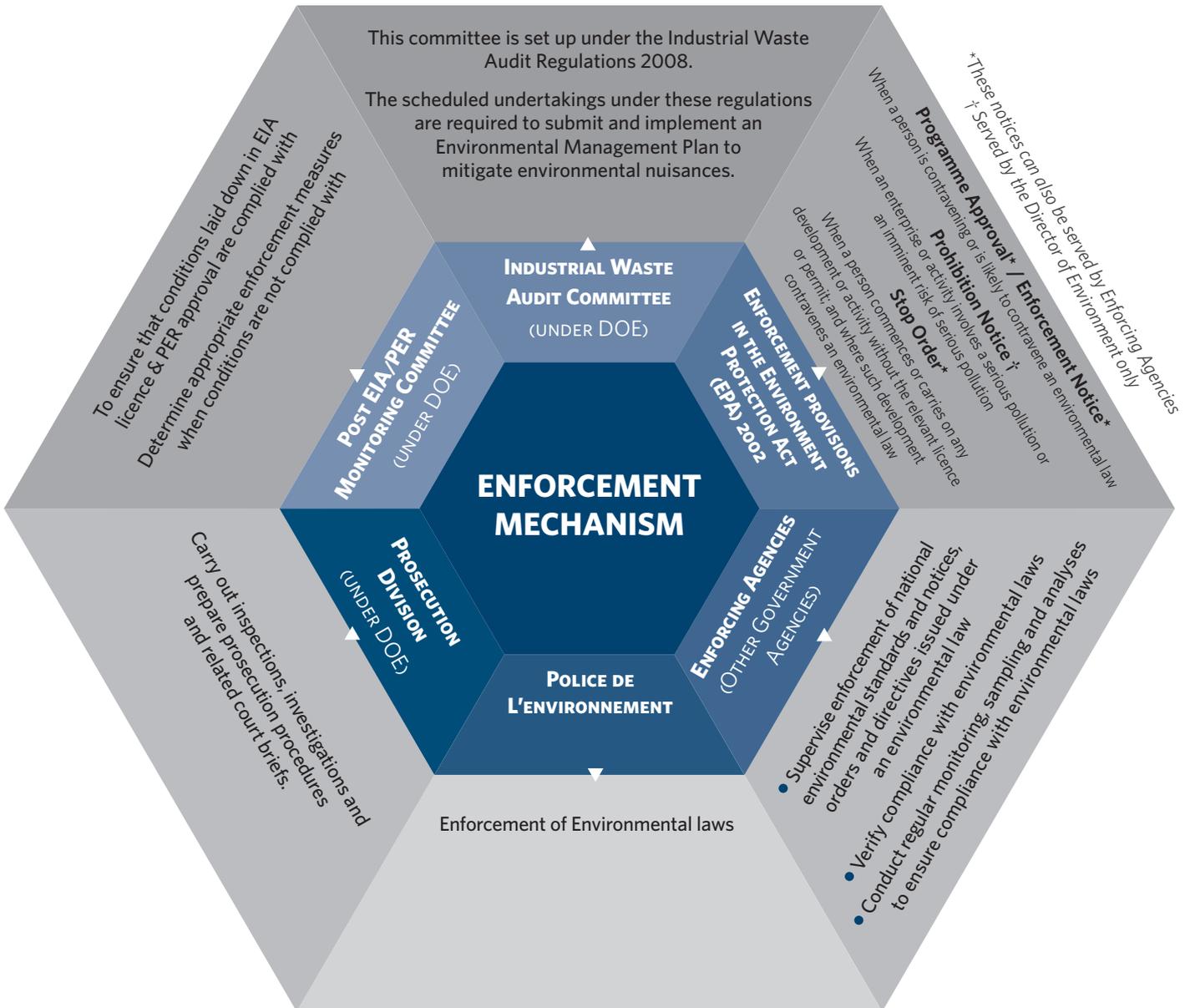


Figure 1.7: Enforcement mechanism



Chapter Summary

- ▶ The environment is influenced by various factors like population growth, economic development and patterns of production and consumption. Yet, economic progress, human well being and social prosperity can only emerge from a healthy environment.
- ▶ Environment should not be sacrificed at the expense of development. Development that takes place by disturbing ecosystem functioning is not economically viable in the long run, but rather should be done in harmony with nature.
- ▶ The 'Maurice Ile Durable' vision is being operationalised to reconcile economic development, social progress and environmental protection.

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Air

Clean air is a prerequisite for human wellbeing and a better quality of life. However, as Mauritius becomes a more industrialised, urbanised and densely populated nation, maintaining a good ambient air quality¹¹ becomes a challenge. As an isolated island state, Mauritius is not directly affected by transboundary air pollution, but air quality is affected locally by anthropogenic sources, such as: industrial activities, transportation, electricity generation and occasional sugar cane burning during the harvest season.

A steadily growing population, increasing consumption and production patterns, rising trade in goods and services, sustained industrial development, expansion of the economy and increased mobility, all stimulate energy and transport demands, which are in fact the main drivers of emissions into the atmosphere¹². These in turn contribute to localised air pollution problems. The most common pollutants¹³

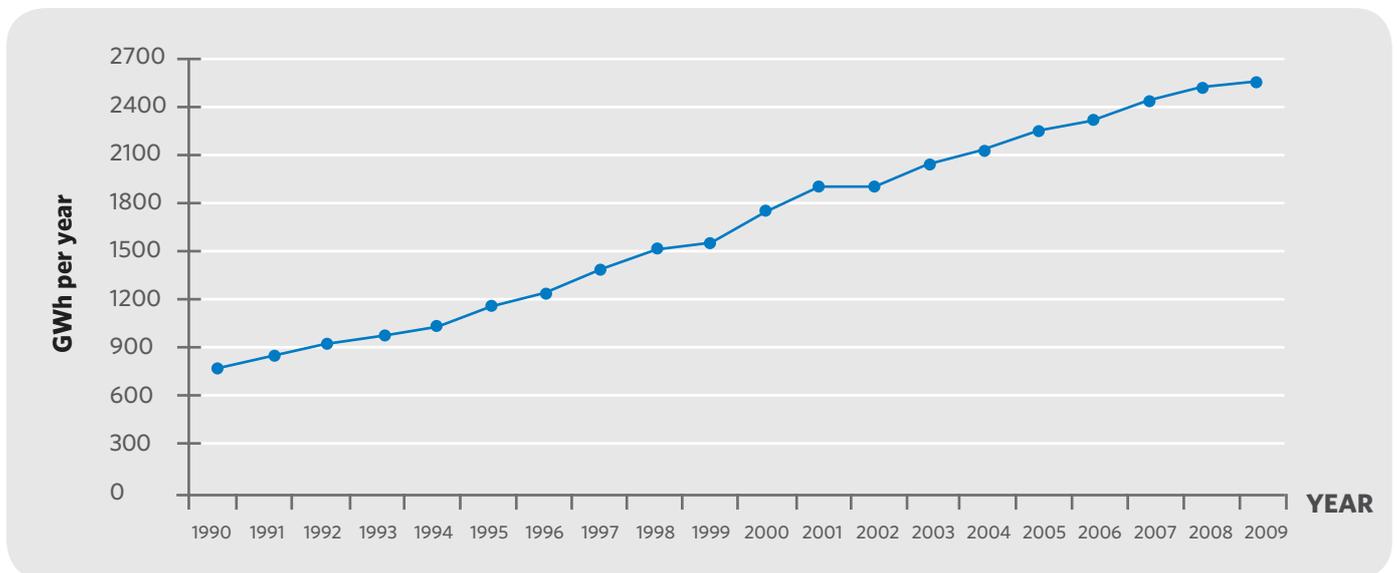
include: particulate matter (PM), sulphur dioxide (SO₂), oxides of nitrogen (NO_x), carbon monoxide (CO), tropospheric ozone (O₃) (UNEP, 2007).

● 2.1 CHALLENGES

◎ 2.1.1 Electricity Generation

Mauritius is heavily dependent on imported fossil fuels for electricity generation and in 2009, 82.5% of the total electricity was produced from coal, heavy fuel oil, diesel and kerosene, the combustion of which generate emissions into the atmosphere. During the past twenty years, energy strategies in Mauritius have been essentially geared towards meeting energy needs. However, despite the introduction of a tariff structure, energy demand has continued to increase. The dependence on fossil fuel implies that as the economy develops emission level increases correspondingly. Figure 2.1 shows the steady increase in electricity production since 1990.

Figure 2.1: Annual electricity production 1990 - 2009



Source: CSO - Digest of Energy & Water Statistics 2009

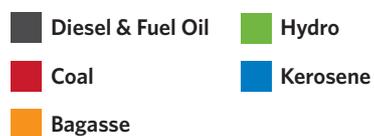
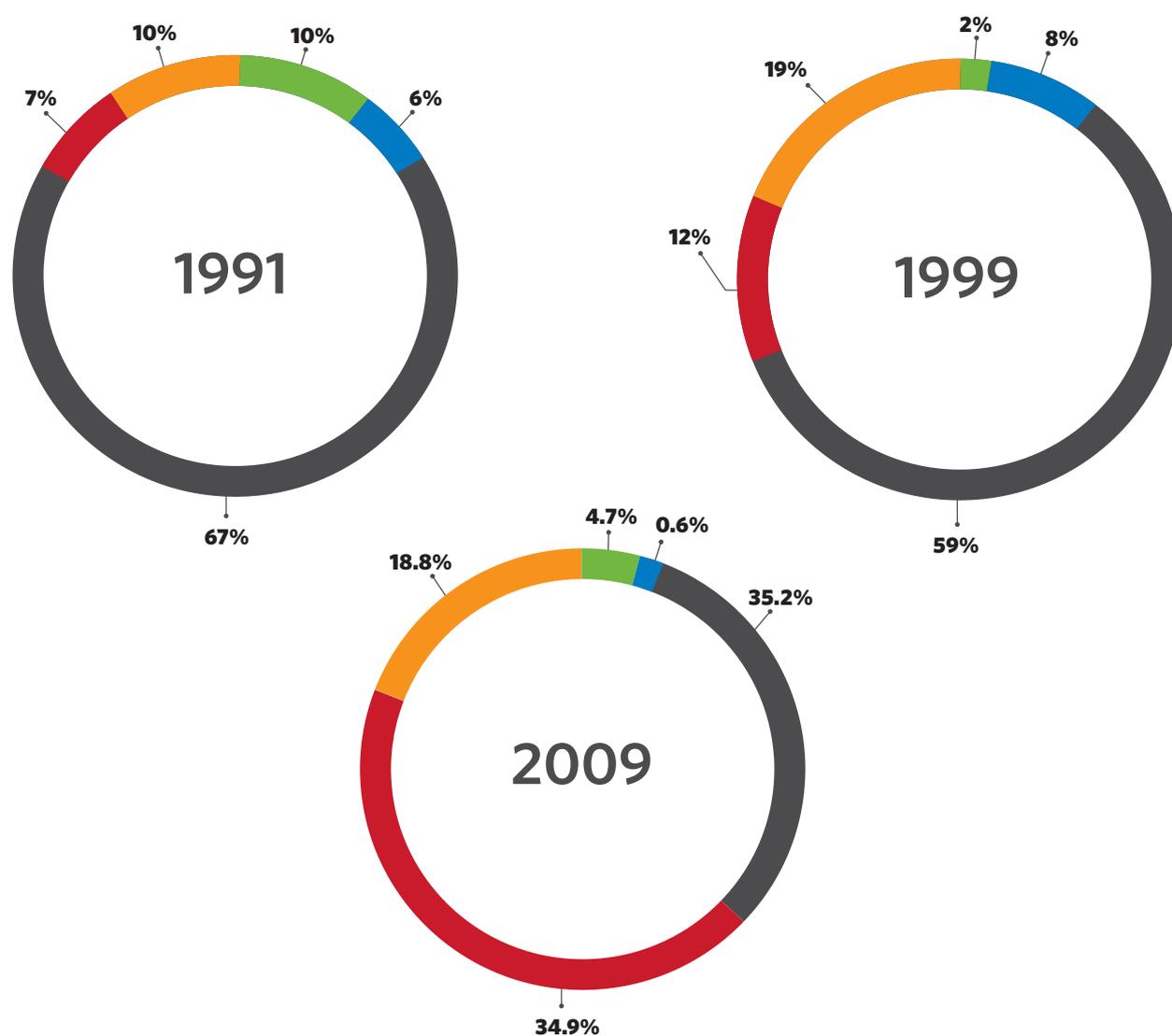
¹¹ Air quality depends on the quantities of emissions generated from natural processes and human activities and on the ability of the atmosphere and ecosystems to absorb and remove these pollutants.

¹² The atmosphere is a shared resource, which includes rainfall, air, solar radiation and wind (UNEP, 2006). The atmosphere has several critical roles: it supports life on Earth, regulates climate, provides oxygen, protects us from harmful solar radiation and maintains a suitable temperature range to sustain life on the planet.

¹³ Air pollutants may be considered primary (emitted directly into the air: e.g. heavy metals, Volatile Organic Compounds and some Persistent Organic Pollutants (POPs) or secondary pollutants that are formed in the air by chemical or photochemical reactions on primary pollutants. Air pollution has adverse effects on human health, crops, ecosystems and materials (UNEP, 2007).

Furthermore, the gradual shift from diesel to coal due to the latter's lower direct cost per unit of electricity production has contributed to increasing atmospheric emissions. Figure 2.2 shows the increasing share of coal in electricity generation.

Figure 2.2¹⁴: Types of fuel used for electricity generation in 1991, 1999 and 2009 (%GWh/year)



Note: Electricity generation was 776 GWh in 1990, 1567 GWh in 1999 and 2546 GWh in 2009.
Source: CSO - Digest of Energy & Water Statistics 2009

¹⁴ There has been a gradual decrease in the use of kerosene due to its high cost and the coming into operation of coal-bagasse power plants.

2.1.2 Industrial Activities

The industries which sustain the growing economy also add to the pollution load and impact on ambient air quality. Localised air pollution episodes have been recorded from manufacturing industries in the following regions: Valentina - Phoenix, Cité St. Luc - Forest Side, Terre Rouge, La Tour Koenig and Cité Vallejee, which are described as industrial hotspots. In fact, the majority of industrial estates were set up prior to the establishment of the Environmental Impact Assessment (EIA) mechanism. Moreover, even though a factory is emitting within standards, the lack of buffer between residential and industrial activities affect quality of life of nearby residents due to particulate matter accumulation.

In 2002, a study was undertaken on the “Environmental Management of Industrial Estates (Vacoas-Phoenix Industrial Estate)” in collaboration with the United Nations Development Programme and the United Nations Industrial Development Organisation, to analyse the impacts of pollution caused by industrial estates on their surrounding environment. The study recommended adoption of cleaner production, use of cleaner fuel, a review of stack heights, dispersion techniques and ambient air quality standards. However, industries could not adopt these measures largely because of financial and technical reasons.

In Mauritius, industries predominately use heavy fuel oil and coal as fuel source and air pollution problems are mostly attributed to the quality of fuel, inefficient management of boilers and also to a lack of skilled and qualified people to operate boilers. In general, boilers do not operate optimally and use an excessive amount of fuel, thus leading to inefficient use of energy in factories. Moreover, auditing of boilers focuses on the health and safety of the employees who operate them, with no consideration for environmental and energy performance monitoring and record keeping. Furthermore, even though the Department of Environment is the enforcing agency for air quality, it still needs more trained technical staff and monitoring logistics to assess, effectively monitor, enforce and ensure compliance to national standards.

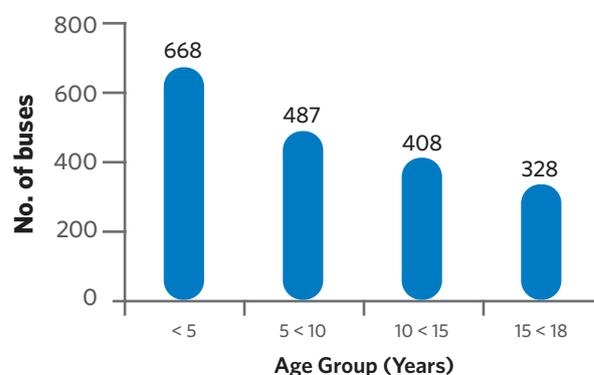


Air pollution from a textile factory

2.1.3 Transport & Vehicular Emissions

Urban pollution in Mauritius is largely caused by exhaust emissions from the transport sector, especially from black smoke emissions from diesel-driven vehicles. Furthermore, despite government subsidies for public transport and import duties on vehicles, the growth in the number of vehicles has not stopped. It is also noted that about 40% of the bus fleet is aged between ten to eighteen years. Fuel quality along with poor servicing, maintenance, overloading, age of vehicles and engine design contribute to air pollution. Figure 2.3 shows the age composition of the bus fleet in Mauritius as at December 2009.

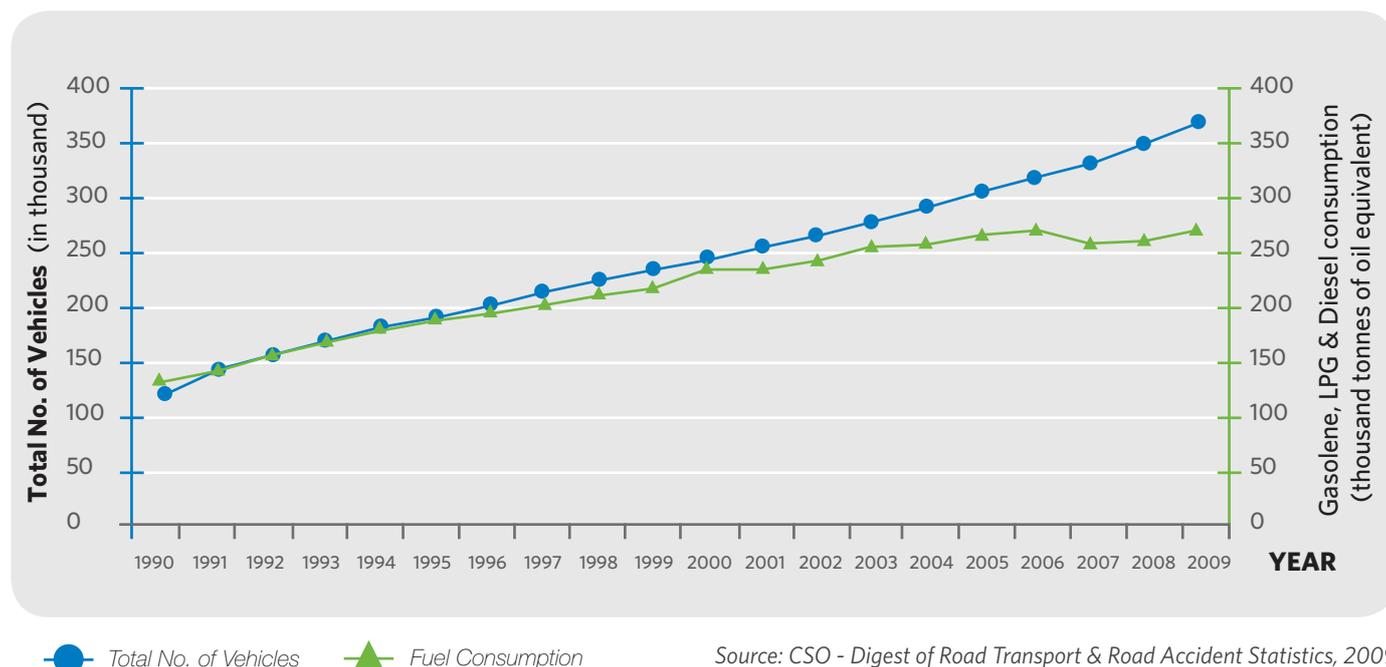
Figure 2.3: Age composition of bus fleet as at 2009



Source: CSO - Digest of Road Transport & Road Accident Statistics 2009

Similarly, the total number of registered vehicles increased from 123,545 vehicles in 1990 to 366,520 in 2009, representing an increase of 196.7%. Figure 2.4 shows the increase in the total number of vehicles compared to fuel consumption from 1990 to 2009.

Figure 2.4: Number of Registered Vehicles, 1999 - 2009



Source: CSO - Digest of Road Transport & Road Accident Statistics, 2009

The increase in income and standard of living will continue to drive up both vehicle ownership and energy use, thus increasing traffic on roads, more congestion and higher vehicular emissions. In fact, according to studies carried out by the Traffic Management and Road Safety Unit,

it is estimated that around 87,000 cars enter Port Louis daily from 7:00 a.m. to 5:00 p.m. Similarly, the irregular maintenance of heavy vehicles engines and poor fuel quality add to the pollution load. However, Figure 2.4 also shows decreasing fossil fuel use. This can be attributed to a new and more efficient fleet of cars on the roads.

Although measures such as upgrading of fuel quality or the promulgation of regulations have been taken to improve air quality, much remains to be done. For instance, while the Road Traffic (Control of Vehicle Emissions) Regulations 2002 has been promulgated to monitor exhaust emissions from diesel powered motor vehicles, its enforcement is rather ineffective. In parallel, there is a need to upgrade technical capacity and logistics of all enforcement authorities. Institutional cooperation among the National Transport Authority, Police Force, Police de l'Environnement and Ministry of Environment & Sustainable Development should be reinforced for more coherent enforcement of the regulations, while the State Trading Corporation concurrently imports fuel of better quality.

2.1.4 Sugar Cane Burning

In Mauritius, sugar cane burning was a common practice before the harvest season to eliminate trash and increase harvest efficiency, but this trend is now being reversed. Out of the 69,000 ha of sugarcane harvested in 2006, less than 15% was burnt prior to harvest (SEA-MAAS, 2007). Sugar cane burning generates large amounts of air borne particulates or fly ash causing nuisance to the local residential and commercial communities, especially with unfavourable wind conditions as well as pollutants such as: carbon dioxide, carbon monoxide, methane and volatile organic compounds. Furthermore, no regulations on sugar cane burning exist in Mauritius as compared to Reunion Island.

2.1.5 Medical Waste Incineration

Improper medical waste incineration releases pollutants such as: dioxins and furans, metals (e.g. lead, cadmium and mercury), particulate matter, acid gases, carbon monoxide and nitrogen oxides. Locally, medical waste is incinerated on the premises of six hospitals and ten private clinics across the island. A survey carried out in 2009 indicates that some 30,000 kg of medical waste is incinerated weekly in hospitals. The amount of medical waste being incinerated in private clinics was surveyed in 2004 and since then no new inventory has been carried out.

The high organic and moisture content of medical waste and old incinerators lead to inefficient combustion as well as the release of pollutants and odour. Odour nuisances arise from the organic components of the waste such as: human parts, placenta and laboratory cultures. Medical waste typically contain a variety of plastic materials such as polyvinyl chloride. Combustion of polyvinyl chloride, especially at low temperatures, causes the release of hazardous substances like dioxins and furans. Moreover, since these facilities are located in very close proximity to communities, emissions and odour emanating from the incinerators constitute environmental nuisances adversely affecting ambient air quality and potentially human wellbeing.

2.1.6 Environment Protection (Standards for Air) Regulations

The Environment Protection (Standards for Air) Regulations 1998 prescribes ambient air quality and stack emission limits for criteria pollutants such as: Total Suspended Particles, Particulate Matter (PM10 - diameter of less than 10 microns), sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), lead (Pb) and ozone (O₃). Experience gained in the implementation of these standards over the past years has revealed a number of loopholes. For instance, proponents for Environment Impact Assessment consideration were not required to carry out air quality modelling. The lack of baseline data and regular monitoring constrain the identification of acute air pollution causes and their impacts.

Furthermore, the fact that ambient air quality measurements do not consider all relevant parameters contributes to weakening the ambient air quality standards. In 2005, a Technical Committee to review the air regulations identified the following loopholes for stack monitoring: absence of sulphur dioxide emission levels, reference conditions, stack height and parameters for incinerators. The University of Mauritius is the only organisation which presently carries out stack (chimney) monitoring exercises.

2.1.7 Air Quality Monitoring

While regulations have been promulgated on air quality, progress about monitoring and enforcement has been mixed. With only two monitoring stations, the Ministry of Environment and Sustainable Development is unable to carry systematic monitoring of ambient air quality across the island. As a result, there is no continuous time series data on the evolution of air quality for a single location. Furthermore, there is a lack of trained technical staff to operate and ensure the maintenance of the air quality monitoring stations. For instance, although a fixed station monitored air quality at the entrance of Port Louis from 2001 to 2007, it required heavy and expensive upgrading, maintenance and repairs. Lack of action¹⁵ on this maintenance and repair led to a consequent reduction in its lifespan. In addition, the Ministry of Environment and Sustainable Development has neither the technical capacity to carry out stack monitoring exercises nor to carry out air quality modelling exercises.

2.1.8 Greenhouse Gases¹⁶

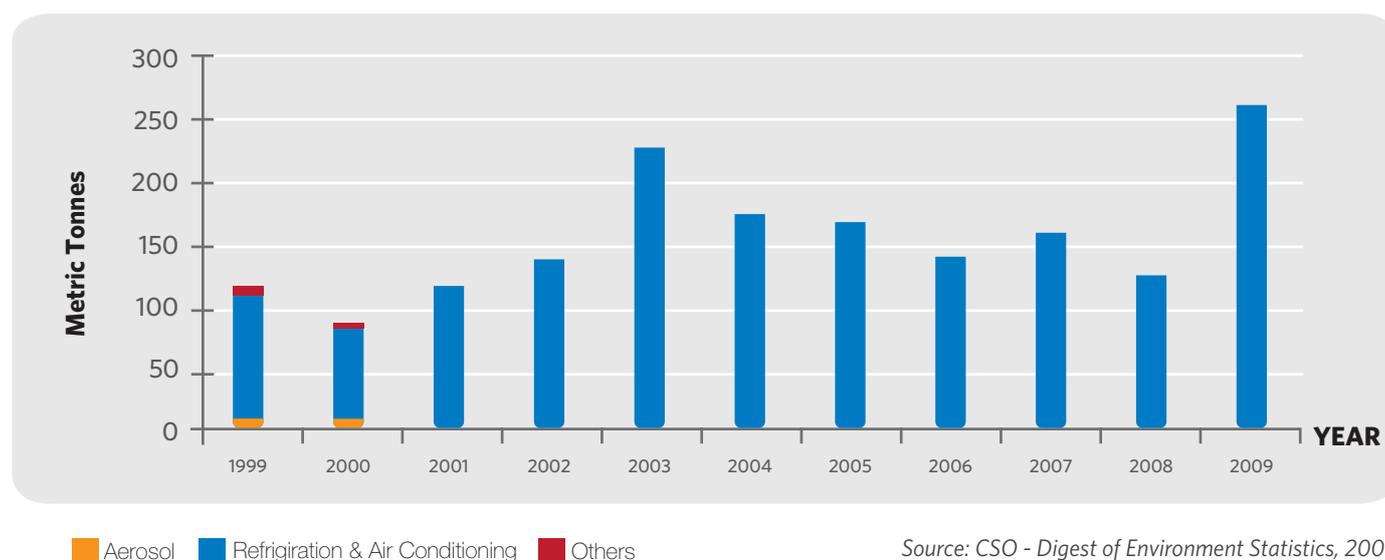
Greenhouse gases (GHG) arise from the combustion of fossil fuels for electricity production, industrial processes

and transport as well as through land use changes, agricultural and waste management practices. Since 1990, GHG emissions are on the rise driven by economic growth.

2.1.9 Ozone Depleting Substances

Previously, Ozone Depleting Substances¹⁷ (ODS) such as Chlorofluorocarbons (CFCs) were used in refrigeration and air conditioning, as solvents, as propellants in aerosols and fire extinguishers and as fumigants. Between 1995 and 2002, 48 tonnes of CFCs were phased out, amounting to 69% of local CFC consumption. In 2005, Mauritius achieved zero imports of CFCs. In parallel to CFC phase out, alternatives of less Ozone Depleting Potential, such as Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HFCs) are being used, as shown in Figures 2.5 and 2.6 below. Although less harmful than CFCs, HCFCs have ozone depleting potential besides being potent GHG. Consequently, hydrocarbons, ammonia and carbon dioxide are being favoured in forthcoming HCFC-phase out programme.

Figure 2.5: Consumption of controlled ODS, 1999 - 2009



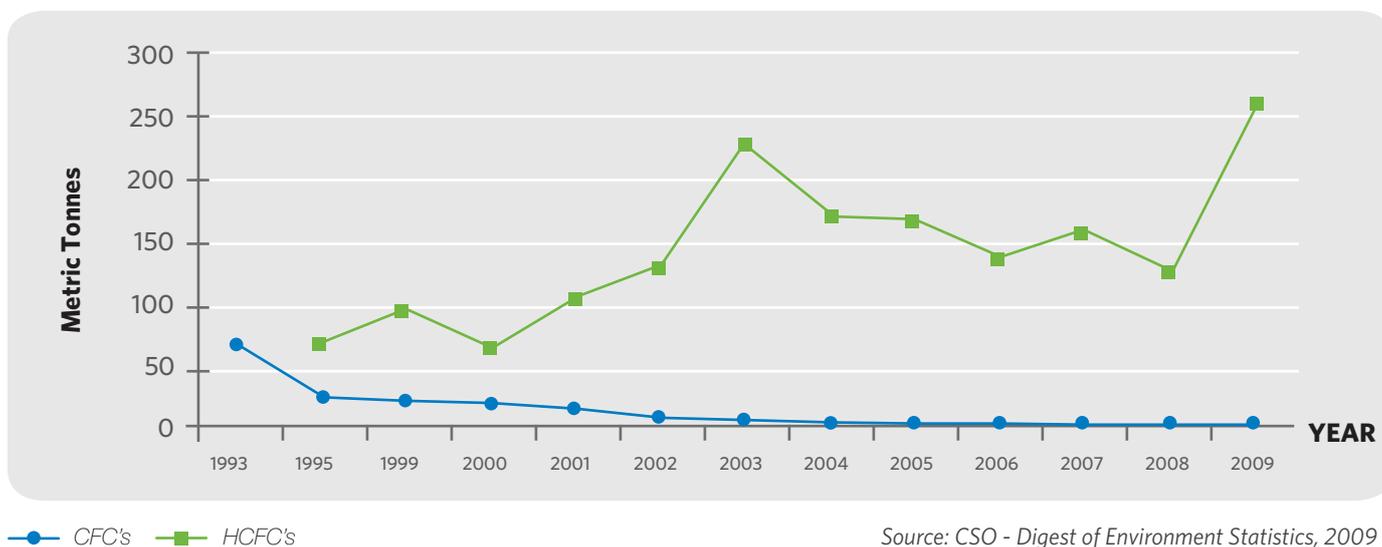
Source: CSO - Digest of Environment Statistics, 2009

¹⁵ A local company was responsible for maintenance and quality assurance of the air quality monitoring stations. In 2008, due to the shutdown of the company and the need for high investments on repair and maintenance, the two monitoring stations had to be taken out of operation.

¹⁶ GHG emissions and climate change are further discussed in Chapter 9.

¹⁷ Ozone Depleting Substances are chemicals that damage the Earth's protective ozone layer, thus allowing harmful solar radiation (UV rays) to reach the Earth's surface. In humans, overexposure to UV rays can lead to skin cancer, cataracts and a weakened immune system. Crop yields and marine life are also affected by increased exposure to UV rays.

Figure 2.6: Consumption of CFCs and HCFCs till 2009



2.1.10 Persistent Organic Pollutants

Persistent Organic Pollutants¹⁸ also constitute important pressures on the atmosphere. Dioxins and furans are the main persistent organic by-products released from combustion. Sugar-cane, bagasse and uncontrolled waste burnings, medical waste incineration and landfill leachate are responsible for more than 75% of the total dioxins and furans releases in Mauritius (Ministry of Environment & NDU, 2005).

2.1.11 State & Trends in Air Quality

Since April 2001, ambient air quality has been monitored in residential and industrial areas as well as in public places. Monitoring exercises are carried out by the National Environmental Laboratory. Between 2001 and 2006, air quality was monitored with the fixed monitoring station posted at Cassis (along the motorway and near the entrance of the capital), while the mobile station attended to air pollution complaints in various regions of the island and industrial hotspots. Parameters analysed were as follows: Total Suspended Particles, Carbon Monoxide (CO), Sulphur Dioxide (SO₂), Lead (Pb), Oxides of Nitrogen (NO_x), Particulate Matter (PM10) and Ozone (O₃).

Table 2.1: Ambient air quality recorded from 2001 to 2006 in different regions in Mauritius

PARAMETER / REGION	PERIOD	DUST	SULPHUR DIOXIDE	NITROGEN DIOXIDE	CARBON MONOXIDE	OZONE	TOTAL SUSPENDED PARTICLES	LEAD
Air Quality Standards		100 µg/m ³	122 ppb (1 hr) 70 ppb (24 hrs) 17 ppb (Annual)	98 ppb (24 hrs)	20 ppm (1 hr) 8 ppm (8 hrs)	47 ppb (1 hr)	150 µg/m ³ (24 hrs) 50 µg/m ³ (Annual)	1.5 µg/m ³ (3 Months)
Central Flacq (Vehicular emissions)	Feb - May 03	35.0	0.2	10.0	0.2	29.0	73.7	ND
St Antoine (Emissions from Industrial Zone)	Jul - Oct 2003	-	-	-	-	-	40.9	ND
Rose Belle (Emissions from Ethanol Plant)	Mar 04	12.8	1.1	2.9	0.23	7.9	-	-
GRNW (Emissions from Industries)	Sep 04	16.0	85	-	ND	14	-	-

¹⁸ Persistent Organic Pollutants are further discussed in Chapter 12.

Table 2.1: Ambient air quality recorded from 2001 to 2006 in different regions in Mauritius

PARAMETER / REGION	PERIOD	DUST	SULPHUR DIOXIDE	NITROGEN DIOXIDE	CARBON MONOXIDE	OZONE	TOTAL SUSPENDED PARTICLES	LEAD
Air Quality Standards		100 µg/m ³	122 ppb (1 hr) 70 ppb (24 hrs) 17 ppb (Annual)	98 ppb (24 hrs)	20 ppm (1 hr) 8 ppm (8 hrs)	47 ppb (1 hr)	150 µg/m ³ (24hrs) 50 µg/m ³ (Annual)	1.5 µg/m ³ (3 Months)
La Tour Koenig (Emissions from industrial zone)	Nov 04 - Jan05	16.4	3.4	-	0.30	7.5	-	-
Forest Side (Emissions from Textile Factory)	Jan-05	10.0	4.0	2.0	0.30	9.0	-	-
Cassis (Vehicular emissions)	Jan - Sep 06	21.6	1.2	-	0.33	6.0	-	-
Aapravasi Ghat (Port-Louis)(Vehicular emissions)	Jan - Mar 06	50.0	0.7	16.5	0.4	1.8	51.8	ND
Valentina Industrial Estate (Phoenix)	Nov 06	34.8	32	-	0.34	3.5	100	ND

In 2009, two new air monitoring stations have been acquired by the Ministry of Environment & Sustainable Development: a Particulate Matter Station and a Gaseous Analyser Station to measure solid (Particulate Matter: PM 10 and PM 2.5 and Total Suspended Solids) and gaseous contaminants (SO₂, NO_x, CO) respectively. With an increase in public complaints on air pollution, monitoring exercises have also increased across the island. Further air quality monitoring results for selected regions are shown in Table 2.2

Table 2.2: Ambient air quality recorded from 2009 to 2010 in different regions in Mauritius

PARAMETER / REGION	PERIOD	DUST (PM10)	SULPHUR DIOXIDE	NITROGEN DIOXIDE	CARBON MONOXIDE	TOTAL SUSPENDED PARTICLES
Air Quality Standards		100 µg/m ³	122 ppb (1 hr) 70 ppb (24 hrs)	98 ppb (24 hrs)	20 ppm (1 hr) 8 ppm (8 hrs)	150 µg/m ³ (24 hrs) 50 µg/m ³ (Annual)
La Tour Koenig (Emissions from industrial zone)	Jul - Sep 2009	-	143.3 (Limit exceeded) (1 hr average) 50.0 (24 hrs average)	8.0 (24 hrs average)	2.0 (1 hr average) 1.5 (8 hrs average)	-
Forest Side (Emissions from Textile Factory)	Sep - Nov 2009	-	73 (1 hr average) 37 (24 hrs average)	3.0 (24 hrs average)	2.1 (1 hr average) 1.62 (24 hrs average)	-
Aapravasi Ghat (Port-Louis)(Vehicular emissions)	Nov - Dec 2009	-	10.7 (1 hr average) 7.0 (24 hrs average)	1.1. (24 hrs average)	2.1 (1 hr average) 1.90 (24 hrs average)	-
Deep River Beau Champ (Emissions from Power Plant)	Oct - Dec 2009	20.8 (24 hr average)	-	-	-	35.3 (24 hrs average)

Table 2.2: Ambient air quality recorded from 2009 to 2010 in different regions in Mauritius

PARAMETER / REGION	PERIOD	DUST (PM ₁₀)	SULPHUR DIOXIDE	NITROGEN DIOXIDE	CARBON MONOXIDE	TOTAL SUSPENDED PARTICLES
Air Quality Standards		100 µg/m ³	122 ppb (1 hr) 70 ppb (24 hrs)	98 ppb (24 hrs)	20 ppm (1 hr) 8 ppm (8 hrs)	150 µg/m ³ (24 hrs) 50 µg/m ³ (Annual)
Terre Rouge (Emissions from Textile Factory)	Feb – Apr 2010	-	18 (24 hrs average)	-	0.7 (1 hr average)	-
					0.7 (8 hrs average)	
Baie du Tombeau (Emissions from Textile Factory)	Jun – Aug 2010	-	81.1 (limit exceeded) (24 hr average)	-	2.06 (1 hr average)	-
					1.05 (8 hrs average)	
Coromandel (Emissions from stone crushing plant)	Jan – Mar 2010	-	-	-	-	216.8 (limit exceeded) (24 hrs average)
La Tour Koenig (Emissions from Textile Factory)	Apr – May 2010	32.4 (24 hrs average)	-	-	-	71.8 (24 hrs average)
Flacq (Emissions from stone crushing plant)	Jun – Aug 2010	57.2 (24 hrs average)	-	-	-	82.0 (24 hrs average)
Cassis (Emissions from Laundry plant)	Oct – Dec 2010	-	-	-	-	212.4 (limit exceeded) (24 hrs average)

2.1.12 Impacts

Impacts on Human Health

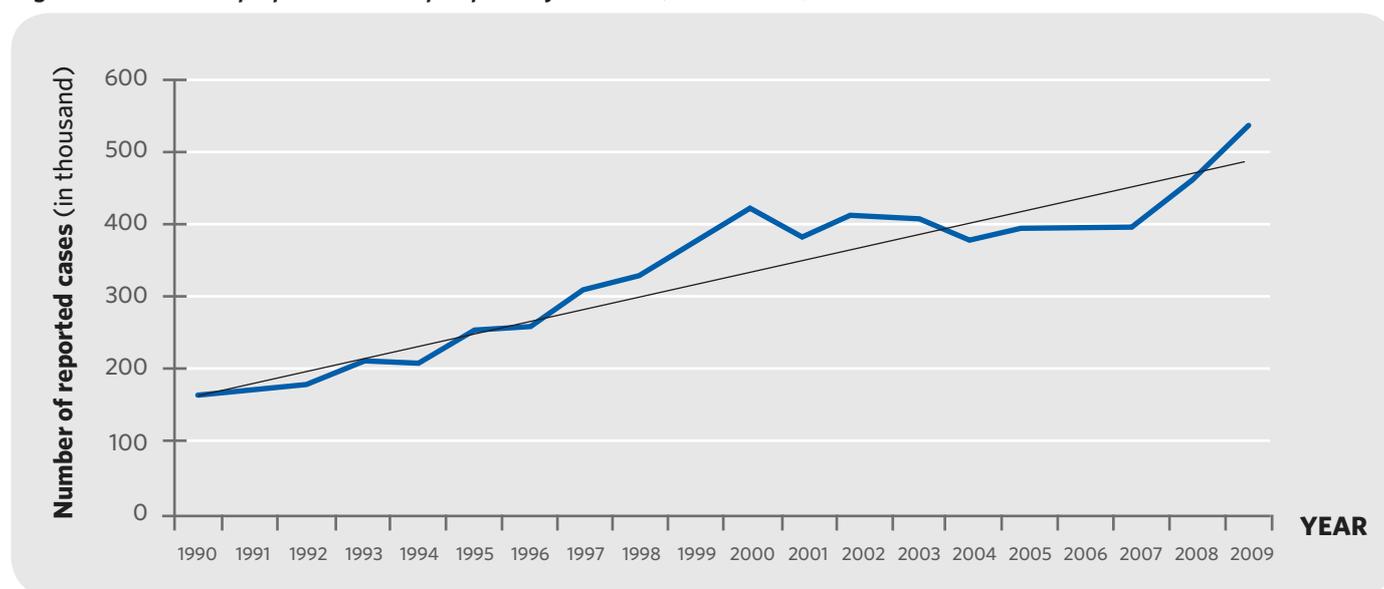
Pollutants such as particulate matter, sulphur dioxide, nitrogen dioxide, carbon monoxide, tropospheric ozone and lead directly impact on human health. Health impacts associated with the common pollutants range from skin, eye, throat and nose irritations to more complicated respiratory diseases like asthma and chronic bronchitis. In Mauritius no comprehensive human-health risk studies have been conducted to determine the risks associated with exposure to air pollution sources. Only a few case to case studies have been carried out in 1993, 2002 and 2007 and the outcomes are shown in Box 2.1 below.

BOX 2.1: HEALTH RISK STUDIES CARRIED OUT IN MAURITIUS

YEAR	STUDY	OUTCOMES
1993	Kruger Consult report on occupational exposure to lead	High lead concentrations in the blood of policemen, gas station attendants and paint factory workers. However, concentrations were below toxic levels. The study showed that traffic pollution contributed to higher blood lead levels of those exposed to it.
2002	Survey on respiratory problems in the Vacoas Phoenix Industrial Estate	Population situated downwind from the industrial estate had a higher prevalence of respiratory problems compared to less exposed populations.
2007	Health survey at La Tour Koenig	64 persons were examined between December 2007 and January 2008. However, only four patients turned up for subsequent check up and therefore the Ministry of Health and Quality of Life could not conclude on the health status of the inhabitants.

Respiratory tract diseases¹⁹ are a good proxy indicator for air quality and as shown below, the trend in the number of respiratory diseases recorded in Mauritius since 1990 is increasing. However, this trend does not differentiate between genetic, environmental or social differences and therefore gives only a general indication as to the actual incidence of respiratory diseases in Mauritius.

Figure 2.7: Number of reported cases of respiratory diseases (1990 - 2009)



Source: CSO - Digest of Environment Statistics, 2009

⊙ Impacts on the Environment

The 1993 Kruger Consult Report also noted significant concentrations of lead in leafy vegetables which were grown close to congested roads. These were 4-13 times higher than in a control area. Emission of greenhouse gases due to human activities is also contributing to global warming and climate change²⁰ and as a result low-lying coastal areas in Mauritius are particularly vulnerable to sea level rise. Similarly, with the banning of coral sand extraction in 2001, there has been an increase in the use of rock sand and a corresponding increase in the number of stone crushing plants. However, in some localities, the close proximity of this land use activity near residential areas has been generating complaints related to dust emissions.

¹⁹ Respiratory tract diseases are diseases that affect the air passages, including the nasal passages, the bronchi and the lungs. They range from acute infections, such as pneumonia and bronchitis, to chronic conditions such as asthma and chronic obstructive pulmonary disease (www.who.int).

²⁰ The impacts of climate change are further discussed in Chapter 9.

²¹ The Vienna Convention for the Protection of the Ozone Layer was adopted in 1985 as an important legal tool for taking international action to protect the Earth's stratospheric ozone layer. The objectives of the convention are to promote cooperation, research and information exchange on the impacts of human activities on the ozone layer and to adopt legislative or administrative measures to mitigate these adverse impacts.

²² Negotiated in 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer aims at phasing out the production and consumption of entire groups of harmful ozone-depleting chemicals in both developed and developing countries.

²³ See footnote in Chapter 9: Climate Change

²⁴ See footnote in Chapter 9: Climate Change

²⁵ The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release and storage. The Stockholm Convention entered into force on 17 May 2004.

● 2.2 PROGRESS

Since the creation of a dedicated Ministry responsible for Environment in 1989, several measures have been introduced to promote better air quality and to reduce atmospheric pollution. These include promulgation of ambient air quality standards, introduction of unleaded petrol, reducing sulphur content of diesel and phasing out of CFCs, amongst others. Mauritius is also a party to several atmosphere related conventions, namely the: Vienna Convention for the Protection of the Ozone Layer²¹ and the Montreal Protocol on Substances that Deplete the Ozone Layer²², the United Nations Framework Convention on Climate Change²³, the Kyoto Protocol on Climate Change²⁴ and the Stockholm Convention on Persistent Organic Pollutants²⁵.

2.2.1 Institutional Framework for Air Quality Monitoring in Mauritius

The Ministry of Environment and Sustainable Development is the enforcing agency for air quality. Monitoring of air quality is carried out by the National Environmental Laboratory, while the Pollution Prevention and Control Division attends to all air-related complaints and enforces the provisions of the Environment Protection Act. Furthermore, the Climate Change Division is responsible for undertaking GHG inventories, developing climate resilient policies and preparing and implementing climate change mitigation and adaptation plans. There are also dedicated teams to implement the provisions of atmosphere-related international environmental agreements, namely the Montreal Protocol and the Stockholm Convention.

2.2.2 Review of Environment Protection (Standards for Air) Regulations 1998

The Environment Protection (Standards for Air) Regulations 1998 have been revised by a Technical Committee, taking into account international standards such as World Bank guidelines, World Health Organisation standards and EU directives among others. New parameters and corresponding thresholds have been proposed to strengthen the air emissions standard for industrial activities. New parameters include: sulphur dioxide, particulate matter, carbon monoxide and nitrogen oxides. The Technical Committee has also recommended that the overall strategy for stack emissions control must include adequate dispersion through appropriate stack heights and combustion efficiency.

The empowerment of the Ministry of Environment and Sustainable Development to prescribe additional standard for a particular industry for the protection of health and environment has been recommended along with the setting up of an Air Pollution Control Unit with a clear mandate, trained human resources and adequate logistics for overall air quality management. Taking into consideration the above, new air quality standards have been drafted and will be promulgated once approval of the State Law Office has been obtained.

2.2.3 Energy Sector²⁶

The Government of Mauritius is now aiming to increase the share of renewable energy to 35% by 2025 in line with the 'Maurice Ile Durable' vision. Several schemes have been introduced to promote the use of renewable energy and improve energy efficiency. These include promoting the use of solar water heaters, compact fluorescent lamps as well as investments in renewable energy sources such as wind, hydro and solar, the optimum use of bagasse for electricity generation as well as alternative ways of producing electricity, namely: from landfill gas and through the contribution of small independent power producers. Switching to renewable energy will limit the release of air pollutants in the atmosphere.

2.2.4 Transport Sector & Vehicular Emissions

Several measures have been taken to improve fuel quality in Mauritius in line with international trends. In 1992, lead content in petrol was reduced from 0.84 g/l to a maximum of 0.4 g/l and in 2002, Government introduced unleaded petrol. Following this exercise, monitoring results by the National Environmental Laboratory showed that lead concentrations in ambient air dropped from 0.11 µg/m³ to trace levels. The introduction of unleaded petrol has also paved the way for more efficient systems such as the use of catalytic converters²⁷ and the introduction of a more efficient younger generation of petrol-driven vehicles. Similarly, the sulphur content of diesel was lowered from 5,000 ppm to 2,500 ppm in 2001 and a further decrease in sulphur content to 500 ppm was brought in 2010. Since February 2011, the Ministry of Environment and Sustainable Development is looking into the further reduction of sulphur content in diesel and cleaner vehicle technologies for reducing vehicular emissions. Equipment for enforcing vehicular emission regulations such as smoke meters and axle Weigh Bridge are being procured.

Presently, the National Transport Authority (NTA) is responsible for monitoring vehicular emissions as per the Road Traffic (Control of Vehicle Emissions) Regulations 2002. The Police de l'Environnement also assists the NTA

²⁶ For more details on the activities being undertaken in the energy sector, see Chapter 8 on Energy resources.

²⁷ A catalytic converter is a device used to reduce the toxicity of emissions from an internal combustion engine. However, these devices are inefficient with leaded petrol.

by carrying out visual road-side checks and issuing notices under the Road Traffic Act to contraveners. The latter have to undertake further tests at NTA Vehicle Examination Centres. From 2001 to April 2010, the Police de l'Environnement has issued 40,296 notices to vehicles emitting black smoke. Vehicle emissions control is a complex issue which is not dependent on a few measures only. It is essential that a comprehensive package of measures be taken for more evident improvements in air quality and these measures include collaboration between all concerned stakeholders, vehicle owners, vehicle users and authorities involved in enforcement of standards and regulations.

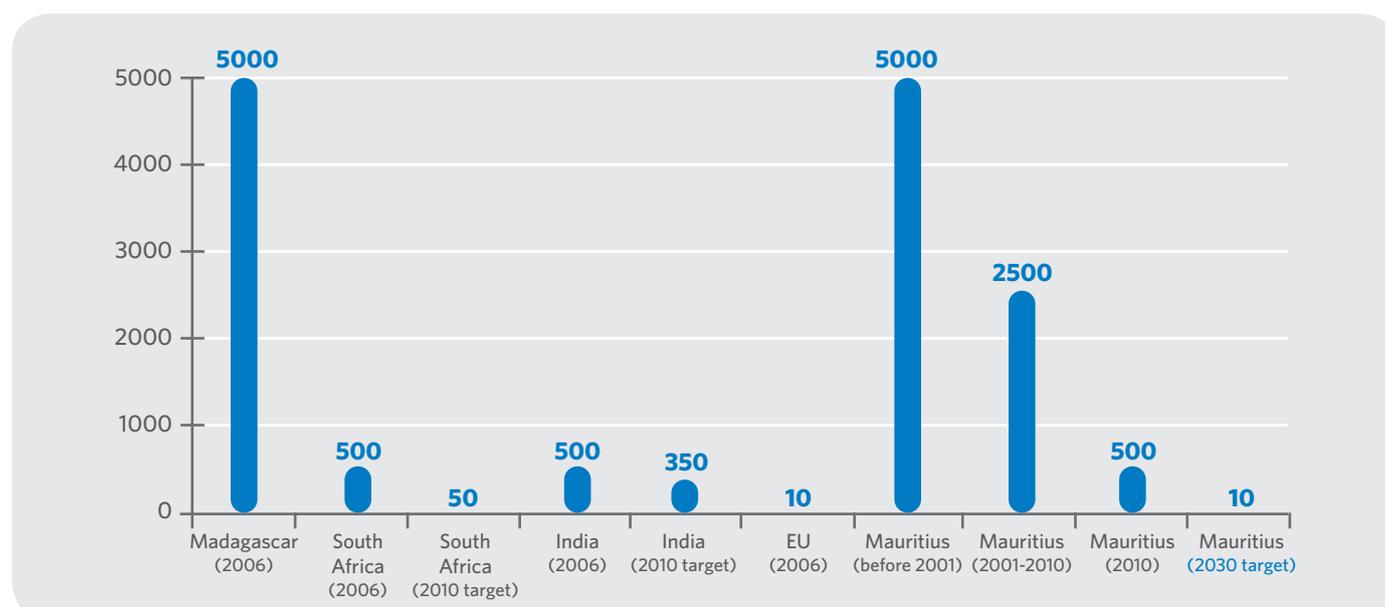
2.2.5 Industrial Activities

Potentially polluting industries still exist adjacent to residential and commercial areas. The National Development Strategy (NDS)²⁸ has recommended that considerations be given to the clustering of uses on a single, well-accessed site and the establishment of a buffer zone up to one

kilometre from sensitive land uses such as residential areas, schools and hospitals and that incentives or penalties should be applied to encourage industries reduce pollution.

As from 1st April 2009, to prompt industries optimise resource use, develop waste management systems and comply with prescribed discharge and emission regulations, the Environment Protection (Industrial Waste Audit) Regulations²⁹ entered into force. Activities having significant impacts on the environment have been targeted and include among others: sugar milling, thermal power plants, dyeing plants, distilleries, dairy processing, wastewater treatment plants, stone crushing plants and medical waste incineration. These industries have to submit industrial waste audit reports on the efficiency of their processes and on the management of their respective waste streams as well as Environmental Management Plans indicating the way forward to rectify processes causing harm to the environment.

Figure 2.8: Sulphur content in diesel



Source: UNEP, 2006

²⁸ For more information in the National Development Strategy, see Chapter 4: Land

²⁹ Under the Environment Protection (Industrial Waste Audit) Regulations, industries are under the obligation to keep a record and report the origin, composition, quantity and disposal routes of waste produced. Wastes produced include any matter whether solid, liquid, gaseous or radioactive, which is discharged, emitted or deposited in the environment. Those who contravene these regulations will be liable to a fine not exceeding 50,000 rupees.

Industrial waste auditing aims at developing a culture of industrial compliance where proactive attitudes are favoured rather than traditional end-of-pipe approaches. It encourages the adoption of cleaner technology and resource use efficiency. It has been noted that after the submission of their Environment Management Plans, several large industries have taken a step further and are now aiming at adopting International Environmental Management Systems like ISO 14001.

2.2.6 Sugar Cane Burning

A voluntary code of practice on sugar cane burning has been adopted by the sugar industry in 2001. To decrease emissions of particulate matter, the Mauritius Sugar Industry Research Institute has recommended the 'cool burning' practice. In the latter, sugar cane fields are burnt during early morning hours to cause less nuisance to surrounding localities. Over the years, sugar cane burning has reduced gradually to less than 15% of cultivated sugar cane area as a result of mechanisation (SEA-MAAS, 2007).

2.2.7 Development of an Air Quality Index for Mauritius

Since 2001, ambient air quality is monitored in residential/ industrial zones and public places. Presently, the Ministry of Environment and Sustainable Development has initiated the project for developing an Air Quality Index. The first phase of this initiative recommended the establishment of a network of fixed and mobile air quality monitoring stations across the island to capture data to be used in computing the index. The latter is considered as being an important tool in demonstrating air quality and pollution levels in various parts of the island.

2.2.8 Ozone Layer Protection

Mauritius has been successful in phasing-out CFCs five years ahead of the scheduled target set by the Montreal Protocol. This has been achieved by a series of measures guided by a first country programme in 1993 followed by a Refrigerant Management Plan³⁰ in 1998 and a Terminal Phase-Out Management Plan in 2003. Measures adopted include amendments to the Consumer Protection (Price Control and Supplies) Act 1999 to control ODS imports, banning equipment containing these substances, sensitisation of importers, training of custom officers to prevent illegal trade on ODS, mandatory labelling of products and equipment using ODS, 40% customs duty on all products containing CFCs, duty reduction on ozone friendly products and recovery and recycling of CFCs, phasing out of methyl bromide³¹ and training on new technology (hydrocarbon technology³²) among others.

Currently, a detailed assessment of HCFC use is being carried out in the country in order to develop a comprehensive HCFC management and phase out plan for Mauritius. The Ministry of Environment and Sustainable Development has a long and fruitful collaboration with stakeholders of the refrigeration and air conditioning industry and the phasing out of ODS has been successful largely due to public private participation and cooperation.

³⁰ The Refrigeration Management Plan was developed to recover and recycle CFCs. This project was implemented by GTZ-Proklima, a bilateral German Agency and Mauritius is one of the 14 African countries having benefited under this technical cooperation (<http://www.gov.mu/portal/sites/legaldb/montreal.htm>).

³¹ Methyl bromide is an odourless, colourless gas and ODS. It is used as a pesticide and fumigant to control pests across a wide range of agricultural sectors.

³² Hydrocarbon Technology is becoming the most probable alternative to CFCs as it is not ozone depleting and has very low global warming potential (<http://www.gov.mu/portal/sites/legaldb/montreal.htm>).

● 2.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Monitoring and compliance to prescribed air quality regulations and standards	<ul style="list-style-type: none"> ~ Develop & adopt integrated and cross-sectoral approaches to air pollution prevention, control and abatement ~ Regular review of air quality standards 	<ul style="list-style-type: none"> ~ Well-developed network of air quality monitoring stations across the island ~ Improved enforcement ~ Dedicated unit with trained staff to monitor, manage and control air quality
Emissions from Energy Sector	<ul style="list-style-type: none"> ~ 35 % electricity produced from renewable sources ~ Cleaner fuel used for electricity generation ~ Efficiency & conservation achieved through demand & supply side management 	<p>AIR QUALITY IMPROVES</p> <ul style="list-style-type: none"> ~ Air Quality Index shows improved air quality ~ Decrease in emission of pollutants into the atmosphere
Emissions from Industries	<ul style="list-style-type: none"> ~ Culture of Cleaner Production, Energy Efficiency & Auditing established in industry ~ Use of state-of-the-art technology in industry 	<ul style="list-style-type: none"> ~ Industrial development in conformity with prescribed planning guidance
Transport and Vehicular emissions	<ul style="list-style-type: none"> ~ Reduce sulphur content of diesel to 10 ppm ~ Mandatory catalytic converters for all vehicles ~ Use of green vehicles and mass transport system 	<ul style="list-style-type: none"> ~ Increase in the fleet of energy efficient vehicles
Commitments to international agreements	<ul style="list-style-type: none"> ~ Ongoing implementation of internationally agreed action plans ~ Monitoring and evaluation of progress achieved 	<p>Mauritius is the leader in the Indian Ocean & among SIDS for the implementation of atmosphere-related conventions</p>

2.3.1 Policy Options for the Future

The Best Case Scenario highlights priority measures with high cost-benefit ratios that must be taken across various sectors to ensure improvement in air quality by 2030. Common to all action area is the urgent need to strengthen local technical capacity in addition to developing and implementing an Integrated Air Quality Management Strategy for monitoring and reducing pollutants. The National Environment Policy also recognises that the basis for an integrated approach towards air pollution control must comprise prevention, enforcement, monitoring and education.

Environment Protection (Standards for Air) Regulations

As recommended by the Technical Committee set up to review air quality standards, the following actions need to be undertaken urgently:

- Promulgation of new 'Standards for Ambient Air Quality and Stack Emissions' for activities such as: thermal power plants, industrial boilers, foundries, fugitive dusts, solid wastes and medical wastes incinerators.
- Publication of guidelines on stack design and manuals for Environmental Performance Monitoring of industrial boilers and incinerators to instil the culture of Good Engineering Practices and cleaner production in industry.

Integrated Air Quality Management

Following the mid-term review of the second National Environmental Strategies (NES 2), emphasis has been laid on the development of an Integrated Air Quality Management Framework for the implementation of sector specific air pollution control action plans. Enforcement, air quality monitoring and assessment studies, pollution prevention efforts, technology transfer, institutional strengthening, demonstration projects and development of financial instruments are essential to sustain the framework. To further progress air quality improvements by 2030 and as proposed in the revised NES 2, projects should focus on the following:

- Establishment of air quality monitoring mechanism and development of an air quality index

- Setting air quality improvement targets and defining projects for implementation
- Implementation of defined projects
- Access to Carbon Finance
- Institutional strengthening and capacity building
- Implementation of the Mauritius Industrial Pollution Prevention Project to strengthen environmental management

Institutional Setup for Air Quality Monitoring

To enable the Ministry of Environment and Sustainable Development execute its role and functions as Enforcing Agency for air quality, both NES 2 and the Technical Committee recommended the setting up of a dedicated unit for the monitoring, management and control of air quality in Mauritius. The unit should comprise a pool of trained technical staff to establish a system for regular and systematic air monitoring, analysis and reporting.

Air Quality Monitoring

Additional mobile and fixed air monitoring stations need to be purchased over the medium term and staff trained to carry out stack monitoring exercises. Preventive maintenance protocols should be established to maximise the use of these equipment. Besides monitoring exercises, technical capacity should be strengthened in the field of air quality management and dispersion modelling. Courses can be run on a regional basis to maximise participation from other countries as well as share experiences on best practices.

Furthermore, besides focusing solely on measuring ambient pollutant concentrations, studies should also be conducted to find out how to reduce their generation. For instance, developing a set of indicators will give a better insight of the magnitude of pollutants being generated by economic activity and can thus be more solution oriented.

○ Sectoral Emissions

A programme-based approach covering a cohesive monitoring system should be developed for the industrial and energy sectors. By 2030, industries must be able to systematically monitor and show compliance with emission standards. The introduction of stricter environmental regulations, the polluter pays principle and economic instruments will trigger technological innovation, cleaner technologies and pollution control technologies. Self-regulation and co-regulation can also be used by large industries as tools to improve the environmental performance of their operations. These industries can also make use of Environmental Management Systems like ISO - 14000, thus taking a step beyond simple compliance with national regulations.

○ Transport

To respond to the increasing use of private cars and the negative perception associated with public transport, the present system must be improved to encourage more commuters use public transport. The development of mass transit systems must also be further explored. Likewise, to reduce vehicular emissions, fuel quality standards should be periodically reviewed for example with further reduction in the sulphur content of diesel while stricter vehicle inspection and maintenance programmes should be in place. Moreover as in cities like Cairo and Delhi, a fuel switch from diesel to LPG can be considered for public transport vehicles to reduce emissions in Particulate Matter and Sulphur Dioxide.

○ New and Emerging Issues

~ *Indoor air quality and environment workplace risks:*

Indoor air quality and workplace risks are emerging issues owing to their potential impacts on human health. Unfortunately, there is little knowledge on indoor air quality, workplace risks and their associated health implications for Mauritius. Today buildings are becoming increasingly sealed from the external environment, thus increasing the concentrations of particulates and other organic compounds. Studies should be carried out to assess the level of indoor and workplace pollution.

~ *Study on the impacts of acid rain:*

There is insufficient information as to the impacts of acid rain on public infrastructure, buildings and agriculture. Studies should be undertaken to assess the implications of acid rain.

~ *Epidemiological studies on the impacts of air pollution on human health:*

The impacts of air pollution on human health have been poorly investigated in Mauritius. Epidemiological studies should be carried out to assess these impacts.

Chapter Summary

CHALLENGES

- ▶ Sustained economic development and changing patterns of consumption are leading to an increase in the emission of atmospheric pollutants from the following sectors:
 - Electricity production
 - Industrial activities
 - Transport
 - Sugar cane burning
- ▶ Pollutants emitted impact on human health, quality of life and the environment; the extent of which have not been extensively studied.
- ▶ Regulations and prescribed standards have a number of loopholes.
- ▶ Progress on air quality monitoring and enforcement of regulations has been mixed due to lack of technical capacity in terms of equipment and trained personnel.
- ▶ There is no continuous time series data on air quality in Mauritius.

PROGRESS

- ▶ To improve air quality, institutional and legal frameworks have been established and the Ministry of Environment and Sustainable Development is the enforcing agency for air quality. The Ministry formulates policies, promulgates regulations and standards, monitors air quality and attends to atmosphere-related complaints. The Police de l'Environnement and NTA monitor vehicle emissions.
- ▶ Standards for air have already been reviewed and need to be urgently promulgated.
- ▶ To reduce emission of pollutants, strategies have been adopted to promote renewable energy and improve energy conservation and efficiency.
- ▶ As per the Environment Protection (Industrial Waste Audit) Regulations 2009, local industries are required to develop Environmental Management Plans to better monitor their emissions and take corrective actions.
- ▶ The introduction of unleaded petrol and diesel with low sulphur content has contributed to improve air quality.
- ▶ Preliminary work has been undertaken for development of an air quality index.
- ▶ Mauritius has successfully phased out CFCs five-years ahead of the scheduled target and is now embarked on a phase out plan for HCFCs.
- ▶ Procurement of equipment for monitoring of vehicular emissions.

PROSPECTS

- ▶ Urgently promulgate new standards for air quality and stack emissions.
- ▶ Adopt an Integrated Air Quality Management Framework comprising monitoring mechanisms, an air quality index, improvement targets, institutional strengthening and capacity building.
- ▶ Implement the Mauritius Industrial Pollution Prevention Project.

Chapter Summary

PROSPECTS

- ▶ Set up a dedicated unit for air quality monitoring and management to enable the Ministry of Environment and Sustainable Development execute its role and functions as Enforcing Agency for air quality.
- ▶ Self-regulation and co-regulation to be used by large industries to improve environmental performance of their operations.
- ▶ Further improve fuel quality and promote other greener alternative means of transport.
- ▶ Undertake studies on outdoor air quality, impacts of rain and impacts of air pollution on human health

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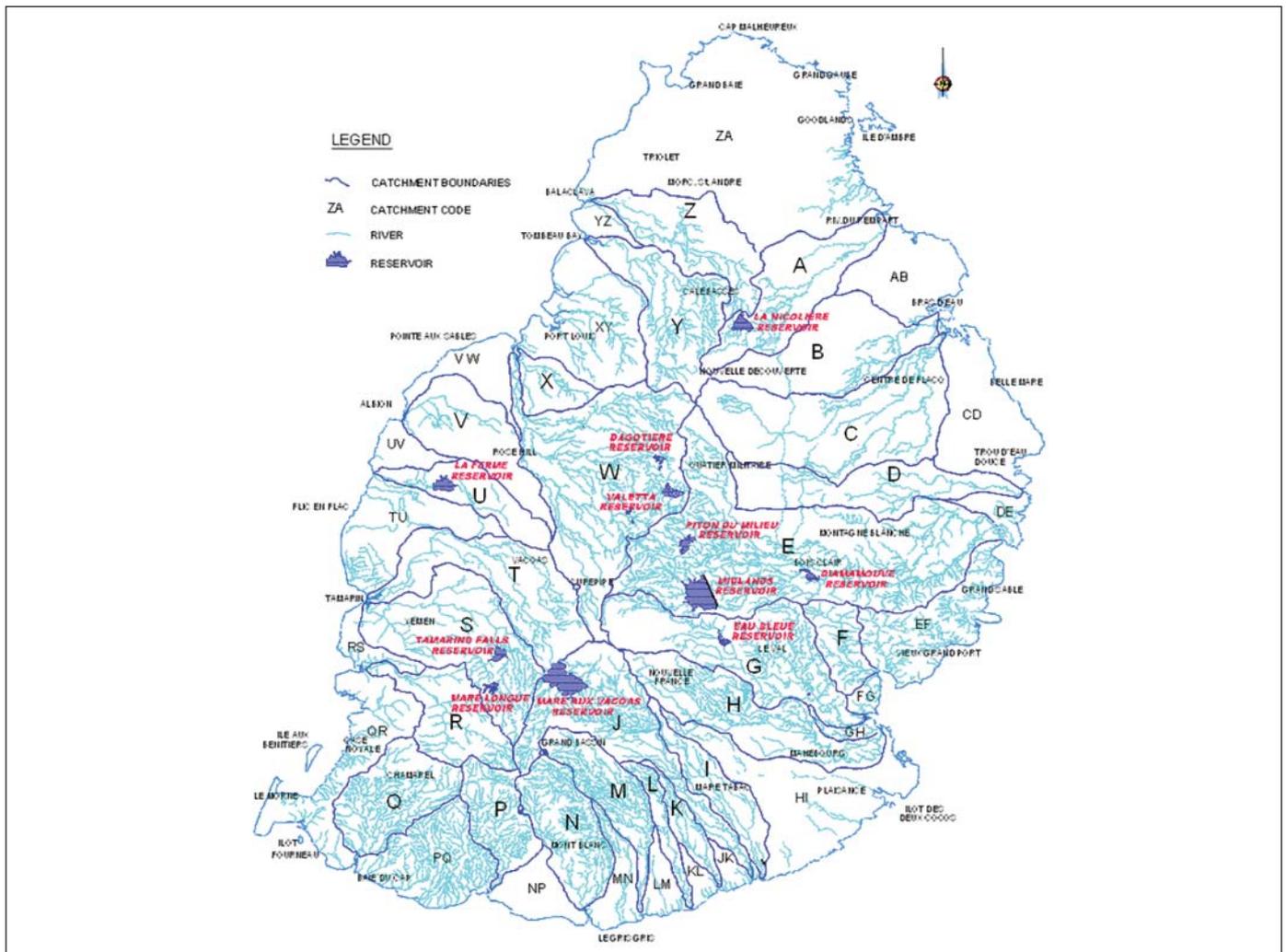
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Freshwater

Water is essential for healthy living and is vital for economic development. In Mauritius, the main sources of water are rainfall, river and underground water. The island receives an average annual rainfall of about 3,700 Mm³ (million cubic meters). However, owing to its topography, hydro-geological conditions and tropical location, Mauritius experiences high levels of rapid runoff³³. Only 10 % of the precipitation goes as ground water recharge, while evapo-transpiration and surface runoff represent 30% and 60% respectively.

Part of the surface runoff is conveyed to the impounding reservoirs, abstracted from rivers for domestic, agricultural and industrial uses and the remaining flows to the sea. Mauritius has a network of 25 major river basins and 21 minor river basins as shown in Figure 3.1. There are 5 main aquifers, 11 reservoirs and 350 boreholes.

Figure 3.1: Rivers and catchment areas in Mauritius



Source: Water Resources Unit

³³ Runoff is defined as that part of precipitation that flows towards the stream on the ground surface or within the soil (International Glossary of Hydrology, World Meteorological Organisation no. 385).

Since the past twenty years, economic development and improvement in the standard of living have led to an increase in water demand. However, as defined by the United Nations, Mauritius is a water stressed³⁴ country and needs to optimise collection and storage of water to meet individual needs and for future development.

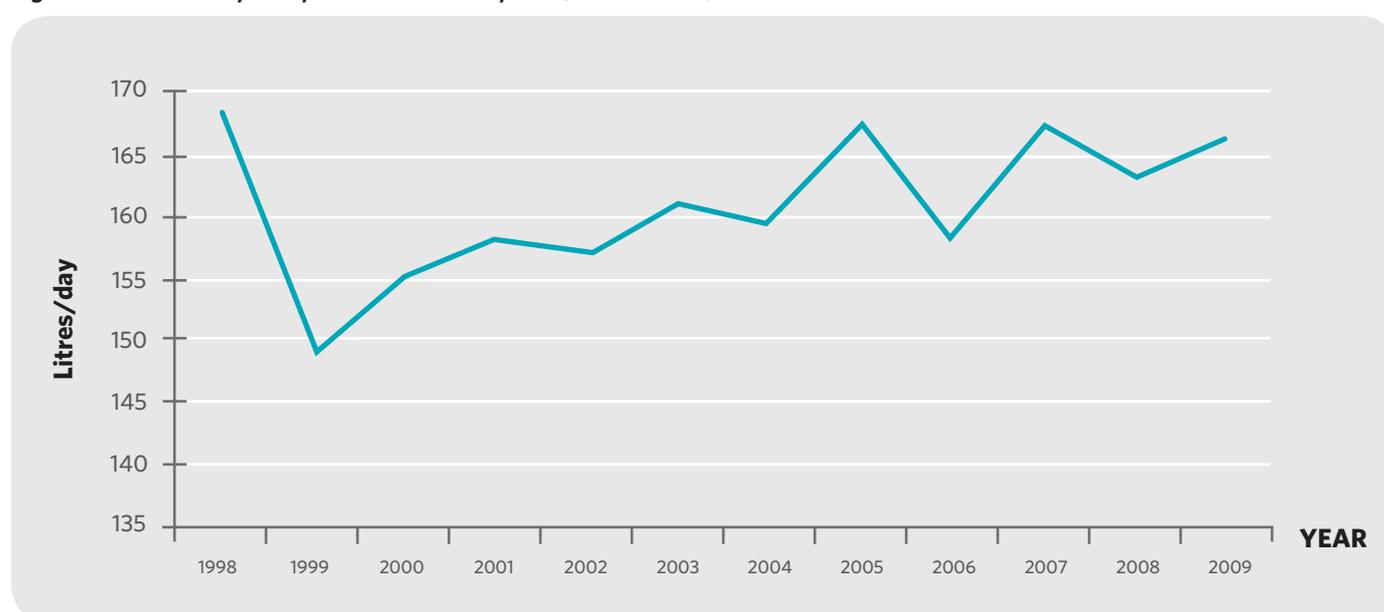
● 3.1 CHALLENGES

The principal challenges in the water sector arise due to increasing demand from economic development, agriculture, industry, tourism and a growing urban population. These in turn result in heavy water extraction and also pollution of water resources.

◎ 3.1.1 Population Growth

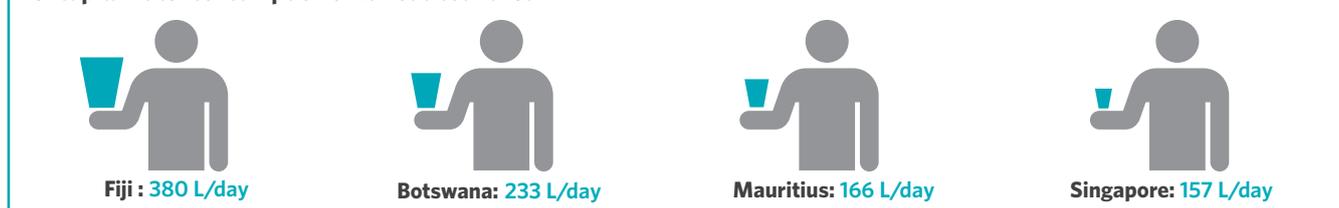
Population growth has a direct bearing on water demand. The trend in domestic per capita consumption of water has increased from 155 litres per day in 2000 to 166 litres per day in 2009³⁵, as shown in Figure 3.2.

Figure 3.2: Domestic per capita water consumption (1998 - 2009)



Source: Digest of Energy and Water Statistics, 2009

Per capita water consumption of various countries:

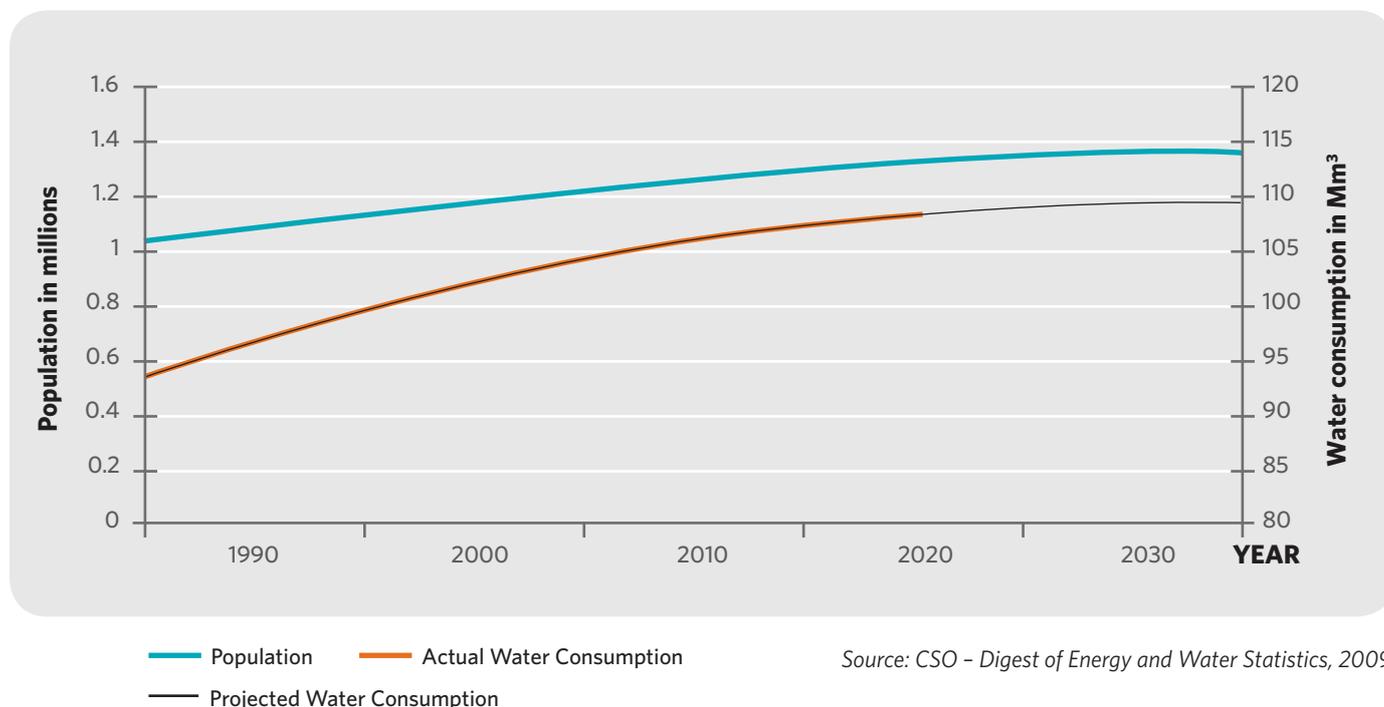


With the changing lifestyle of the local population, it is expected that per capita water demand will further increase. By 2040, total water demand is projected at 1,200 Mm³ per year, which is in excess of projected supplies and close to the utilisable renewable potential of 1,233 Mm³ per year. Figure 3.3 gives a projection of water consumption based on population growth (the projection does not take into account water needed for new developments such as hotels, IRS, new industries).

³⁴ Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor water quality restricts its use. Hydrologists typically assess scarcity by looking at the population-water equation. An area is experiencing water stress when annual water supplies drop below 1,700 m³ per person. When annual water supplies drop below 1,000 m³ per person, the population faces water scarcity, and below 500 m³ "absolute scarcity".

³⁵ The fall in consumption in 1999 is due to an unusually severe drought.

Figure 3.3: Population and water use projections



3.1.2 Water Demand

In 2009, Mauritius used 39.9% of water for irrigation, 36.8% for hydropower and 22.3% for domestic, tourism and industrial purposes, amounting to 1,000 Mm³. 56% of freshwater used came from surface water from rivers and streams, 31.9% from reservoirs and the remaining 12.1% came from groundwater aquifers. Table 3.1 shows water use in different sectors in 2009 and Figure 3.4 depicts water utilisation sector-wise since 2000.

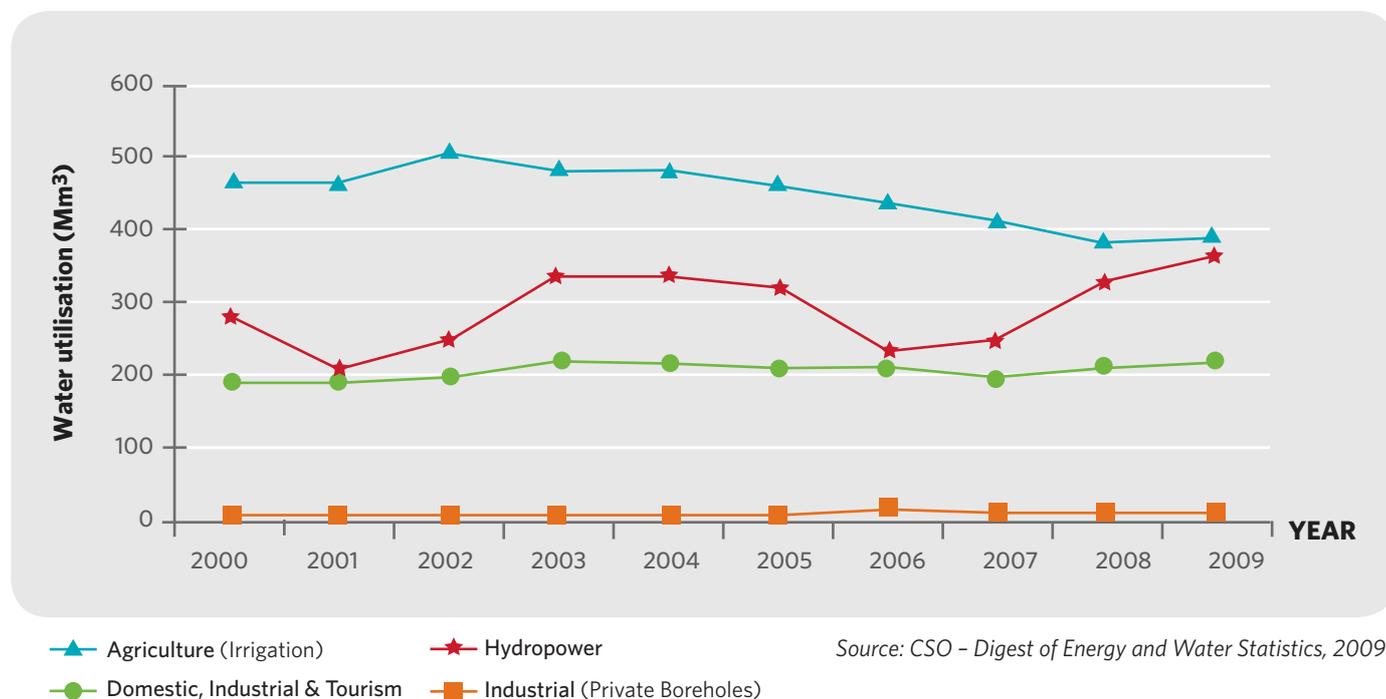
Table 3.1: Water utilization in 2009 (Mm³ per year)

	SURFACE WATER				
	RIVERS	RESERVOIRS	AQUIFERS	TOTAL Mm ³	%
Agricultural irrigation	320	74	5	399	39.9%
Hydropower ³⁶	199	169	-	368	36.8%
Domestic, Industrial & Tourism	36	76	111	223	22.3%
Industrial (Private boreholes)	5	0	5	10	1%
Total Mm³	560	319	121	1000	
%	56%	31.9%	12.1%	100%	

Source: CSO – Digest of Energy and Water Statistics, 2009

³⁶ It must be noted that part of the water used for hydropower generation is also used for irrigation.

Figure 3.4: Water use by sector (2000 - 2009)



A few coastal hotels in Mauritius have installed desalination plants so as to cater for their daily water requirements. While desalination is an alternative in such cases, especially during periods of water scarcity, the environmental impacts associated with desalination plants should be recognised. In addition to being an energy intensive process, desalination can cause disturbance to the marine environment through the discharge of brine in seawater. Moreover, abstraction of seawater for desalination done through boreholes³⁷ can also exacerbate the effects of salt water intrusion.

3.1.3 Pressures on Water Resources

Sources of freshwater pollution include industrial effluents, dumping of liquid and solid waste in rivers and streams, run off from agricultural fields and untreated sewage.

Dumping of Solid Waste in Rivers

Rivers and streams continue to be a common receptacle of waste generated from human activities and several cases of illegal disposal have been observed. In fact, considerable amounts of solid waste are collected during the cleaning of rivers undertaken by the Ministry of Environment and Sustainable Development.

Dumping of waste in rivers obstructs river flow, especially during heavy rains thus causing flooding of adjoining areas. These waste not only pollute water courses, but also give rise to odours and pose health hazards as they become breeding grounds for pests, rodents and other disease transmitting organisms.



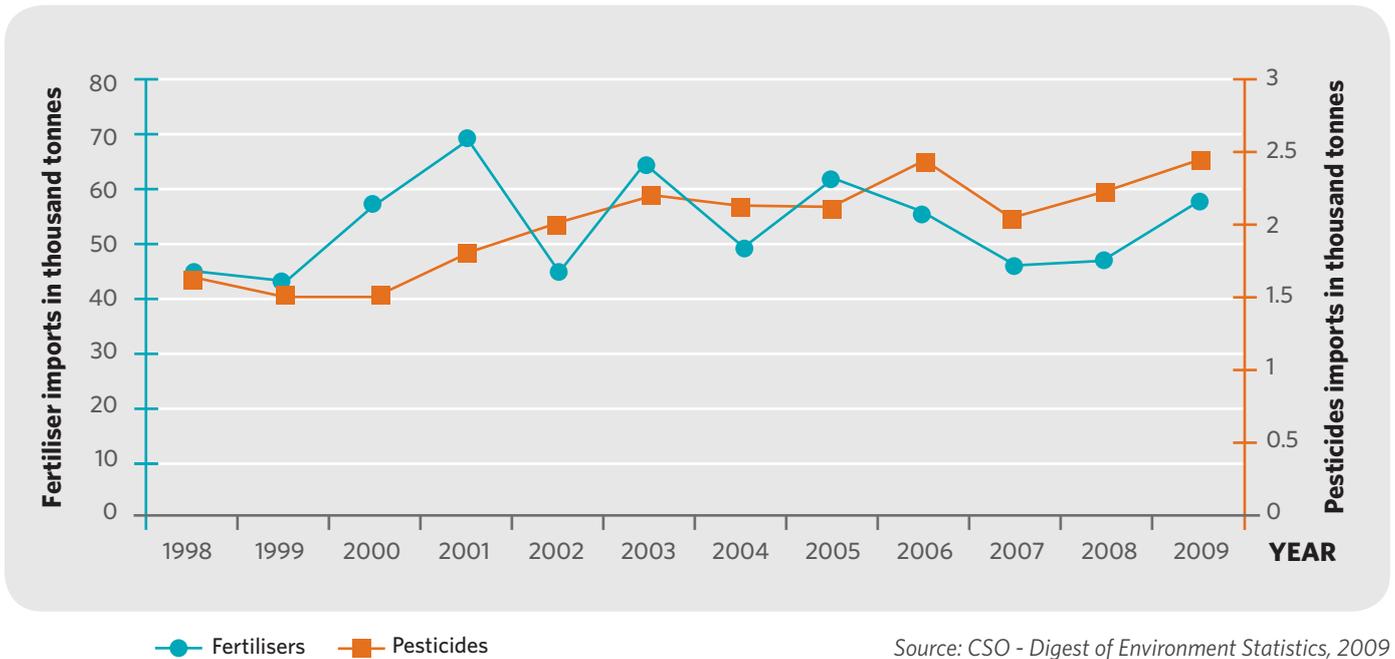
Dumping of solid waste in rivers

³⁷ The usual practice of hotels for undertaking desalination is to have two inland boreholes: one for abstraction of seawater and the other for discharge of brine, a by-product of desalination.

○ Agricultural Practices

The extensive use of agrochemicals can impact on water resources if not properly managed. Figure 3.5 shows the trend in the use of pesticides and fertilizers in Mauritius. It is to be noted that the importation of fertilizers has been fairly constant over the last decades, whereas a general increase has been noted for pesticides.

Figure 3.5: Imports of fertilisers and pesticides (1998 - 2009)



Farming activities also constitute a potential source of water pollution. For example, an independent study on ground water pollution at St. Martin Pig Farm in 2004 showed contamination of boreholes as a result of effluents from the pig farm. To improve food security, Government is encouraging diversification of agricultural activities and is promoting the setting up of livestock farms. Improper management of waste from these activities will put additional pressure on water resources.

○ Backfilling of Wetlands

Development in the coastal zone has led to backfilling of wetlands in regions like Flic en Flac and Grand Baie. As a result, the natural functions of wetlands, that is: water drainage and filtering of toxic substances, have been impaired. In 2008, a survey carried out in the Grand Baie region revealed a gradual decrease of the wetland area.

PERIOD	PERCENTAGE DECREASE IN AREA OF WETLAND
1980 - 1990	10 %
1990 - 2000	30 %
2000 - 2008	23 %

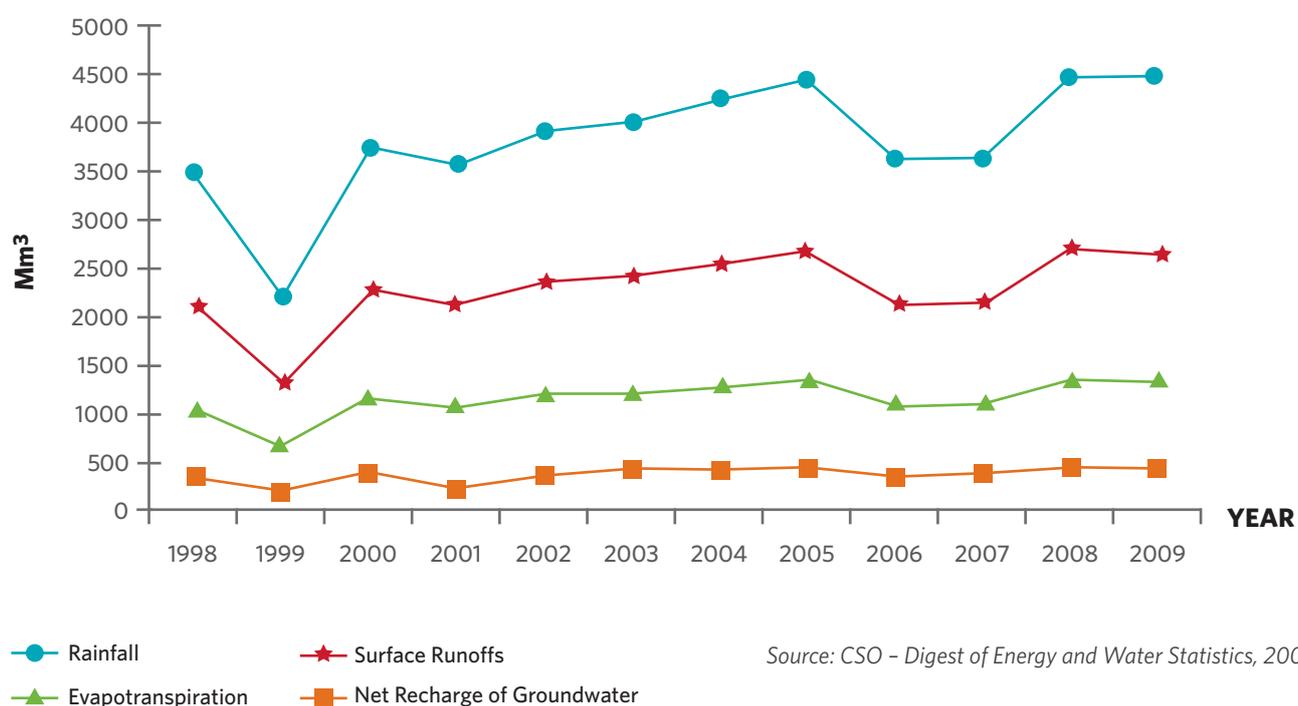
○ Sewage Disposal

Presently, only 29 % of the island is connected to the sewer network. The remaining 71% either dispose of their liquid waste in absorption pits or via septic tanks, given that sewerage systems are confined to some parts of the island namely: Port-Louis, parts of Grand Baie, Baie du Tombeau and Plaine Wilhems district. These non-point sources may potentially contaminate surface and groundwater resources.

3.1.4 Water Stress and Water Scarcity

The present usable freshwater potential has been estimated at 1,233 Mm³ per year, equivalent to 1,027 m³/person/year, which puts Mauritius within the water stressed category. It is to be noted that climate change is expected to further exacerbate water scarcity due to decreasing rainfall and rising temperatures. Between 1905 and 2007, a decrease of 8% in rainfall, along with more frequent droughts has been observed³⁸. Figure 3.6 gives the water balance for Mauritius.

Figure 3.6 - Water balance (1998 - 2009)



3.1.5 Surface and Groundwater Quality

The increasing use of water for domestic consumption, industrial and tourism development and the corresponding volume of wastewater which must be disposed of, have given rise to serious concerns of the impact of water pollution on health, freshwater resources and on biodiversity.

The water supplied to the public generally meets the required physicochemical and bacteriological standards for drinking water with a compliance level of 99.5 % to the World Health Organisation level (Central Water Authority Customer Charter, 2007). Similarly, monitoring of rivers,

groundwater and other freshwater bodies is carried out by the National Environmental Laboratory and the Central Water Authority Laboratory. The physical and chemical parameters measured for rivers are within the range of the Guidelines for Inland Surface Water Quality, therefore indicating that pollution effects are not significant. Table 3.2 lists the physicochemical parameters of some rivers around the Island.

³⁸ See Figure 9.6: Mean Annual Rainfall over Mauritius in Chapter 9: Climate Change.

Table 3.2: River water quality by selected physicochemical parameters for 2009

PARAMETERS (UNITS)	BLACK RIVER	RIVIÈRE DES CRÉOLES	RIVIÈRE LA CHAUX	RIVIÈRE DES ANGUILES	RIVIÈRE FRANÇOISE	RIVIÈRE DU POSTE (EAST)	GRAND RIVER SOUTH EAST	GUIDELINES FOR INLAND SURFACE WATER QUALITY
	BLACK RIVER GORGES	RICHE EN EAU	BEAU VALLON	RIVIÈRE DES ANGUILES	CONSTANCE	PROVIDENCE	BEAU CHAMP	
Temperature (°C)	20-28	23-29	24-29	23-27	NA-30	NA-30	NA-29	NA
pH	6.2-7.9	6.9-7.3	6.9-7.6	6.9-7.6	6.8-8.2	6.8-7.9	6.7-7.7	6.5-9.0
Dissolved Oxygen (mg/l)	7.6-8.8	6.1-7.0	6.8-8.4	7.8-8.6	7.7-8.6	7.6-8.3	7.7-8.6	6
Total Suspended Solids (mg/l)	ND-5	2-8	ND-5	ND-29	ND-11	ND-12	ND-30	10
Phosphate as P (mg/l)	0.01-0.02	<0.01-0.03	<0.01-0.05	<0.01-0.05	<0.01-0.02	0.01-0.02	<0.01-0.04	0.1
Chemical Oxygen Demand (mg/l)	NA-9	ND-6	ND-6	ND	ND-10	ND	ND-30	NA
Magnesium as Mg (mg/l)	NA-2.97	NA-3.44	NA-5.19	NA-4.73	NA-5.19	NA-8.57	NA-4.28	NA
Calcium (mg/l)	4.57-6.16	NA-9.73	NA-10.27	NA-7.65	NA-12.23	NA-19.21	NA-19.21	NA
Chloride (mg/l)	10.4-25.3	7.9-18.5	13.8-19.5	8.7-17.6	11.6-22.3	13.5-23.2	11.9-20.4	NA
Sodium (mg/l)	9.8-15.5	8.2-10.3	8.6-11.8	7.8-16.9	12.0-13.0	13.9-17.2	10.1-12.6	NA
Potassium (mg/l)	0.4-0.7	0.4-0.8	0.5-0.6	0.4-1.0	0.7-0.8	0.7-1.1	0.5-0.8	NA

NA - Not applicable ND - Not detectable

Source: CSO - Digest of Environment Statistics, 2009

● 3.2 PROGRESS

Initiatives undertaken at different levels to progress towards the sustainable management of the country's water resources include:

- A reformed institutional framework
- Implementation of the National Sewerage Programme
- Preparation of a National Water Policy
- Cleaning of rivers
- An integrated Water Resource Management Plan
- A Study on Environmentally Sensitive Areas
- Implementation of a National Programme on Sustainable Consumption and Production
- Measures to reduce unaccounted for water



Mare aux Vacoas Reservoir

Courtesy: S. Seeruttun

3.2.1 Management of Demand & Supply

On the main island, 99.7% of total population has access to safe filtered and treated piped water for domestic use (Central Water Authority, Customer Charter 2007). However, only 65 % of the population has 24 hour supply during wet seasons and this figure decreases depending on the severity of droughts.

3.2.2 Institutional and Legal Framework

The Water Resources Unit under the aegis of the Ministry of Energy and Public Utilities is responsible for the assessment, development, management and conservation of water resources in Mauritius. The Ministry of Environment and Sustainable Development is responsible for the preparation and issue of guidelines, standards and regulations on water quality and effluent limitations, while the Central Water Authority provides a sustainable water supply service to the people and to support economic development. The Wastewater Management Authority is responsible for the collection, treatment and disposal of wastewater from domestic, commercial and industrial sources.

The following standards and regulations have been promulgated by the Ministry of Environment and Sustainable Development for protection of water resources:

- Environment Protection (Standards for Effluent Discharge) Regulations 2003

- Environment Protection (Standards for Effluent Discharge into the Ocean) Regulations 2003
- Environment Protection (Effluent Discharge Permit) Regulations 2003, and
- Environment Protection (Industrial Waste Audit) Regulations 2009

Under the Environment Protection Act 2002 as amended in 2008, a number of undertakings (activities) are required to conduct an environmental impact assessment. These include amongst others, hotels, dye houses, distilleries and power generation plants.

3.2.3 Implementation of the National Sewerage Programme

A National Sewerage Programme was prepared in 1994 under the First National Environmental Action Plan with the aim to connect 50% and 80% of the population to the public sewerage network by the year 2015 and 2030 respectively. Some of the main objectives are to improve sanitation and to halt and reverse the trend of environmental degradation. Since early 2000, the sewerage network is being extended to increase connection in the District of Port Louis, part of Plaines Wilhems and Grand-Baie region. The preparation of a second sewerage master plan has been initiated.

Table 3.3 shows the municipal wastewater treatment plants operational in Mauritius to date including their respective level of treatment and the final disposal of the respective treated wastewater. The annual volume of wastewater treated by public wastewater treatment stations has increased from 20.5 Mm³ in 2000 to about 25.0 Mm³ in 2009.

Table 3.3: Operational municipal wastewater treatment plants in Mauritius

TREATMENT PLANT	LEVEL OF TREATMENT	DISPOSAL	ACTUAL FLOW, m ³ /DAY	TREATMENT PLANT DESIGN CAPACITY, m ³ /DAY	NUMBER OF HOUSEHOLDS SERVED BY THE SEWERAGE SYSTEM
Grand Baie	Tertiary treatment	Borehole injection or irrigation	1,500	5,500	1,500
Baie du Tombeau	Preliminary treatment	Long sea outfall	25,000	45,000	1,500
Montagne Jacquot	Primary treatment followed by disinfection	Long sea outfall	30,000	48,000 (phase 1)	20,000
St. Martin	Tertiary treatment	Irrigation/ sea outfall	42,000	69,000 (phase 1)	27,000

Source: UNEP-GEF WIO-LaB Project, National Report on Status of Municipal Wastewater Management in Mauritius (October 2007, figures updated in May 2010).

The Ministry of Environment and Sustainable Development carries out an Independent Audit of Wastewater Projects yearly. The audit exercise has revealed that wastewater treatment plants are operating satisfactorily with effluents being most of the time within permissible limits of the relevant standards (irrigation, discharge into the ocean as applicable). In Baie du Tombeau, microbiological levels in lagoons are high on some occasions since wastewater is treated at preliminary level only. With regards to private wastewater treatment plants in hotels, the treated effluents are reused for irrigation of landscaped areas.

3.2.4 Preparation of a National Water Policy

A National Water Policy is being prepared. This will include the review of major legislation for a better protection of water resources. The Master Plan for the water resources of Mauritius will set strategies for implementing a number of the policy measures.

3.2.5 Projects on Cleaning of Rivers

Following the rise in vector-borne diseases (e.g. Chikungunya) that hit Mauritius in 2006 and flooding episodes experienced in various places, mostly as a result of heavy siltation and accumulation of debris in rivers, Government has intensified the cleaning of rivers all over the island. Between 2010 and 2012, it is expected that 15 km of rivers will be cleaned and maintained to restore water flow (Programmed Based Budget 2009, Ministry of Environment and Sustainable Development).

3.2.6 Integrated Water Resources Management Plan

The Water Resources Unit has worked out an integrated plan for harnessing additional resources to meet the water requirements of the various sectors of the economy up to the year 2040. The 1991 Master Plan for water resources had identified several projects, which have been implemented during the last two decades. These comprise further exploitation of ground water, construction of

run-of-river diversion schemes and a number of storage dams. As a first step, the construction of Midlands Dam had started in January 2000 and was completed in December 2002. Other dams planned and in progress, as shown in Table 3.4, will add 53.4% to existing capacity.

Taking into consideration the change in land use, increasing water demand by the different sectors, the emergence of new economic projects (e.g. new hotels and Integrated Resort Scheme) and climate change, the Ministry of Energy and Public Utilities is currently reviewing the existing Master Plan of 1991, which includes an assessment of the present situation and will identify and recommend the strategy to be adopted in the long term.

Table 3.4: Future projects for increasing water storage capacity

STORAGE DAMS	PROPOSED IMPLEMENTATION DATE	REGIONS TO BE SERVED	ESTIMATED CAPACITY
Bagatelle Dam	2010	Lower Plaines Wilhems & Port Louis	13 Mm ³
Rivière des Anguilles Dam	2011	South Water Supply System	14.25 Mm ³
Chamarel Dam	2015	South District Water Supply System	11.33 Mm ³
Calebasses Dam	2020	North District Water Supply System	5 Mm ³
Mon Vallon Dam	2020	Lower Plaines Wilhems & Port Louis	5 Mm ³
Total planned	2010-2020	Central, South and North regions	48.5 Mm³

3.2.7 National Programme on Sustainable Consumption and Production

The Ministry of Environment, in collaboration with UNEP, has developed the following project “National Programme on Sustainable Consumption and Production (SCP) for Mauritius”. One of the strategic priorities identified in the programme concerns sustainable water consumption. The following projects have been identified and are at various stages of implementation:

- Establishment of water efficient plumbing codes and regulations.
- Regulations for mandatory water efficiency audits for high water users.
- Development of rain water harvesting systems
- Initiation of a sustained national awareness campaign on water savings.

3.2.8 Study of Environmentally Sensitive Areas in Mauritius

The Ministry of Environment and Sustainable Development undertook a study of Environmentally Sensitive Areas in Mauritius and Rodrigues (ESA Study) with the main objective to identify, classify and map all ESAs and to develop a comprehensive policy as well as legislative framework for the protection, conservation and sustainable development of ESAs. Boreholes, reservoirs, lakes and rivers have been identified as ESA types. The study has also developed a ranking system for three categories of ESAs, as well as a concrete policy and legal framework for the protection and management of the ESAs. The study has been approved by Government and a legislative framework will be established during the 2010-2012 period (Programmed Based Budget 2009, Ministry of Environment and Sustainable Development).

3.2.9 Awareness Campaigns

Different authorities, including the Ministry of Environment and Sustainable Development, the Ministry of Energy and Public Utilities and the Central Water Authority (CWA) conduct major awareness raising campaigns aimed at different target groups and the general public for the protection and judicious use of water resources, especially during severe droughts.

3.2.10 Measures to Reduce Unaccounted for Water

Unaccounted for water³⁹(non-revenue water) averages 47% of production out of which at least 65% is lost through leakage and 35 % through illegal tapping. The CWA has embarked on an ambitious project for the reduction of unaccounted for water to an acceptable level of 25 %. The CWA has also embarked on a pilot project encompassing 24 regions, where an integrated approach for reducing non-revenue water was adopted. As at January 2010, the overall efficiency of the network in the targeted regions was 59%. The CWA will be extending the programme to the northern and eastern regions.

3.2.11 Quality and Ecological Assessment of Freshwater Bodies

The National Environmental Strategies 2008 has identified this project as one of the priority projects and covers the entire surface waters including lakes and rivers. The specific objectives of the project are:

- To enable development of a single program that addresses sources of water pollution across all economic activities.
- To enable development of a water quality monitoring framework that would facilitate decision making on water pollution issues.
- To enable a holistic approach to preservation of water quality.
- To establish a database on freshwater ecosystems.

³⁹ Unaccounted for water: water that is lost through leaks or through illegal tapping.

● 3.3 PROSPECTS

ISSUES	BUSINESS AS USUAL SCENARIO FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Water stress and water scarcity including reduction in rainfall due to climate change	Implement the Integrated Water Resource Management Plan	Increased water storage capacity
Rising water consumption	Implement the National Water Policy, including water quality management	Per capita domestic water consumption stabilises to 160 l/day
47 % unaccounted for water	Implement the National Programme on SCP	85 % of the population have uninterrupted water supply
Surface and ground water quality	Implement Phase 2 of the National Sewerage Programme	80 % of households connected to the sewer network
	Sustained cleaning of rivers	Unaccounted for water reduced to 25 %
	Implement the recommendations of the ESA Study	
	Implement programme for the reduction of unaccounted for water	

The business as usual scenario makes the following assumptions:

- A rising water consumption as a result of sustained economic growth.
- Reduced rainfall as a result of climate change.
- Construction of additional dams for storage of water as per the IWRM Plan leading to an increased storage capacity during rainy periods.
- The ongoing implementation of the CWA programme to reduce unaccounted-for-water and the renewal of the piping network.
- The implementation of the National Programme on SCP which will promote rainwater harvesting, increase awareness on water savings and establish water efficient plumbing codes.
- The implementation of the second phase of the National Sewerage Programme will lead to improved groundwater quality through a reduction of on-site disposal systems (cesspits, septic tanks with absorption pits) and will also promote the reuse of treated water for agriculture. The reuse of treated wastewater for irrigation will also smoothen the demand for freshwater for irrigation purposes.

RISK OF FAILURE (WORST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Water stress and water scarcity including reduction in rainfall due to climate change	No additional dams are constructed	Severe water shortage and increase in water prices
Rising water consumption	National Water Policy not implemented	Reduction of per capita consumption due to unavailability of water
47 % unaccounted for water	National Programme on SCP not implemented	Reduction in economic growth
Surface and ground water quality	National Sewerage Programme not implemented	Unaccounted for water is 47 % or more
	No cleaning of rivers	Deterioration of the water quality by wastewater disposal
	Recommendations of the ESA Study not implemented	
	Unaccounted for water increases	

The assumptions used in the formulation of the worst case scenario are:

- Reduced rainfall as a result of climate change
- The water storage capacity remains constant since no additional dams are constructed.
- The available water storage capacity is not sufficient to capture enough water during high torrential rains. A considerable amount of water is lost by surface run-off.
- There is a deterioration of the water quality due to poor sanitation and the degradation of the ESAs.
- There is an increase in unaccounted for water due to poor maintenance of the distribution network

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Water stress and water scarcity including reduction in rainfall due to climate change	Implement the Integrated Water Resource Management Plan	Increased water storage capacity
Rising water consumption	Implement the National Water Policy including water quality management	Per capita domestic water consumption reduced to 140 l/day
47 % unaccounted for water	Implement the National Programme on SCP	Rainwater harvesting implemented in schools and 20 % of the population
Surface and ground water quality	Implement Phase 2 of the National Sewerage Programme	95 % of the population have uninterrupted water supply
	Promulgate and enforce laws related to water	80 % of households connected to the sewer network
	Sensitisation and awareness of the Mauritian Population	Unaccounted for water reduced to 20 %
	Implement the recommendations of the ESA Study	
	Implement programme for the reduction of unaccounted for water	

The assumptions made in the formulation of the best case scenario are as follows:

- The integrated water resource management plan is fully implemented with the construction of all dams and water collection infrastructure.
- The 2nd phase of the national sewerage programme is fully implemented and all municipal wastewater treatment plants are operating satisfactorily.
- Implementation of the National Programme on SCP.
- Laws are promulgated and strictly enforced so as to protect the water media.
- The CWA programme to reduce unaccounted for water is implemented island-wide.
- A fully conscious population on the issue of water savings.

3.3.1 Policy Options for the Future

In the Best Case Scenario, Mauritius is fully aware of the challenges in the water sector and has initiated several projects to increase water storage capacity, water supply and to further improve water quality. For a more integrated approach of water resources management, the Water Authority is fully operational and responsibilities of the different agencies in the water sector namely the Central Water Authority, Water Resources Unit, Irrigation Authority and Wastewater Management Authority have been harmonised.

In order to increase water availability and protection of freshwater resources, the following actions are undertaken:

- Promote the Integrated Water Resources Management approach.
- Upgrade the water distribution network and reduce unaccounted for water.
- Review water related legislations.
- Review the present water tariff structure in order to foster water reuse and conservation, especially in the agricultural sector where freshwater tariffs for agricultural use is less than treated wastewater sold by the Wastewater Management Authority.
- Establish high water tariffs and charges as a disincentive to prevent unsustainable consumption of water.
- Achieve significant water conservation in industry, domestic and agricultural sectors.
- Implement the Sustainable Consumption and Production concept in the water sector through: optimised water use in industries and in households, promotion of rainwater harvesting and promotion of efficient water use techniques in agriculture.
- Consider mandating the installation of water-saving devices in building regulations.
- Work in partnership with industries to ensure that they do not pollute water resources and that they adopt cleaner production techniques; abide by regulations and economic instruments for good water quality.
- Develop and implement a water quality indexing system for surface waters.
- Enhance water quality monitoring and enforcement through improved synergies among the various organisations involved in such exercises.
- Implement sustainable wastewater collection, treatment and disposal systems.
- Optimise re-use of treated wastewater.
- Carry out the Quality and Ecological Assessment of Fresh Water Bodies Project (QEAP) to cover the entire surface waters including lakes and rivers.

Chapter Summary

CHALLENGES

Mauritius has to overcome a number of challenges in order to meet the water needs of individuals and for future development. The major issues in the water sector are:

- ▶ Mauritius is a water-stressed country and faces water scarcity, which is being further exacerbated by climate change.
- ▶ Per capita demand for water has increased from 155 L/day in 2000 to 166 L/day in 2009. Rising water consumption is due to population growth, changing consumption patterns and economic development.
- ▶ 47% of water (unaccounted-for-water) is lost through leaks in the piping systems and illegal tapping.
- ▶ Rainwater harvesting is not widespread in Mauritius and more than half of rainwater is lost.
- ▶ Freshwater resources are threatened by dumping of solid waste in rivers, heavy use of agrochemicals, backfilling of wetlands and sewage disposal.
- ▶ Legislation to reduce pollution has been poorly implemented.
- ▶ 35% of the population has interrupted water supply.
- ▶ Only 29% of the population is connected to the sewerage network. Little waste water is reused. Irrigation systems commonly use ground water supplies, which have a high potential to be used for potable purposes.

PROGRESS

Mauritius has made significant investment in the water sector and to date 99.7 % of the population is connected to the piping network. Currently, 65 % of the population has uninterrupted water supply. In order to increase the availability of water, Government has launched various initiatives aimed at increasing water supply, namely:

- ▶ Reformed institutional framework for the assessment, development, management and conservation of water resources in Mauritius.
- ▶ Implementation of the National Sewerage Programme.
- ▶ Preparation of a Wastewater Master Plan Study for the period 2014 - 2033.
- ▶ Preparation of a National Water Policy and an Integrated Water Resources Management Plan to meet water requirements till 2040.
- ▶ An ambitious project for the reduction of unaccounted for water to an acceptable level of 25% has been initiated.
- ▶ Ongoing river clean-up to prevent siltation and accumulation of wastes.
- ▶ The physical and chemical parameters measured for a number of rivers are within national guidelines.
- ▶ Implementation of the National Programme on Sustainable Consumption and Production, which promotes water-use efficiency.

PROSPECTS

The future challenge is to satisfy the demand of water both in terms of quality and quantity. The main actions for the future are to:

- ▶ Set up and operationalise a Water Authority to enhance overall water management.

Chapter Summary

PROSPECTS

- ▶ Implement the Integrated Water Resources Management Plan.
- ▶ Review water related legislations.
- ▶ Reduce unaccounted for water to 25% by 2030.
- ▶ Promote sustainable watershed management.
- ▶ Achieve significant water conservation in industry, domestic and agricultural sectors.
- ▶ Implement the sustainable consumption and cleaner production concepts in industry to reduce water consumption and pollution loads.
- ▶ Implement sustainable water collection, treatment and wastewater disposal systems and optimise reuse of treated wastewater.
- ▶ Connect 50% of the population to the sewerage network by 2015 and 80% by 2033.
- ▶ Promote Research and Development for improving water management.
- ▶ Build capacity of water management professionals.

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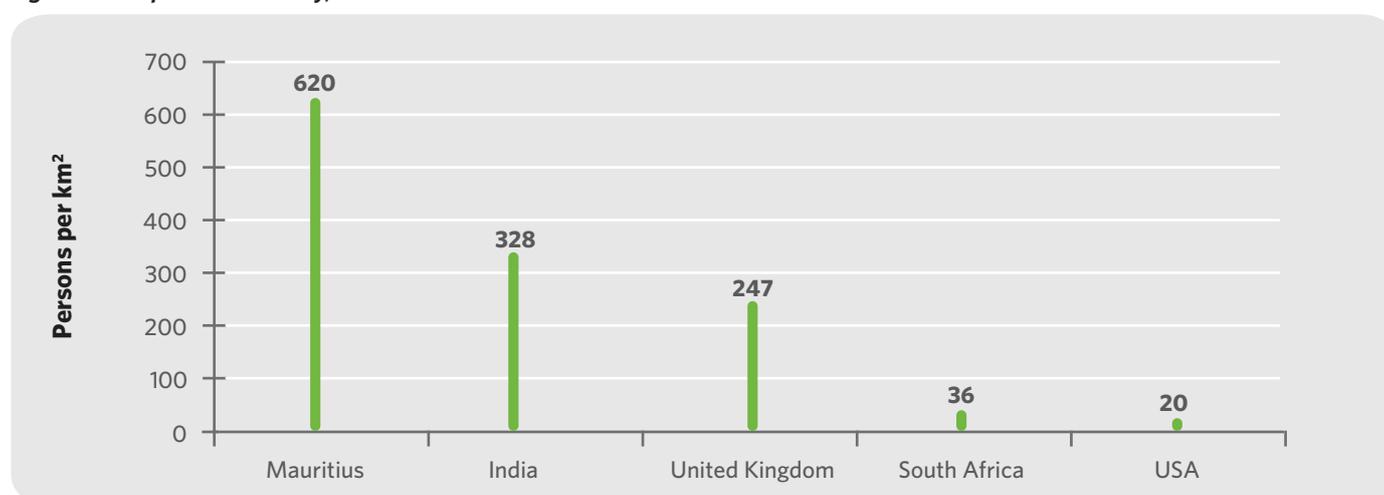
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Land

Land is a key finite and fragile resource that plays an important role in supporting livelihoods, economic growth and ultimately human wellbeing. Land includes: soil, which is important for agriculture and food production; land cover essential for the environment (e.g. water catchment and storage, forestry) and economic activity and landscapes that are necessary components for human habitat, recreation and welfare. As a result, control over land and its use is often an object of intense human interaction.

The Republic of Mauritius consists of a group of islands with a total land area of around 2,045 km² within an Exclusive Economic Zone of 1.9 million km². Mainland Mauritius is the largest with an area of 1,865 km² and comprises a coastline of 322 km, out of which some 42 km are declared public beaches (National Assessment Report, 2010). Land in Mauritius is largely privately owned with the exception of State Lands distributed throughout the island and the coastal Pas Géométriques⁴⁰, which are government owned. Given the limited land resources and the pressure for development, a judicious use of land and mix of activities are required to mitigate various impacts related to: food, water and energy security, climate change, coastal development, urban development, traffic congestion, poverty alleviation, development support and sanitation.

Figure 4.1: Population Density, 2006



Source: <http://www.worldatlas.com>

⁴⁰ The 'Pas Géométriques' are the reserved lands along the sea coast, the breadth of which is 81.2 metres measured from the high water mark. They form part of the 'domaine public' and are inalienable and imprescriptible.

● 4.1 CHALLENGES

◎ 4.1.1 Increasing Demand for Land

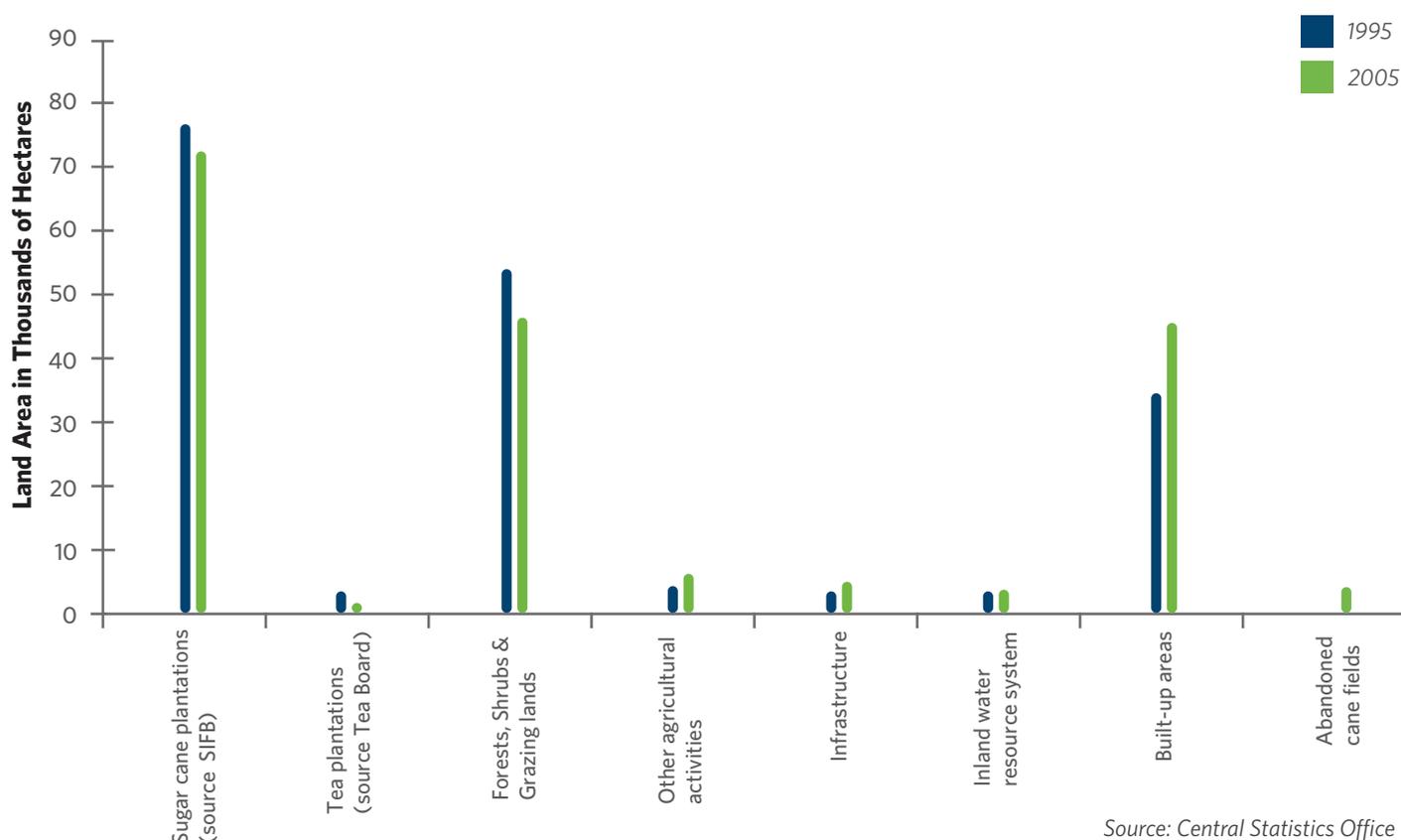
Like many Small Island Developing States, Mauritius has a limited area of land suitable for development. Mauritius is one of the most densely populated areas in the world, particularly in coastal areas where land has a prime value for competitive uses. Figure 4.1 shows population density in Mauritius in 2006 compared to other countries. The population density of Mauritius was 665 persons per km² as at end 2009.

Rapid economic development in Mauritius over the past 25 years has seen increasing pressures on land resources with rising demand for urban and infrastructural expansion and to support the agricultural, industrial, manufacturing and tourism sectors. 400 ha may be needed for new schools, colleges and universities and other institutions, in addition to the current major school construction programme.

4.1.2 Agricultural Production

Although agriculture still occupies 43 % of the total land area, over the last decade more and more agricultural lands have been converted to other uses such as: expansion of the road network, construction of hotels, Integrated Resort Schemes (IRS), industrial and Information and Communication Technology (ICT) parks and residential estates including those of the Voluntary Retirement Scheme⁴¹. Figure 4.2 shows the different land-uses by category.

Figure 4.2: Land use by category in 1995 and 2005



Source: Central Statistics Office

With the dismantling of the ACP-EU sugar protocol⁴², Mauritius is diversifying its agricultural sector into a wider range of crops and livestock. As part of the diversification programme, some 5,000 ha of land unsuitable for sugar cane cultivation will be released for other activities. Part of this acreage would be available for crops and livestock farming, for forestry, while others will be converted for non-agricultural uses. The total food requirement of the country is estimated at 686,000 tonnes annually, with a local production meeting only 23% of national consumption. Consequently, additional land will be required for food production, in order to increase national food security, thus putting additional pressures on land.

⁴¹ The Voluntary Retirement Scheme was introduced in 2001 and some 8,200 employees of the sugar industry opted for voluntary retirement. The benefits guaranteed to such employees were 300 m² of land and a cash compensation of 2 months' salary per year of service for male agricultural workers who are 55 years and above and female agricultural workers who are 50 years and above (Government of Mauritius, 2005).

⁴² In 2003, the legality of the ACP-EU Sugar Protocol was challenged at the World Trade Organisation. Rulings of the World Trade Organisation compelled the EU to reduce its import tariffs on sugar, including some 1.6 million tonnes currently imported from ACP countries and India. However, studies undertaken indicate that Mauritius will not be able to be a cost competitive supplier in the new market environment. Unless the costs of production in the sugar industry are substantially brought down and other avenues explored through rapid diversification within the sugar cane cluster, the Mauritian economy will face a catastrophic situation. In such a context, Mauritius has no option but to undertake a major reform to increase its level of competitiveness.

4.1.3 Development Along the Coastline

Approximately 20% of the population reside in the coastal zone⁴³. The latter also supports varied economic activities such as: agriculture, recreation, tourism, fisheries, trade and industry. Many coastal settlements and related developments do not conform to the planning guidelines for setback, sea defences, access to the beach and height of buildings. Certain non-conforming settlements are mainly due to illegal occupation of State Land where the usual permitting systems of construction of houses were not complied with and this can be seen at Mahebourg and La Gaulette.

On the other hand, at Flic-en-Flac and Grand-Baie, unsustainable patterns of development such as development on wetlands and the absence of drains, have been noted mainly due to lack of proper planning, non-compliance of promoters and poor enforcement mechanisms. These areas are prone to floods during heavy rains and cyclones. In many coastal areas, rapid development of housing and commerce has outstripped the rate of provision of environmental services. Furthermore, increasing tourist arrivals with the target of attracting two million tourists by 2015 is putting pressure on already scarce and fragile coastal lands for the development of more hotels and IRS.

4.1.4 Traffic Congestion

Another important area of concern within the built environment is traffic congestion which is concentrated along the main routes to Port-Louis. Most Government departments, the commercial port and business headquarters are located in Port Louis. Despite Government policies to encourage industry and employment in rural areas, 60% of industries are located in the central urban zones. The population living in the Plaines Wilhems District

has grown from 321,713 in 1990 to 382,996 in 2009 out of a total population of 1,237,790 (Digest of Demographic Statistics, 2009). As a consequence, the influx in the city centre has amplified resulting in traffic congestion, particularly during the peak hours thus increasing journey times and fuel consumption.

Another major cause of traffic congestion is the significant increase in the number of vehicles on the road, which was not accompanied by adequate road infrastructure. For instance the total vehicles on the road was 291,605 in 2004 and 366,520 in 2009, while the road network only increased from 2,020 km in 2004 to 2,066 km in 2008 (Digest of Road Transport and Road Accident Statistics, 2009).

4.1.5 Development on Wetlands

Environmentally Sensitive Areas (ESAs), such as wetlands, are being degraded or lost mainly due to backfilling for housing and hotel development or illegal construction. Estimates made by the Department of Environment in 1998 indicate that some 20% of wetlands in the Northern Tourist Zone and 50% in the western area of Flic en Flac have been backfilled and that 50% of remaining wetlands are under pressure including the Belle Mare Tourist Zone on the East coast (National Environmental Strategies, 1998). Box 4.1 summarises ecosystem functions of wetlands.

There is no legislation for the protection of wetlands, but development is controlled to some extent through the National Ramsar Committee, which oversees wetland management, the EIA mechanism and the Outline Planning Schemes. However, the present setup is largely inadequate and the promulgation of the Wetland Bill is sorely felt.

BOX 4.1: IMPORTANCE OF WETLANDS

- Unique ecosystems where aquatic and terrestrial life-forms assemble.
- Provide crucial habitats for terrestrial species having an aquatic life stage or requiring water for survival.
- Capture surface water flows, slowing down water movement to the sea.
- Natural sediment and pollution traps.
- Promote sedimentation of large particulate matter.

⁴³ Coastal zone: As per the Environment Protection Act 2002, 'Coastal zone' is defined as any area which is situated within 1 km or such other distance as may be prescribed from the high water mark, extending either side into the sea or inland.

● 4.2 PROGRESS

◎ 4.2.1 The National Development Strategy and its Related Enactments

During the last five years, concerted efforts have been made to promote sustainable land use. The National Development Strategy (NDS) provides the basis for land use planning. It was approved in 2003 and subsequently given legal force through proclamation of the relevant section of the Planning and Development Act in June 2005. In September 2006, the policies and proposals of the NDS were successfully translated at the local level through the preparation and approval of local development plans (commonly known as Outline Planning Schemes). Further monitoring of these local plans are being undertaken to keep these up to date and in line with present socio-economic objectives of Government.

The Planning and Development Act 2004 provides an updated framework for land use planning and decision making at national and local level. A new awareness is emerging for the value of architectural style, removing eyesores and promoting a built environment that is in harmony with the natural environment of the country (e.g. palm tree type antenna for mobile phones). But much more needs to be done in terms of good planning and urbanisation.

A series of Planning Policy Guidance (PPG) have been prepared to assist developers, Local Authorities and the general public in complying with principles of good design, appropriate siting and location of activities. For example, a

new housing scheme must cater for a green space and satisfy minimum parking requirements. The PPG also seeks to avoid locating hazardous businesses close to sensitive uses but encourages the creation of small and medium business estates close to but outside residential zones.



Palm tree type antenna for mobile phones

BOX 4.2: PLANNING POLICY GUIDANCE

The objective is to create a set of performance criteria and design standards that are applicable to most forms and scales of development for use by individual site owners, developers of large schemes and for assisting Government and Local Authorities when considering permit applications. Design Guidance has been produced for a range of key land uses, including:

- Residential development
- Commercial development
- Industrial development
- Hotels and Integrated Resort development

Design Sheets have also been produced that consider special design circumstances and supplement the key land use Design Guidance.

4.2.2 The Environment Protection Act

The Environment Protection Act 2002 as amended in 2008 provides for control over land use planning and development through the Environmental Impact Assessment (EIA) and Preliminary Environmental Report (PER) mechanisms. EIA and PER enable project promoters take into consideration environmental issues at the stage of conception and planning. It also allows developers to compare alternative technologies and adopt pollution prevention and control strategies.

4.2.3 The Land Administration, Valuation and Information Management System

Government has embarked on the Land Administration, Valuation and Information Management System (LAVIMS) project since December 2008. The LAVIMS project carries three major components namely: the establishment of a cadastral database, the adoption of a modern property valuation system and the setting up of a parcel-based Deeds Registration System, integrated in an appropriate Information Management System (Government Information Service, 2008). The programme is aimed at establishing the foundation of a modern and effective land administration and management system for Mauritius.

4.2.4 Social Housing Project

In order to reduce illegal occupation of State Land and to alleviate poverty, Government has initiated various projects and initiatives aimed at providing decent housing to those in need. To date, some 10,500 low cost housing units have been built. The low cost housing projects also have to adhere with the relevant planning guidelines.

4.2.5 Sugar Sector Reform Plan

With regards to the Sugar Sector Reform Plan, Government will obtain about 800 ha of land from the Mauritius Sugar Producers Association. Government will use around 400 ha of that land to set up a programme for social housing on 20 sites in partnership with NGOs and drawing on Corporate Social Responsibility as well as Government funds. The remaining 400 ha is earmarked for agricultural diversification.

4.2.6 Cross Border Initiatives

The Regional Development Company Ltd. is a private company with the Government of Mauritius as sole shareholder. Its object is to promote regional food security and other regional development projects. The Government of Mozambique is proposing to lease some 23,500 hectares of land (18,500 hectares in the Province of Maputo and 5,000 in the Province of Manica) to Mauritius. The land will be used to cultivate major crops such as wheat, rice, pulses, maize, onions and potatoes to attain food self-sufficiency, as well as for the development of renewable energy projects (Government Information Service, 2010).

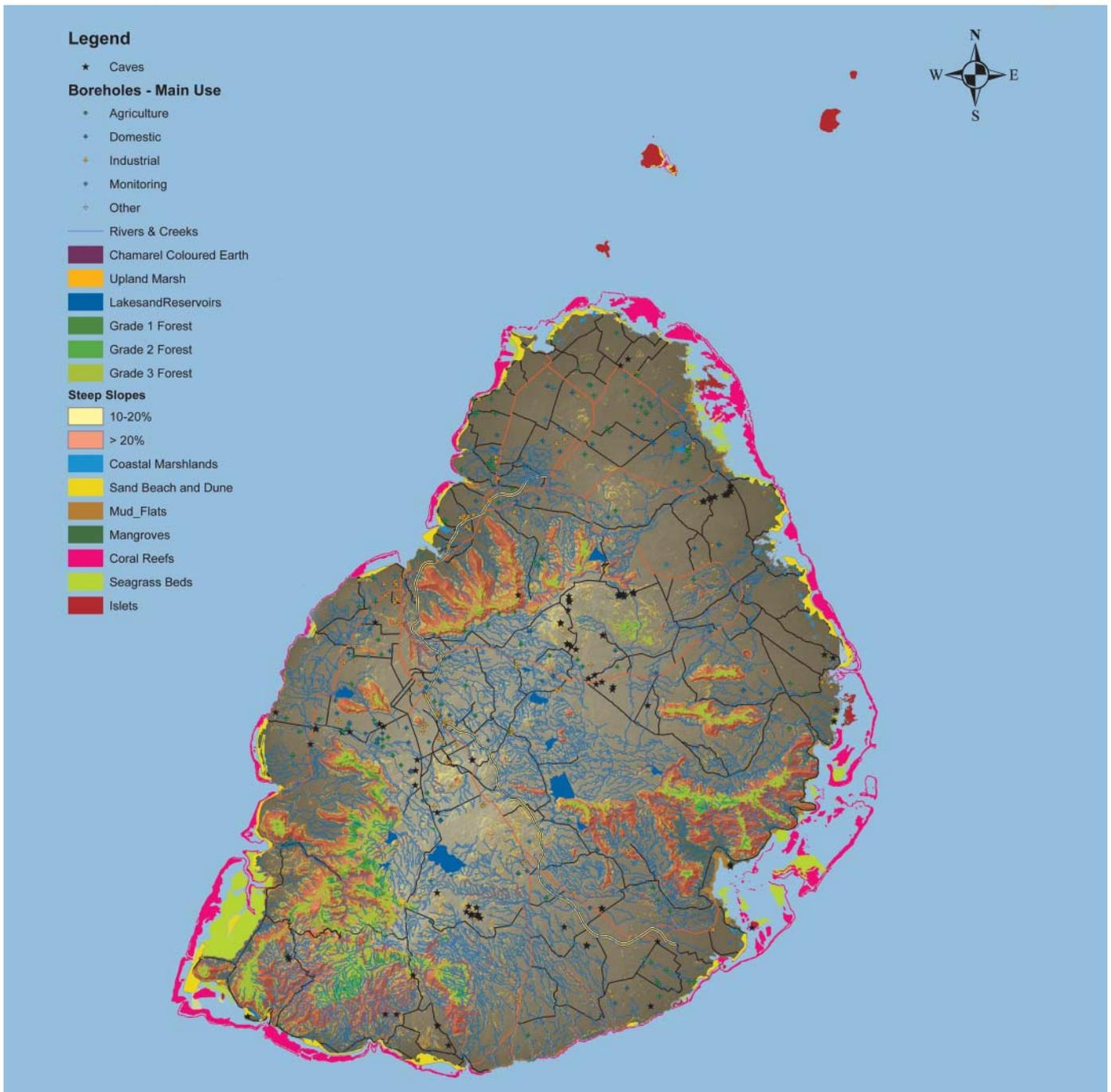
4.2.7 Management of Environmentally Sensitive areas

A study of Environmentally Sensitive Areas (ESAs) in Mauritius and Rodrigues was commissioned by the Ministry of Environment. The overall objective of this project was to categorize and protect ESAs through the use of planning and economic instruments. The study consisted of three parts or phases:

1. Demarcation and inventory of wetlands in Mauritius and Rodrigues.
2. Identification and demarcation of ESAs other than wetlands.
3. Development of a comprehensive policy, legal and management framework for protection and management of ESAs

The main terrestrial ESAs include: coastal freshwater marshlands, boreholes, caves (and other geological features), rivers and streams, lakes and reservoirs, upland marsh, steep slopes and forests with high native content. The recommendations of the study have been approved by Government and a proper framework will have to be setup for the implementation of the recommendations.

Figure 4.3: ESA Type in Mauritius



Source: ESA Strategic Plan, 2009

4.2.8 Integrated Coastal Zone Management

In 2007, the Ministry of Environment commissioned a study to establish an ICZM framework for the Republic of Mauritius to effectively manage the valuable and pressurised resources through the:

- Development of an ICZM strategy for Mauritius
- Review and preparation of a national policy and comprehensive legislative framework
- Institutional strengthening and capacity building
- Preparation of Local Area Action Plans for six pressure zones, namely: Grand Baie, Le Morne, Ile d'Ambre, South Coast of Mauritius, Belle Mare and the East Coast of Rodrigues
- Preparation of Environmental monitoring plan and good practice guidance for coastal activities.

The study has been completed and the finalized ICZM framework has been adopted by Government in 2010 for implementation.

4.2.9 Reforms on Leases of State Land

The 2006-2007 budget brought reforms in the leases of state land for residential purposes along the coast by reviewing the rental for leases to reflect the actual market value in the area. For instance, the rental fee which was as low as Rs. 125 per acre per month has been reviewed to a fee in the range of Rs. 125,000 to Rs. 250,000 per acre per annum depending on the zoning of the site. This reform has injected in the treasury considerable revenues thus consolidating the socio-economic base. The exercise is being extended to other industrial leases to generate revenues that commensurate with their strategic location. Good governance practices with respect to budgeting exercises and project management is having a positive effect on project delivery and delivery of efficient planning services.

4.2.10 Sustainable Land Management

Sustainable land management is essential to minimise land degradation, rehabilitate degraded areas and ensure optimal use of land resources. Government, in collaboration with UNDP/GEF and the Food and Agricultural Organisation, has embarked on the sustainable land management project with the long term goal of maintaining productivity and ecological functions of agricultural, pasture, forest and other terrestrial ecosystems in Mauritius and Rodrigues.

The main components of the project, which are at different stages of implementation, include:

- Mainstreaming sustainable land management into Forestry and Forest Action Plan
- Development of a policy and regulatory framework.
- Development of a sustainable land management investment plan
- Capacity building
- Establishment of a Forest Land Information System
- Preparation of a National Action Programme

● 4.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
High density of development particularly along the coastal zone	Elaborate new policies and programmes to consolidate Outline Planning Schemes	Coastal zone resilient to sea level rise
Degradation of ESAs	Forest, shrubs and grazing land maintained to 20% of the total land area	ESAs used for conservation and leisure activities
Increasing tourist arrival	Invest in infrastructure particularly with regards to transportation	Smooth traffic flow
High traffic congestion	Implement the ICZM Framework and invest in the upliftment of the coastal zone	All development to conform to Outline Planning Schemes and Policy Planning Guidance
High dependency on imported food items	Implement crop diversification strategy	Imports of food items reduced to 20 % of total consumption

4.3.1 Policy Options for the Future

The patterns of development over the next ten years will need at least 12,200 hectares of land for tourism, housing, business and infrastructure development (National Development Strategy, 2003). As outlined in the Best Case Scenario, the following actions will provide guidance to achieve sustainable land management:

Planning

- Develop integrated planning for optimising the balance of the natural environment and the built infrastructure.
- Reform and enforce planning guidelines to take into consideration emerging issues such as: population increase, two million tourists by 2015, additional requirements for space, housing, waste disposal, the impacts of climate change and sea level rise.
- Consolidate other urban centres, redevelop residential areas and inner town centres to limit urban sprawl and encourage higher development densities, closeness to job centres and services.

Governance

- Promote good governance based on participatory, transparent, responsive, consensus-oriented and equitable choices for better decision-making.

Reducing Traffic Congestion

- Progressively decentralise work places and commercial activities from Port Louis to reduce traffic flow.
- Improve the road network and introduce mass transit systems, pedestrian routes and cycle ways to complete the transport alternatives.

Management of Land Resources in the Coastal Zone

- Implement the recommendations of the Integrated Coastal Zone Management Framework and the study on Environmentally Sensitive Areas.

Chapter Summary

ISSUES

- ▶ Mainland Mauritius has limited area of land suitable for development and is also one of the most densely populated areas in the world.
- ▶ Urban expansion, including land requirements for housing, industry, tourism and infrastructure development and leisure activities put pressures on scarce land resources.
- ▶ Environmentally Sensitive Areas and coastal lands are being threatened by unplanned development.
- ▶ Poor urban planning and concentration of administrative and economic activities in Port Louis have resulted in heavy traffic congestion.

PROGRESS

In order to promote sustainable land management, the following initiatives have been undertaken:

- ▶ Elaboration of a National Development Strategy and its translation in the Outline Planning Schemes and legislation.
- ▶ Integration of zoning and planning considerations in the development of new projects through the EIA/ PER mechanism.
- ▶ Development of a Land Administration, Valuation and Information Management System in order to provide a national digital cadastre.
- ▶ Provision of low cost housing units to prevent illegal land occupation.
- ▶ A study of Environmentally Sensitive Areas which has enabled the development of appropriate management plans of priority areas.
- ▶ Development of an Integrated Coastal Zone Management Framework for better management along the coastal zone.

PROSPECTS

The following actions will provide guidance to achieve sustainable land management:

- ▶ Develop integrated planning and enforce planning guidelines.
- ▶ Consolidate other urban centres, redevelop residential areas and inner town centres to limit urban sprawl and encourage higher development densities, closeness to job centres and services.
- ▶ Relevant siting considerations for all development.
- ▶ Provide necessary measures and facilities to reduce traffic congestion.
- ▶ Ensure sound development practices in sensitive areas and along the coastal zone in line with the ESA Study and the ICZM framework.

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Solid Waste Management

Solid waste⁴⁴ is the inevitable consequence of material use and has been a growing feature of the developing world economy, of the expanding tourist industry and the modern way of life. The sound management of solid waste has become an increasing challenge with the ever growing volume of waste, limited disposal capacity and current low rates of recycling. This chapter deals with different types of waste as listed below but excludes industrial hazardous waste and medical waste⁴⁵.

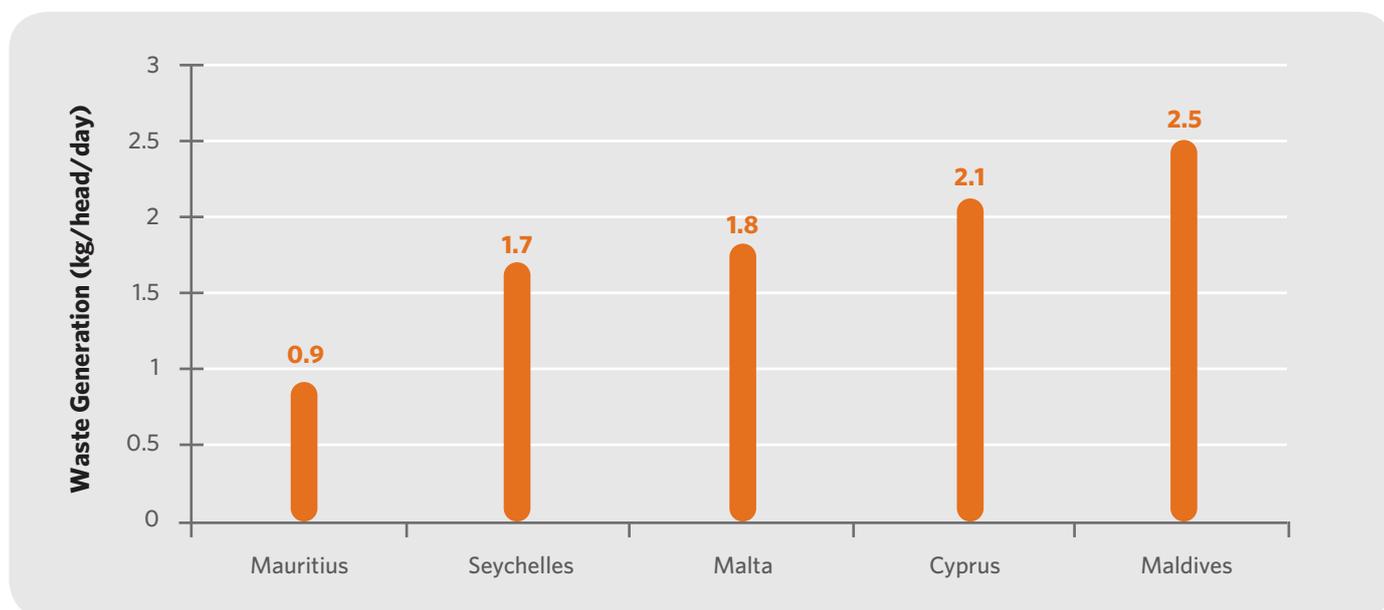
- Municipal Solid Waste is a waste type that includes predominantly household waste (domestic waste) and commercial waste collected by a municipality within a given area.
- Construction and demolition waste
- Commercial waste and industrial waste
- Port waste

● 5.1 CHALLENGES

◎ 5.1.1 Population Growth

Population and tourism growth are major factors contributing to the generation of solid waste. The number of tourist at any one time on the island amounts to, on average, about 25,000, while the population of the island of Mauritius at the end of 2009 was 1,239,788. The amount of waste reaching the landfill in 2009 was nearly 416,000 tonnes. On the basis of these figures, it follows that the per capita waste generation on mainland, Mauritius, is 0.9 kg per day including the tourist population. The growth in population and the achievement of the official aim of two million tourists by the year 2015 can be expected to cause an increase in waste although by comparison with certain other SIDS, Mauritius has a low level of solid waste per head as shown in Figure 5.1.

Figure 5.1: Per capita waste generation in Mauritius and other SIDS⁴⁶



Source: National Assessment Reports 2010

⁴⁴ "Waste", as defined by the Local Government (Dumping and Waste Carriers) Regulations 2003, includes "anything which is discarded or otherwise dealt with as if it were a waste and includes any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled other than hazardous waste".

⁴⁵ These waste types have been covered in chapter 12 on Chemicals and Hazardous Wastes.

⁴⁶ Note: For Maldives, the figure represents waste generation in Malé only

5.1.2 Economic Development

The rapid economic growth experienced by Mauritius since 1990 has not only led to new waste streams but has also affected the volume and composition of waste generated by various sectors like construction, agriculture and industry as shown in Table 5.1.

Table 5.1: Solid waste input at Mare Chicose Landfill from 2003 to 2009

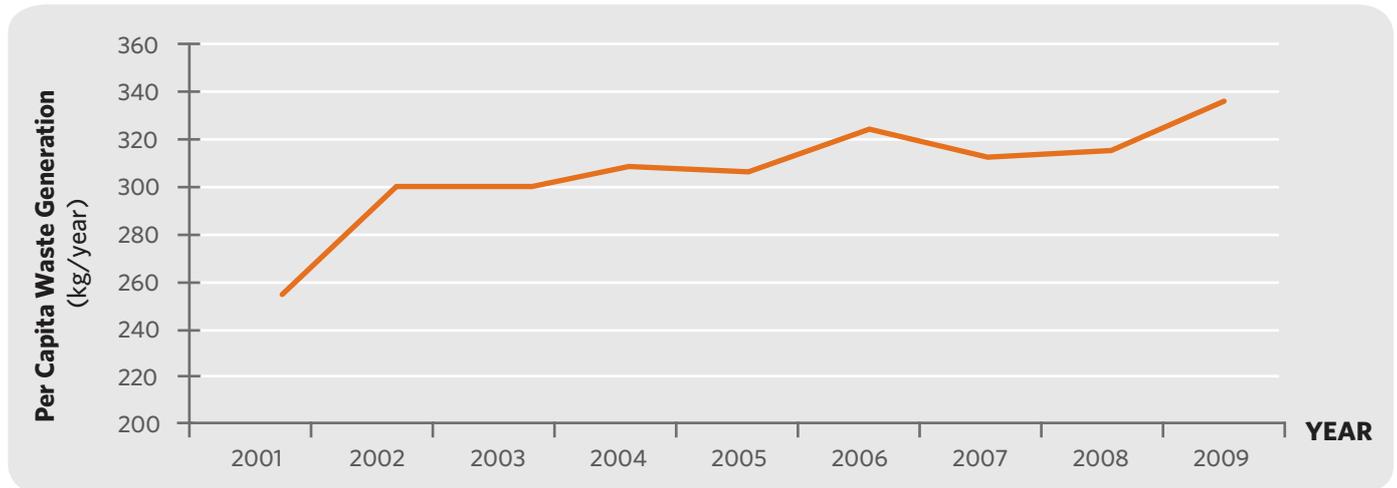
WASTE TYPE	2003	2004	2005	2006	2007	2008	2009
Construction	7,199	6,097	3,756	1,109	502	2,065	671
Domestic	352,915	365,528	363,776	387,751	365,824	373,860	389,999
Industrial (inc. textile)	4,421	3,097	2,340	2,619	2,157	1,798	1,470
Tuna waste/Sludge	120	189	5,913	8,056	13,077	12,148	9,126
Poultry	3,236	3,962	3,930	3,752	3,387	6,867	7,209
Rubber Tyres	378	423	394	465	223	347	365
Asbestos	71	36	85	14	260	32	26
Condemned goods	2,754	1,770	2,114	3,265	2,036	2,361	1,164
Difficult and hazardous	-	12	22	8	4	5	0.4
Others	-	-	-	-	6,648	5	5,918
TOTAL (Tonnes) (Rounded off figures)	371,000	381,000	382,000	407,000	394,000	400,000	416,000
Per Capita Waste Generation (kg)	300	308	306	324	312	315	336

Source: CSO – Digest of Environment Statistics 2009 and Ministry of Local Government & OI
(Units: Tonnes except for per capita waste generation)

5.1.3 Production and Consumption Patterns

Apart from population growth and economic development, waste has increased with social development, changes in lifestyle and patterns of consumption, production, packaging and marketing. Figure 5.2 shows the trend in per capita waste generation from 2001 to 2009.

Figure 5.2: Trend in the annual per capita waste generation (2001 - 2009)

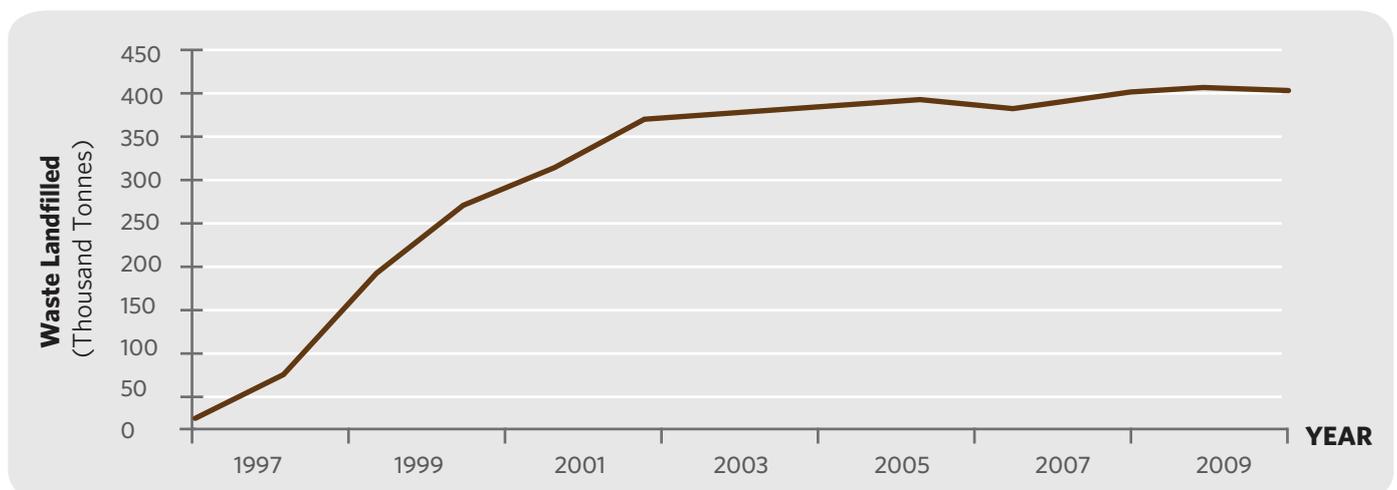


Source: CSO - Digest of Demographic Statistics, 2009 and Ministry of Local Government & OI

5.1.4 Trend in Landfilling of Waste

The total amount of solid waste disposed at the Mare Chicose sanitary landfill went up from 6,854 tonnes in 1997 (when the landfill started operation) to 416,000 tonnes in 2009, as shown in Figure 5.3. Since 2005, the average annual increase has been 2.2%.

Figure 5.3: Waste landfilled at Mare Chicose (1997 - 2009)⁴⁷



Source: Ministry of Local Government & OI

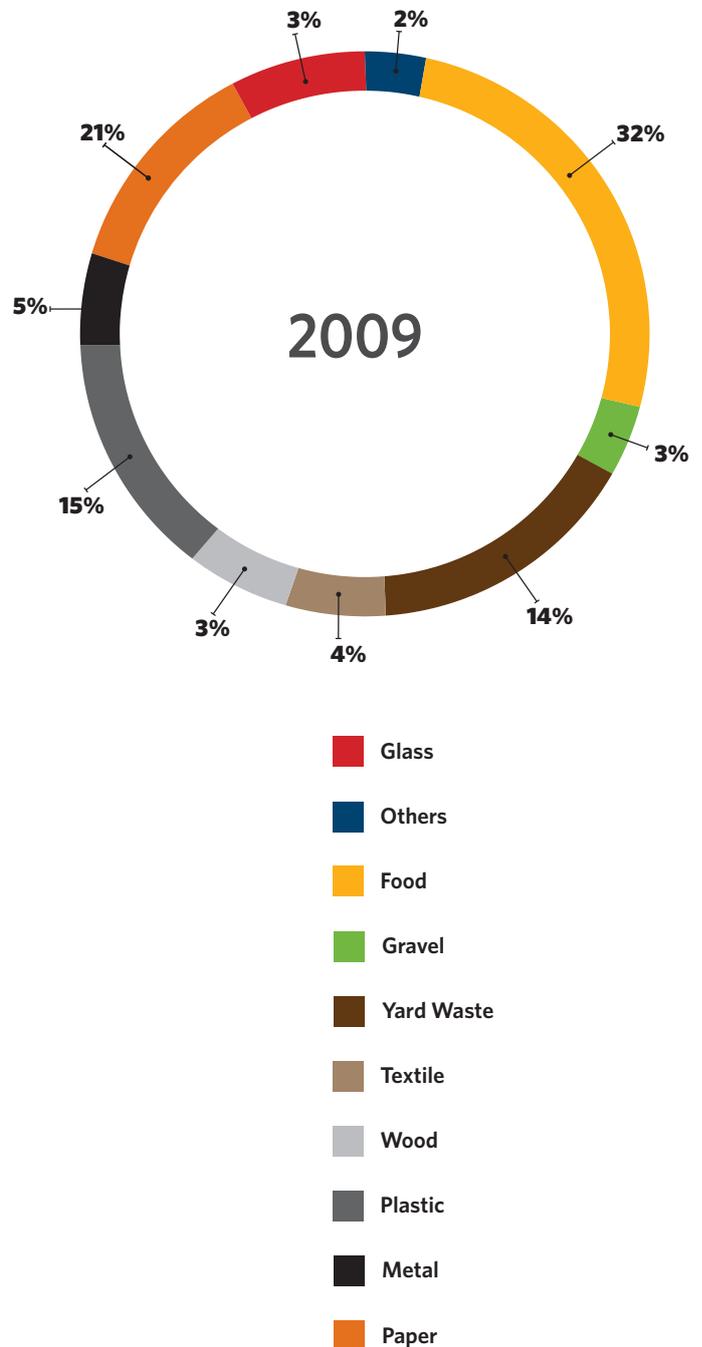
⁴⁷ National waste collection was already in place when the Mare Chicose landfill started operations in 1997. However, open dumps were still receiving waste. These dumps were closed in phases until 2001. This explains the low waste input at the landfill in 1997, which substantially increased with the closing of the dumps.

5.1.5 Waste Composition

Waste characterization studies in Mauritius date back to 2004, but no study has been commissioned by Government in the last six years. Measurements taken at the landfill indicate that nearly 95% of the waste is domestic. However, since there is no sorting policy in Mauritius, domestic waste is very diverse in composition comprising organic components like kitchen and garden waste, construction waste, bulky items and also some hazardous components like expired drugs and used Compact Fluorescent Lamps among others.

The results of a waste characterization study commissioned by the Municipality of Curepipe in 2009 are shown in Figure 5.4. The following items offer potential for recycling: paper (21%), plastic (15%), and glass (3%). Yard waste (14%) and food waste (32%) can be composted for production of organic fertiliser. Thus, over 80% of the waste has potential for recycling. In Singapore, the target for recycling is 65% by 2020 and 70% by 2030 as shown in Box 5.2.

Figure 5.4: Waste composition (Municipality of Curepipe, 2009)



5.1.6 Waste Management

At present, 100% of urban population and 96% of rural population are served by municipal waste collection services. Solid waste collected from different localities transit through a network of five transfer stations where they are compacted prior to final disposal at the Mare Chicose landfill. The transfer stations are being upgraded to increase the efficiency of waste management. Box 5.1 outlines the challenges of waste collection.

The national sanitary landfill started operation in 1997 with three cells, all of which have now been filled to capacity. Two new cells have been developed from 2004 to 2006 and an additional one in 2007. With the new cells, the lifespan of the landfill is expected to be till December 2011. The landfill receives around 1,000 to 1,200 tonnes of waste daily and requires the development of additional cells, depending on availability of land around the landfill. The landfill also has a new hazardous waste⁴⁸ cell which is operational since December 2009.

Source: Sustainable Solid Waste Management Report

⁴⁸ More details on hazardous waste management are provided in Chapter 12: Chemicals and Hazardous Waste.



New waste cell at Mare Chicose Sanitary Landfill (Courtesy: Ministry of Local Government & OI)

○ Leachate⁴⁹ Management at the landfill

A pipe reticulation ensures the collection of leachate from the waste mass⁵⁰. The leachate collected is stored in three ponds having a total capacity of 9,000 m³ and taken away by wastewater carriers (licensed by the Wastewater Management Authority) to Roche Bois pumping station. The leachate is then pumped to Baie du Tombeau where it receives only preliminary treatment, comprising screening and degritting, before being discharged into the high sea.

BOX 5.1: THE CHALLENGES OF WASTE COLLECTION

- A low percentage of the population has proper storage bins, for which there are no standards.
- The inadequate facilities for waste storage lead to the proliferation of rodents and ingress of water, which in turn results in production of more leachate and makes waste collection difficult.
- Waste collection frequencies are variable in different Local Authorities.
- Waste collection trucks are not adequately equipped to minimize leachate production during transport.
- The small number of waste collection contractors on the market limits competition.

⁴⁹ Leachate is the liquid that drains from a landfill and is classified as hazardous.

⁵⁰ The leachate collection drains are slotted on the top to allow the liquid to percolate through the waste to get into the drains.

5.1.7 Recycling

Waste segregation and recycling are still at their early stages in Mauritius. Presently, the materials being recycled include paper, plastic, glass, textile, metals and some hazardous waste. Table 5.2 gives an overview of the recycling status in Mauritius as at 2006.

Table 5.2: Recycling status

	NUMBER OF RECYCLERS	AMOUNT GENERATED (TONNES)	AMOUNT RECYCLED (TONNES)	PERCENTAGE RECYCLED
Paper	4	38,700	3,710	9.6%
Plastic	5	47,300	1,642	3.5% ⁵¹
Textile	2	17,200	5,400	31.4%
Metals	6	8,600	26,180*	NA
Glass	1	-	94	-

* This discrepancy is due to the fact that some recyclers import scrap metals NA – Not Applicable Source: Ministry of Local Government & OI

There are two companies involved in fixer solutions (used in photography and X-rays) and three involved in export of batteries. Retreading of used tyres is undertaken by four companies and it is estimated that only about 15% of used tyres are being recycled. The biodegradable sector may now slowly take off with the establishment of the composting plant⁵².

5.1.8 Inadequate Legal and Policy Framework for Waste Management

Major deficiencies in the solid waste management sector are the absence of an integrated solid waste management strategy as well as a specific legislation on waste. The Local Government Act 2003 is a broad-based legislation which covers various issues relating to the establishment and administration of Local Authorities and the services they provide. Consequently, the legislation only minimally provides for waste collection and disposal⁵³ with no obligation for waste reduction, recovery, reuse, sorting or recycling.

New legislation to provide for waste recycling obligations and for registration and licensing of waste recyclers is being envisaged in Mauritius. It is also planned to incorporate Materials Recovery Centre to existing transfer stations to facilitate both generators and recyclers. A waste management strategy is also under preparation. Box 5.2 shows the recycling targets in the EU and Singapore.

5.1.9 Public Expenditure on Waste Management

As the amount of waste increases, so does the cost of waste management (including collection, operation of transfer stations and the landfill). The cost of municipal waste management in 2009 was around Rs. 1 billion.

⁵¹ The collection and recycling of Polyethylene Terephthalate (PET) bottles has gradually increased to 37 % in 2009 (See Section 5.2: Progress).

⁵² A composting plant with a capacity of 100,000 tonnes of mixed waste per year is being set up by the private sector.

⁵³ As defined in the Local Government Act 2003, 'disposal' includes the sorting, carriage, transportation, treatment, storage, tipping above or underground, incineration and the transportation operations necessary for its recovery, reuse or recycling.

BOX 5.2: RECYCLING TARGETS IN THE EUROPEAN UNION (EU) AND SINGAPORE

The Directive 2008/98/EC on Waste prescribes the following waste hierarchy as a priority order in waste prevention and management legislation and policy:

**Recycling targets in EU:**

- To set up separate collection for at least paper, metal, plastic and glass by 2015.
- To increase the recycling of at least paper, metal, plastic and glass to 50% (by weight) by 2020.

(Island states like Malta and Cyprus, which are now members of the EU, will also have to abide by these targets.)

Recycling targets in Singapore:

In Singapore, high recycling rates have been achieved for a number of waste streams such as: construction and demolition waste, metals and used slag. A number of waste streams such as food and plastic waste offer potential to further increase the recycling rate. Singapore's overall recycling rate increased from 40% in 2000 to 56% in 2008. As per the Singapore Sustainable Blueprint, the target is to increase recycling rate to 65% by 2020 and 70% by 2030. (Singapore National Assessment Report, 2010)

5.1.10 Social Problems at the Landfill

The fact that the landfill is situated in the village of Mare Chicose has adversely affected the quality of life of the villagers due to:

- (i) Odour from the landfill (from waste and gas emanation),
- (ii) Odour from waste carriers along their passage,
- (iii) Noise pollution caused by waste carriers,
- (iv) Traffic hazard due to speeding of waste carriers along narrow and winding roads, and
- (v) Village littered by waste from poorly covered waste carriers.

In 2005 Government decided to relocate and compensate the inhabitants of Mare Chicose village with a grant of Rs. 76 million. All the infrastructures of the new residential estate for the villagers are ready and the relocation of the inhabitants to Rose Belle will be undertaken in the near future.

5.2 PROGRESS**5.2.1 Policies and Programmes**

The National Environment Policy sets out the policy framework for a sustainable waste management system based on an integrated waste management approach. The National Programme on Sustainable Consumption and Production has also identified 'Integrated Solid Waste Management and Recycling' as one of the priority areas. Five projects focusing on recycling, integrated waste management in local authorities and the introduction of the Extended Producer Responsibility⁵⁴ were recommended and implementation has been initiated.

A major policy response taken to minimize the use of plastic bags has been the introduction of an excise duty on all plastic carry bags (local and imported). This was announced within the 2006/2007 budget speech. Plastic carry bags have thus been subject to a Rs. 1 excise duty as from July 2006 and Rs. 2 as from November 2010. In 2006, early feedback reports have suggested a drastic reduction in plastic carry bags consumption of the order of 75 - 80 % in supermarkets.

⁵⁴ Extended Producer Responsibility (EPR) is as an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. This policy is characterised by the shifting of responsibility upstream toward the producer and away from municipalities and the provision of incentives to producers to take into account environmental considerations when designing their products (www.oecd.org).

However, despite the introduction of the above measure, plastic carry bags are being distributed freely⁵⁵ in markets and fairs. Moreover, to evade this excise duty, plastic bags without handles are flooding the market.

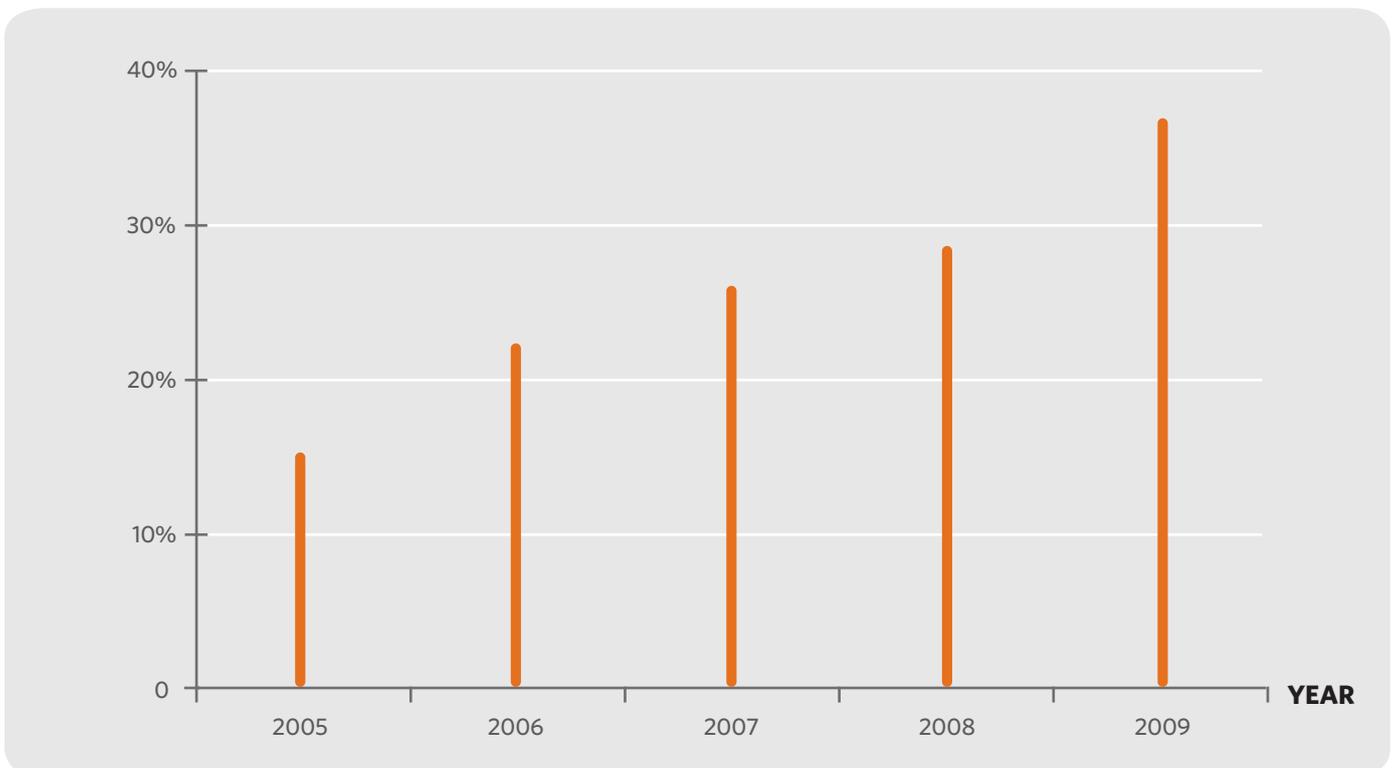
5.2.2 Legislation

The main legislation presently governing the solid waste sector is the Local Government Act 2003. This Act has been effective in setting the stage for the basic requirements in waste management, namely providing powers for waste collection and disposal. However, this needs to be further reinforced to include waste prevention, minimization, sorting, reuse and recycling approaches. The Local Government (Dumping and Waste Carriers) Regulations 2003 provides mainly for licensing of waste carriers and offences relating to dumping and littering.

Two regulations promulgated under the Environment Protection Act 2002, control the production and use of plastic bottles and plastic carry bags. These are as follows:

- The Environment Protection (Polyethylene Terephthalate (PET)) Bottle Permit Regulations 2001 have been promulgated to develop 'product responsibility' among bottlers for the proper management of used PET bottles, so that these do not become an environmental nuisance when littered haphazardly. These regulations place a mandatory permitting system requiring bottling companies to submit returns on the annual collection of PET bottles for recycling. The collection and recycling of PET bottles has gradually increased from 17% in 2005 to 37% in 2009 as shown in Figure 5.5.
- The Environment Protection (Plastic Carry Bags) Regulations were promulgated in 2004 to prohibit the production of non-degradable vest-type plastic carry bags for the local market and to provide for the production of degradable plastic carry bags with a minimum wall thickness of 20 microns.

Figure 5.5: Progress in collection and recycling of plastic bottles (2005 - 2009)



⁵⁵ Enforcement of the imposition of the levy on plastic carry bags was successful in supermarkets but not in markets and fairs. There is no monitoring and enforcement to ensure that users in markets and fairs are paying the tax.

5.2.3 Recycling Initiatives

Projects Being Implemented by the Ministry of Environment and Sustainable Development

~ Recycling of Paper Waste

The Ministry of Environment & Sustainable Development has initiated the separate collection of waste paper for recycling purposes. This project contributed to raise awareness of public officers on the importance of recycling, judicious use of resources and waste minimization, besides reducing the amount of waste disposed at the landfill.

~ School Compost Project and Waste Segregation in Primary Schools

In 2006, the Ministry of Environment and Sustainable Development launched the "School Compost Project" in some 40 primary schools in collaboration with various stakeholders. However, the scope of the project was broadened to encourage sorting of other non-degradable waste as well. In this context, the "Waste Segregation Project" was launched in June 2010 in all primary schools. The aim of this project is to inculcate in school children the concept of waste sorting for recycling or composting. Labelled bins for collecting plastic bottles and paper wastes and compost bins for green wastes have been distributed to all the 293 primary schools in Mauritius. All primary schools have been sensitised on the importance of waste segregation and recycling.

Projects Being Implemented by Other Organisations

~ Waste Segregation and Recycling Initiative by the NGO Mission Verte

Drop-off bins for the separate collection of plastics, cans, paper and carton have been placed at 13 locations around the island. Citizens are being sensitised and encouraged to sort waste and dispose in the special bins for recycling purposes.

Box 5.3: PROGRESS WITH WASTE SORTING AND RECYCLING AT THE MUNICIPALITY OF CUREPIPE⁵⁶

- ▶ The Municipality of Curepipe in collaboration with the NGO, Mission Verte, initiated a waste sorting programme by placing a container bin for collection of plastics, cans, glass, carton and paper waste. The Municipal council has since then extended this programme by placing street litter bins at eight strategic sites and special container bins in all supermarkets within the town for the separate collection of plastic, paper and cans.
- ▶ Special bins have also been placed in all schools of the town for collection of paper waste. The waste paper is then sold to a recycler and the money thus earned is used by the Parents Teachers Association for the benefit of the school and children.
- ▶ Another initiative of this Local Authority is the setting up of a compost plant for green waste in the Botanical Garden of Curepipe. This facility will also include a visitor's centre for the sensitization of the citizens and the general population on the importance of sorting and composting.



⁵⁶ The evaluation of these initiatives have not yet been undertaken

5.2.4 Landfill Gas-to-Energy Project

The pipe reticulation at the Mare Chicose landfill has been upgraded to enhance capture of methane – a potential GHG. The reduction in methane emissions thus achieved has enabled Mauritius to become eligible for claiming carbon credits under the Clean Development Mechanism of the Kyoto Protocol⁵⁷. A project is planned for the conversion of the gas into electricity with an expected production capacity of 2 to 3 MW (representing about 0.75% of the total electricity production) as from 2011.

5.2.5 Waste Treatment

Government received two private sector proposals, firstly, for the setting up of a waste-to-energy plant with an annual capacity of 300,000 tonnes⁵⁸ of waste and an electricity generation capacity of 20 MW⁵⁹ and secondly, a composting plant with a capacity of 100,000 tonnes of mixed municipal wastes.

Government has already approved the development of the composting plant. The facility is expected to be ready for reception of waste in 2011. With the coming into operation of the composting plant, some 20% of municipal solid waste will be composted.

As for the waste-to-energy plant, negotiations are currently underway to come to an agreement on the technical and financial terms of the proposal. However, there has been some opposition to setting up of the waste-to-energy plant by the public. As a result, this project is under judicial tribunal review.



Street litter bins in the town of Curepipe for the separate collection of paper, cans and plastics

5.2.6 Management of Port Waste

Waste generated from ships is a special category of waste with respect to its management, especially transportation, as certain types of waste are potentially dangerous from a biological point of view. They can contain hazardous microbial, chemical or physical agents such as pathogens, fungus, insects which are non-indigenous to Mauritius. Waste generated from ships also include galley waste (food waste from ships), spoilt meat, vegetables, plants and animals. As per the Ports Act (1998), the Mauritius Ports Authority has the overall responsibility for the proper management of waste in the port area. An incinerator has been set up in Port Louis Harbour for the disposal of ship-generated waste.

Box 5.4: MAJOR ACHIEVEMENTS IN THE SOLID WASTE SECTOR

Transfer Stations

A thorough audit of the four transfer stations⁶⁰ was undertaken to upgrade both waste handling capacity and tipping efficiency. A new transfer station has been constructed at La Laura.

Sanitary Landfill

The first three cells of the Mare Chicose sanitary landfill had only basic clay liners. With the increasing awareness of the possible contamination of groundwater from landfill leachate⁶¹, the subsequent cells were equipped with a double lining system. Two gas flares and horizontal piping were installed to capture more landfill gas, thus minimizing odour nuisance emanating from the landfill.



⁵⁷ The procedures under the Clean Development Mechanism have been initiated and registration will be completed in early 2011.

⁵⁸ 75% of current total waste.

⁵⁹ Around 5% of total electricity production.

⁶⁰ These transfer stations are located at Roche Bois, St. Martin, Poudre d'Or and La Brasserie.

⁶¹ In landfills, elevated vertical stacks or chimneys, known as gas flares are installed to vent and/or burn waste gas which results from the decomposition of materials.

● 5.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

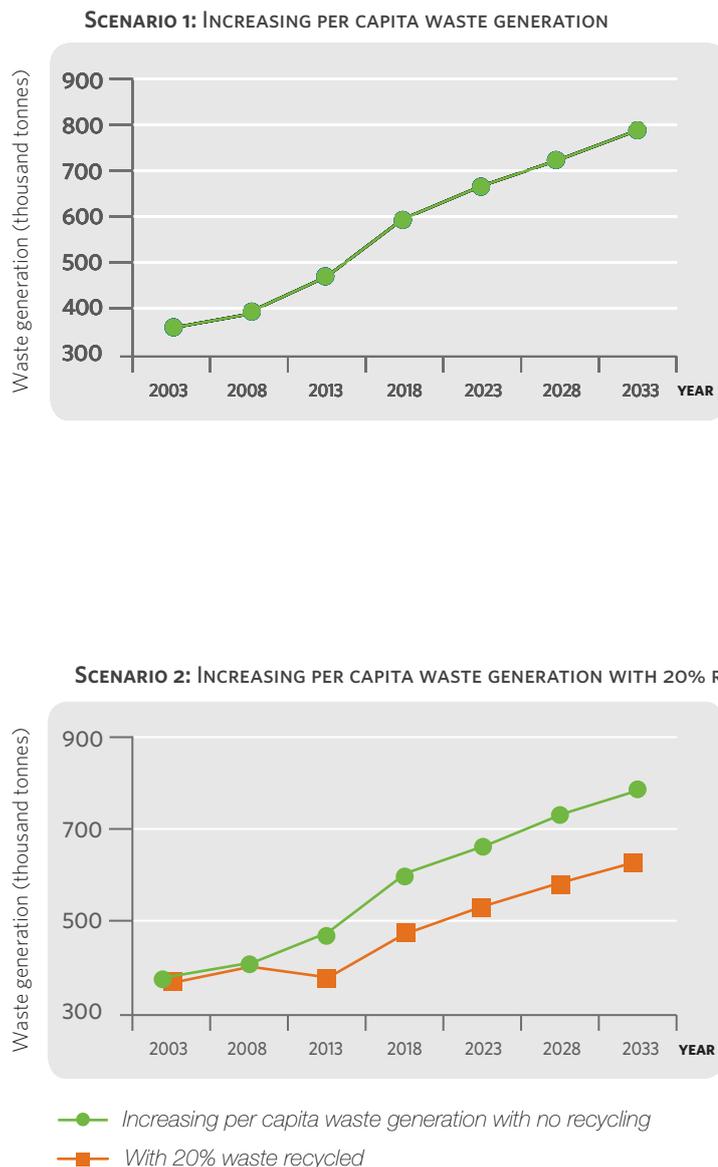
ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Unsustainable consumption patterns	Introduce Extended Producer Responsibility	Optimum resource recovery and reuse
Increasing waste amounts	Develop and implement an Integrated Solid Waste Management Strategy	20% of non-degradable waste recycled by 2030
Low recycling levels	Waste reduction at source	
No waste sorting policy	Put in place waste segregation and recycling	All organic waste recycled by 2030
No specific legislation on waste	Introduce waste management legislation	Improved waste management
Inadequate infrastructure/facilities for separate collection and transport of wastes	Set up Civic Amenity Centres and material recovery centres	
Negative impacts of landfilling	Construct leachate treatment plant at the landfill	Environmental contamination under control
High cost of waste management	Explore possibility for regional cooperation for certain waste streams	Less financial resources required for waste management

5.3.1 Policy Options for the Future

Progress in the solid waste management sector has been rather slow and staggered. Various issues need to be addressed, including the introduction of a specific legislation on waste management and the development of a waste management strategy with recycling targets. A more coherent, structured and sustained approach is required if Mauritius is to achieve environmentally sound waste management.

Waste collection at the Mare Chicose sanitary landfill amounted to more than 400,000 tonnes in 2009 with a per capita waste generation of nearly 1 kg/day. With increasing affluence, changing lifestyles and increased consumption per capita waste generation will steadily increase unless further steps are taken for integrated waste management. If integrated waste management strategies are put in place so that per capita waste generation remains at or below 1 kg/day, then the amount of waste generated will remain at or below current levels of about 400,000 tonnes per year despite population increase and a rise in the number of tourists. The different waste generation scenarios together with the assumptions made and the expected results are shown below:

Figure 5.6: Projections in waste generation



Considerations:

- Increasing population
- Increasing tourists
- Increasing per capita waste generation

Assumptions:

- Government’s aim of receiving 2 million tourists will be attained by 2015.
- There will be no further increase in tourist arrivals after 2015, as carrying capacity will have been reached on the island (in terms of hotels, beaches); therefore the number of tourist at any one time on the island was assumed to be around 50,000 as from 2015.
- The per capita waste generation in Mauritius will reach the current EU level of 1.5 kg/head/day by 2030.
- Recycling is negligible.

Expected Result:

- Waste requiring disposal reaches nearly 790,000 tonnes in 2030.

Considerations:

- Increasing population
- Increasing tourists
- Increasing per capita waste generation

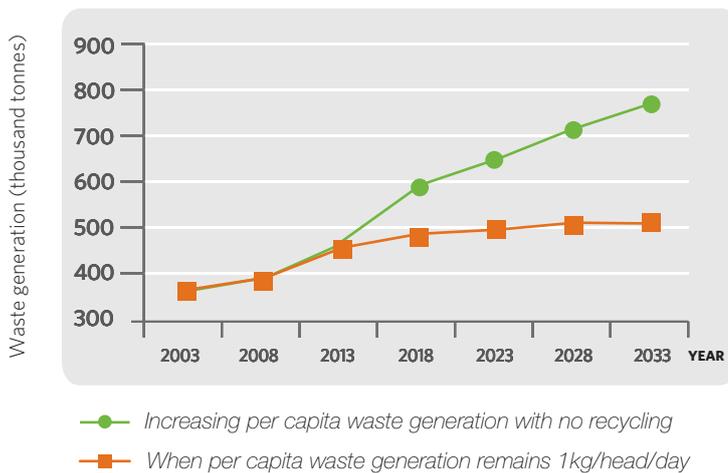
Assumption:

- 20% waste recycling achieved through composting plant and ongoing recycling initiatives. (For comparison, the graph in scenario 1 is also included.)

Expected Result:

- The amount of waste requiring disposal is around 600,000 tonnes (i.e. almost 200,000 tonnes less than without recycling).

SCENARIO 3: WASTE GENERATED 1KG/CAPITA/DAY AND RECYCLING NEGLIGIBLE



Considerations:

- Increasing population
- Increasing tourists

Assumption:

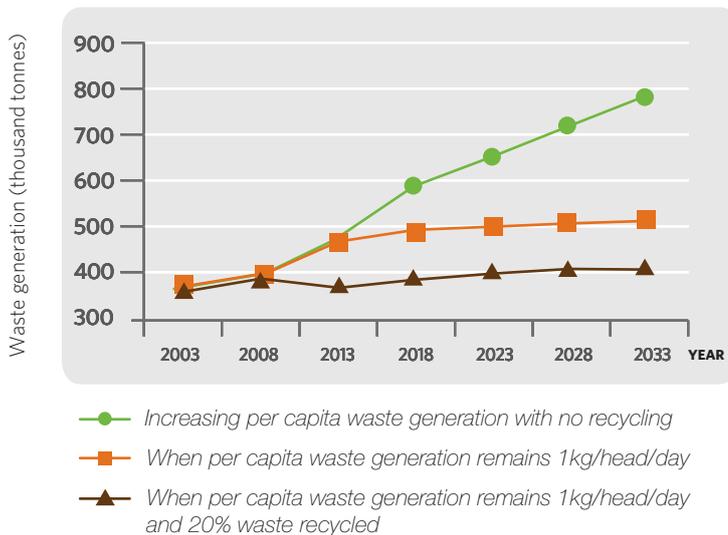
- Per capita waste generation remains 1 kg/head/day.
- Recycling is negligible.

(For comparison, the graph in scenario 1 is also included.)

Expected Result:

- The amount of waste requiring disposal is around 500,000 tonnes.

SCENARIO 4: 1 KG/CAPITA/DAY WASTE GENERATED WITH 20% WASTE RECYCLED



Considerations:

- Increasing population
- Increasing tourists

Assumptions:

- Per capita waste generation remains 1 kg/head/day.
- 20% waste recycled through composting plant and ongoing recycling initiatives.

(For comparison, the graph in scenario 1 is also included.)

Expected Result:

- The amount of waste requiring disposal is around 400,000 tonnes (i.e. the 2009 level)

Scenario 1 will have huge implications on national waste treatment and disposal capacity. This would imply more financial resources to be allocated for waste management to cater for the increase in transportation costs, possible extension of Mare Chicose landfill and identification of new sites for landfilling with its ensuing social problems including the possible need for payment of compensation. If the waste-to-energy plant materialises by 2013, Government will have to spend a consequential sum of money as tipping fee for waste incineration and also incur additional costs for a new landfill to dispose of the remaining waste.

In **Scenario 2** if 20% of the waste is recycled, then only 600,000 tonnes of waste will require final disposal. However, new disposal sites still need to be identified or the existing landfill must be further extended. The main assumption in **Scenario 3** is that per capita waste generation remains 1 kg/day (close to current levels), while recycling is negligible. This will imply that about 500,000 tonnes of waste will have to be disposed by 2030.

Scenario 4 is the most interesting one (best case scenario) given that if waste generation is 1kg/head/day and 20% waste is recycled, then the amount of waste that will require disposal by 2030 will be around 400,000 tonnes, which is the current level. This will imply some increase in disposal capacity through the extension of the landfill. In addition, some bold measures will have to be put in place to achieve at least 20% recycling. These include:

- Waste reduction at source
- Two-stream waste segregation adopted
(i.e. separation of organic waste from inorganic waste)
- Setting up of Material Recovery Centres⁶² and Civic Amenity Centres⁶³ at existing transfer stations
- Setting up of the composting plants
- Home composting

This scenario, which is very much in line with “Maurice Ile Durable” vision, implies a longer life span of the Mare Chicose landfill and unchanged volumes of waste to be transported. In environmental terms, this would also mean less organic waste reaching the landfill, therefore change in quality (less polluting) and quantity of leachate produced leading to lower risks of contamination of groundwater resources at the landfill site. Also, composting of waste would entail the use of less agrochemicals for cultivation and therefore reduced risks of environmental contamination. In social terms, this would imply a well aware society, which understands the importance of sorting, composting and recycling. This would also mean less odorous waste being transported through built up areas.

The main policy measures that need to be taken in the solid waste sector are to:

- Develop and implement an integrated solid waste management strategy.
- Translate the solid waste management strategy into waste management legislation with obligations for waste reduction, reuse, sorting and recycling.
- In the short term, put in place a two-stream waste segregation policy (*separation of waste into degradable and non-degradable fractions*) to encourage sorting and better recovery of recyclable wastes.

⁶² A Material Recovery Centre is a facility where mixed residential wastes are sorted out to separate materials that can be recycled into new products.

⁶³ A Civic Amenity Centre is a facility where the public can dispose of household waste, especially those that cannot be collected by local waste collection schemes such as bulky waste. These centres often also provide recycling points for the collection of recyclable waste such as green waste, metals, glass and other waste types.

Chapter Summary

CHALLENGES

- ▶ Increasing waste amounts are due to population and economic growth, increase in tourist arrivals and unsustainable consumption patterns. The amount of solid waste disposed at the landfill went up from 6,854 tonnes in 1997 to 416,000 tonnes in 2009.
- ▶ Waste characterisation studies date back to 2004 and no new study has been commissioned.
- ▶ There is no specific legislation on waste, no waste sorting policy and recycling levels are low.
- ▶ Around Rs. 1 billion is spent yearly on waste management.

PROGRESS

- ▶ At present, 100% of urban population and 96% of rural population are served by municipal waste collection services.
- ▶ Existing transfer stations have been upgraded in both their waste handling and tipping efficiency. A new transfer station has also been constructed.
- ▶ New cells at the landfill are equipped with a double lining system to prevent contamination from leachate. Landfill gas is being captured for electricity production.
- ▶ There are some sorting and recycling initiatives taken by both public and private sectors.
- ▶ A composting plant is expected to be operational in 2011.

PROSPECTS

- ▶ Develop and implement an Integrated Solid Waste Management Strategy.
- ▶ Translate the solid waste management strategy into specific waste management legislation.
- ▶ Introduce mandatory waste reduction, reuse, sorting and recycling.
- ▶ Promote home composting of organic waste.
- ▶ Set up Civic Amenity Centres and Material Recovery Centres at transfer stations for recovery of recyclable wastes.
- ▶ Upgrade leachate management at landfill site by putting up a leachate treatment plant.
- ▶ Explore possibility of regional cooperation for certain waste streams.

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Coastal and Marine Resources

Mainland Mauritius has a coastline of 322 km and is surrounded by 150 km of protective coral reefs, covering an area of around 300 km². The coastal zone consists of near shore wetlands and mangroves, lagoon coral, fringing coral reef and associated marine life. The coastal zone protects the island from the ocean and represents strategic assets for the socio-economic development of the country. Mauritius recognizes the value of its coastal and marine environment and ensuring their sustainable management has become a high priority objective. Box 6.1 gives more information on the coastal zone of Mauritius.

6.1 CHALLENGES

Intense pressure is exerted on coastal and marine resources from both sea and land based activities. Factors such as population growth and economic development put pressure on these resources, which if not adequately managed, can result in their depletion or degradation. In addition, natural causes such as cyclones, climate variability and sea level rise may significantly impact on the coastal zone.

6.1.1 Development along the Coastline

Currently, some 20% of the population reside in the coastal zone, which also supports various economic activities such as: agriculture, recreation and fisheries among others. Since the past twenty years, several residential estates have been developed in coastal villages such as Flic en Flac, Albion, La Gaulette and Balaclava. In some regions, unsustainable patterns of development such as backfilling of wetlands for construction, the absence of drains and sewer network are putting pressure on the coastal zone. For example, during heavy rains and cyclones, some areas are flooded as rapid development and backfilling of wetlands have impinged on the natural functions of these ecosystems. Furthermore, given that the majority of coastal villages are not connected to any sewerage network, sewage disposal constitute a threat to the marine environment.

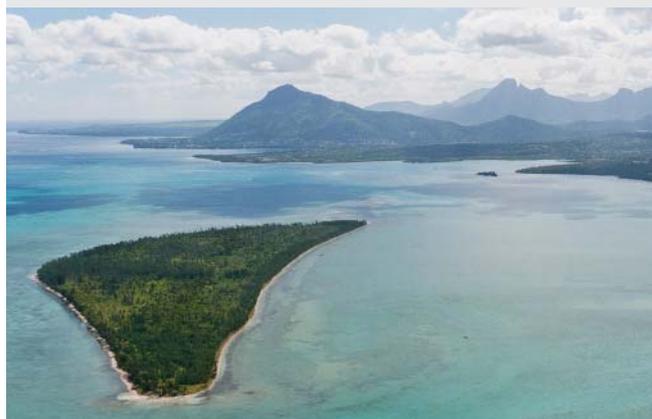
BOX 6.1: THE COASTAL ZONE OF MAURITIUS

The coastal zone of Mauritius is legally defined in the Environment Protection Act, as any area which is situated within 1 km or such distance as may be prescribed from the high water mark, extending either side into the sea or inland. It includes:

- ▶ Coral reefs, the lagoon, beaches, wetlands, hinterlands and all islets within the territorial waters of Mauritius and Rodrigues.
- ▶ Any estuary or mouth of river.
- ▶ The island of Agalega and St. Brandon and outer islets.

The Republic of Mauritius with a total area of around 2,045 km² is made up of a group of islands with:

- ▶ Total coastline of 496 km.
- ▶ 1.9 million km² of Exclusive Economic Zone (EEZ)⁶⁴.
- ▶ Continental Shelf Area of 27,373 km².
- ▶ Extended Continental Shelf Area⁶⁵.



⁶⁴ The EEZ extends from the coasts of the island of Mauritius, Rodrigues, St Brandon (Cargados Carajos Shoals), Agalega, Tromelin and Chagos Archipelago.

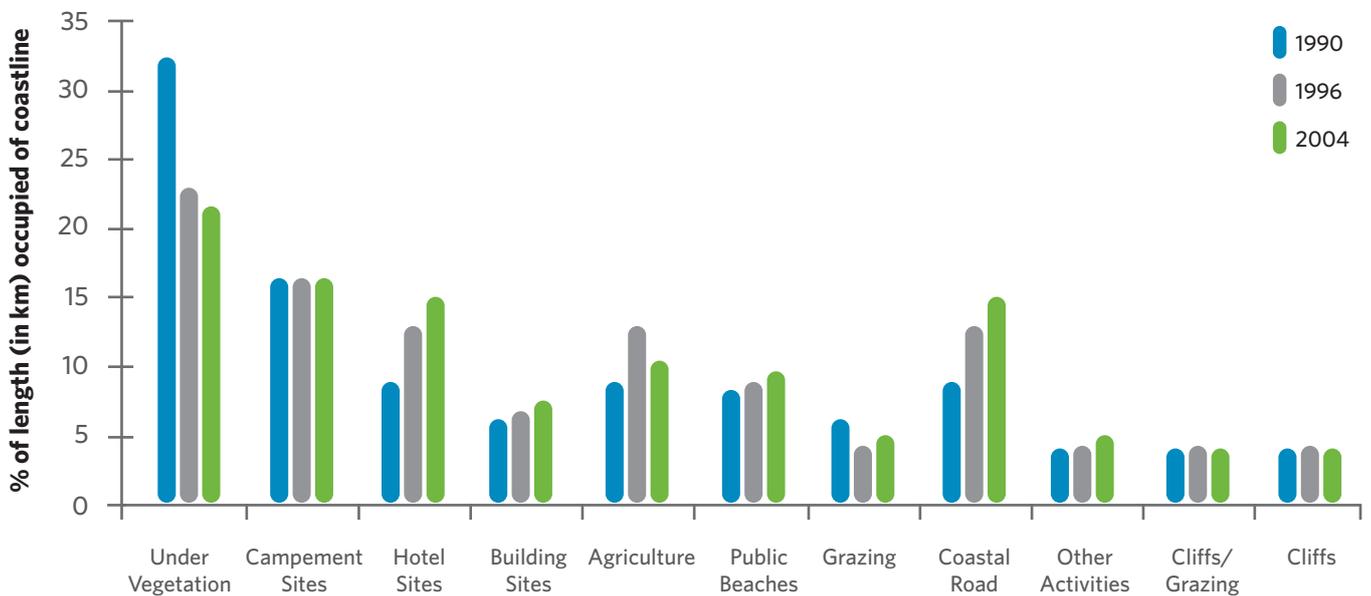
⁶⁵ The Republic of Mauritius made a submission to the United Nations Commission on the Limits of the Continental Shelf for an extension of the continental shelf in December 2009 according to the provision of the United Nations Convention on the Law of the Sea

6.1.2 Tourism

Tourism is now the third largest sector of the economy. The Financial Strategies Report of the ICZM Framework Study (2010) estimates the revenue directly generated from the coastal zone, to be about Rs. 74 billion⁶⁶, equivalent to 36% of the GDP, 99% of which is presently generated by tourism. It is Government's policy to further develop the tourism industry by welcoming two million tourists by 2015. The increase in tourist arrivals will bring considerable pressures on the coastal zone, with the construction of more hotels and increasing tourist related activities in the lagoon. As shown in Figure 6.1, between 1990 and 2004, there has been an increase in the area of land for hotels and public beaches and a decrease in the area under agriculture and vegetation.

In 2004, hotels occupied about 48.6 km of the coastline of mainland Mauritius, while public beaches accounted for 28.9 km, together covering 24% of the coastline. Figure 6.2 makes a long term projection of percentage coastline to be occupied by hotels sites and shows that about 35% of the coastline may be occupied by hotels in 2030. If serious harm to the very resources on which tourism depends, is to be avoided, this growth must be managed. In its programme 2005-2010, Government has declared its commitment to create the necessary conditions to encourage sustainable growth in the tourism sector.

Figure 6.1: Percentage distribution of the coastline for 1990, 1996 and 2004 for mainland Mauritius

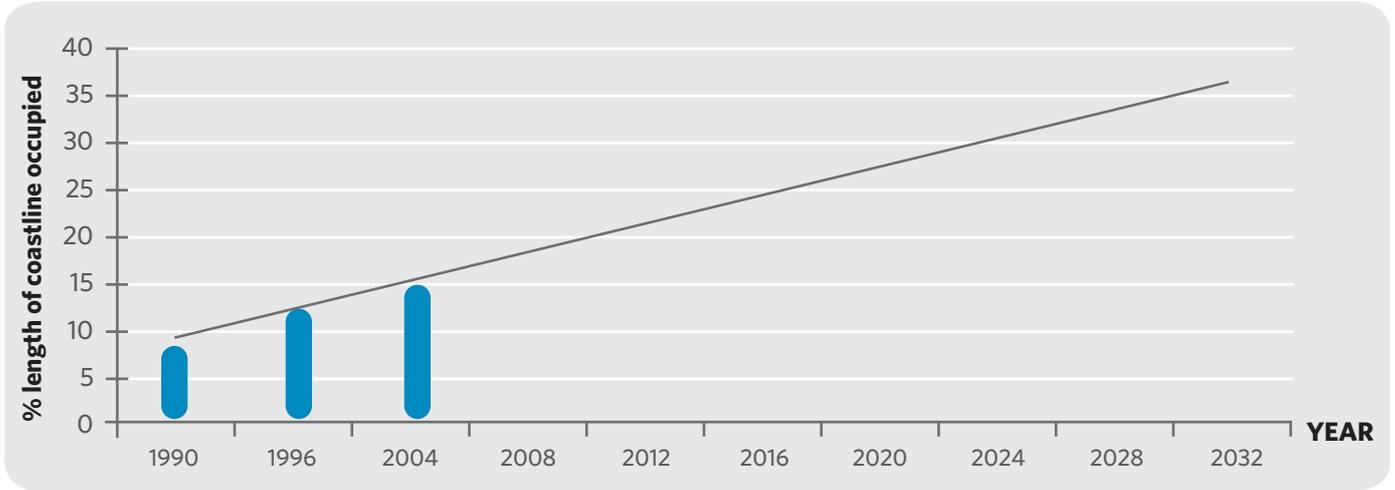


(Source: 1990: from NPDP⁶⁷, 1996: from Ministry of Housing and Lands, 2004: Interim estimate by Ministry of Housing and Lands)

⁶⁶ Excluding port revenue

⁶⁷ The introduction in 1994 of the National Physical Development Plan (NPDP), prepared under the Environmental Investment Programme, marked a historical step towards handling multi-sectoral issues such as housing, industry, leisure, and environment, within the overall development process in an integrated fashion. The NPDP has been reviewed and replaced by the National Development Strategy.

Figure 6.2: Percentage of coastline occupied by hotel sites with projections up to 2030



Source: CSO - Digest of Environment Statistics, 2007
 Data on length of coastline occupied from 2005 to 2010 are not available.

6.1.3 Beach Erosion⁶⁸

Many sandy beaches are affected by erosion resulting in loss of beach space and biodiversity. According to the study on coastal erosion in Mauritius, approximately 7 km (2%) of beach is known to be significantly affected by erosion (Baird Report, 2003). Historically, sand dunes in Mauritius have been exploited for construction purposes. Prior to its ban in year 2001, sand mining, which was conducted at a rate of 800,000 tonnes per year, had been linked to loss of beaches.

Beach erosion is further exacerbated by the presence of hard structures on the beach such as sea walls, groynes, jetties, piers, breakwaters and slipways. These hard structures restrict the natural movement of sand by trapping sand on one side and accelerating erosion on the other side. Moreover, the policy of using gabion baskets to prevent erosion was initiated in 1996, at various sites throughout Mauritius, namely: Flic en Flac, Rivière des Galets, Cap Malheureux, Grand Bay, Riambel and La Prairie. However, this policy has been found to be ineffective as the integrity of the basket is short lived (4-5 years), especially due to intense pressure from waves and human interference. With the collapse of the baskets, much of gabions functions were lost and the rusting wires represented eyesores and health hazards (ICZM Strategy Report, 2010).



Beach erosion at Flic en Flac public beach



Beach protection works at Flic en Flac public beach

⁶⁸ So far, only erosion occurring on beaches has been assessed in Mauritius. The South region from Souillac to Blue Bay as well as the region stretching between Albion and Flic en Flac has a series of cliff faces. Pocket beaches which may form as a result of natural erosion of the cliffs, have not been evaluated to date.

6.1.4 Pressures on Coastal Water Quality

Marine ecosystems including corals, sea grass and mangroves are dependent on water quality for their optimum functioning. Changes in water quality are mainly induced by human activities, but may also arise due to natural causes.

Effluents

The main sources of pressure on the marine environment are effluents from households, industries, hotels⁶⁹ and agriculture. Most of the industries discharge their wastewater into the sewer system. Those found outside sewer areas have their own treatment plants or cart away to a public sewer system. Three ocean outfalls located along the coast of Baie du Tombeau, Montagne Jacquot and Pointe Moyenne discharge approximately 53,000 m³ of effluents into the sea daily.

Agricultural run-off

The volume of agricultural run-off entering the marine environment is difficult to quantify. The main food crop production zones in the coastal catchment areas are along the eastern coastal belt. They comprise about 2.4 km² in the region of Belle Mare/Palmar and Trou d'Eau Douce and some 0.25 km² on the sloping land in the region of Petit Sables, Grand Sables, Quatre Soeurs and Bambous Virieux.

Due to the low fertility of the sandy soil in these areas, vegetable growers depend heavily on inorganic fertilisers to sustain crop production. In addition, the low water retention capacity and high infiltration of the soil favour leaching of nutrients. The beaches at Belle Mare/Palmar have been suffering from bulk accumulation of algae (reaching 1 m in thickness), for some time, and this is attributed to the heavy use of inorganic fertilisers in onion plantations and to the livestock farming at Palmar Livestock Station (National Status Report on the Coastal and Marine Environment, 2007).

6.1.5 Trends in Fisheries Stocks

The Fisheries sector accounted for 1.2% of the GDP in 2009. Table 6.1 lists the fishing activities and the fishery resources⁷⁰ exploited in the Republic of Mauritius. Over the last 16 years, total fish catch (lagoon and off lagoon) has decreased by three folds, with a catch of 19,690 tonnes in 1993 and 6,978 tonnes in 2009 as shown in Figure 6.3. The total fish catch may decrease over the next 20 years if management measures are not implemented to conserve the valuable marine resources for future generations.

Table 6.1: Type of fishing activity and fisheries resources exploited in the Republic of Mauritius

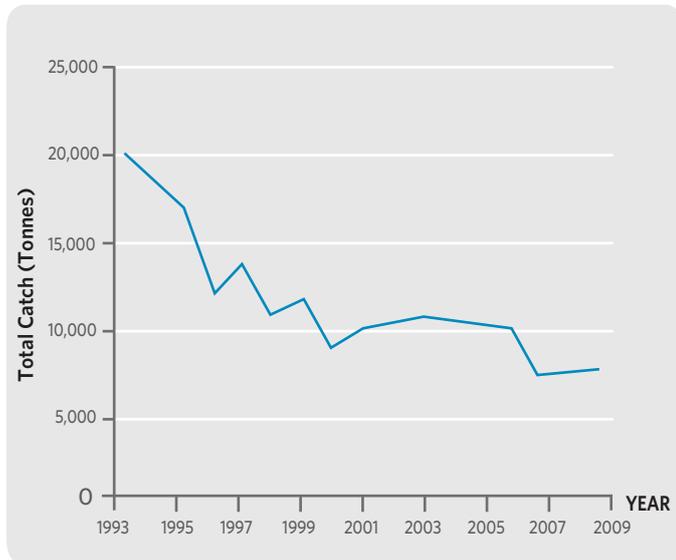
MAIN FISHERIES	SPECIES EXPLOITED
Bank Fishery	Lethrinids, snappers, groupers
Artisanal Fishery	Lethrinids, snappers, groupers, octopus
Semi Industrial Fishery	Snappers, groupers
Sports Fishery	Marlins, wahoo's, tunas
Amateur Fishery	Lethrinids, siganids, etc.
Tuna Fishery in the Western Indian Ocean	Tunas and associated species
Aquaculture	Red drum and sea bream species

Source: National Status Report on the Coastal and Marine Environment, 2007

⁶⁹ Hotels with more than 75 rooms are required to have wastewater treatment plants.

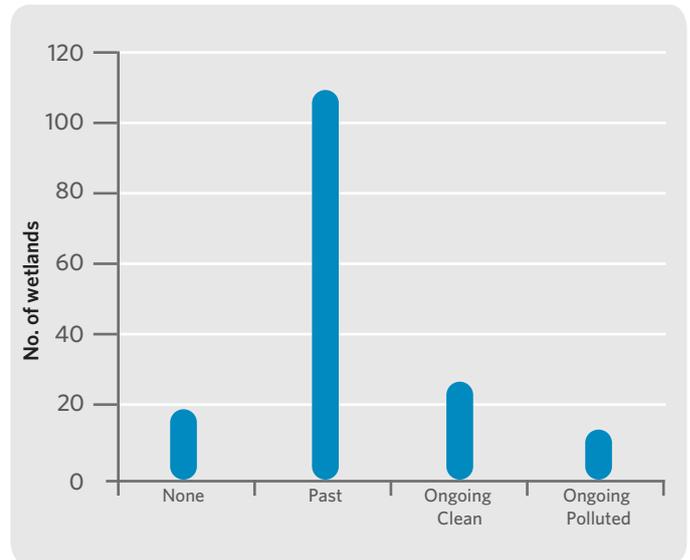
⁷⁰ Fresh fish is landed along the coast of Mauritius at 61 fish landing stations by the artisanal fishers who fish inside the lagoon and in the vicinity of the outer reef. In 2009, there were 2,020 active fishermen in the artisanal fishery and 1,591 fishing boats in Mauritius. The total fresh fish production from the artisanal fishery was 820 tonnes and the average catch per fisherman-day was 6.4 kg.

Figure 6.3: Total lagoon and off lagoon fish catch
(in tonnes) (1993 - 2009)



Source: Ministry of Fisheries and Rodrigues, Fisheries Division

Figure 6.4: Wetlands affected by backfilling in Mauritius



Source: Technical Report on Freshwater Wetlands, 2009

6.1.6 Coastal Wetlands

There are 203 coastal wetlands in Mauritius and Rodrigues (Technical Report on Freshwater Wetlands, 2009). Wetlands act as an interface between terrestrial and marine systems and play important environmental and economic functions by reducing erosion, acting as nursery for fish stocks, protecting the coast and filtering runoff before it enters the sea.

Backfilling of wetlands for construction is affecting 90% of all wetlands and resulting in a reduction of biological habitats. A comparison of wetland area in Grand Baie over time revealed an estimated 23% decrease from 2000 to 2008 due to backfilling⁷¹ and increased urbanisation. Flooding in Grand Baie and Flic en Flac has been exacerbated by backfilling of wetlands.

6.1.7 Coral Reefs

Coral reefs are one of the most biologically diverse ecosystems on earth, providing critical habitats to approximately 25% of marine species. The coral reef habitats around Mauritius are being degraded due to a combination of factors such as: coral bleaching, excessive growth of algae occurring due

to increased seawater temperatures, land based sedimentation and extensive coastal development. The natural threats to coral reefs are strong tropical cyclones, which damage delicate branching corals and overturn table corals. Coral bleaching⁷² is occurring mainly due to increase in seawater temperature causing coral mortality. Coral bleaching was observed in Mauritius in 1998, 2004 and 2009. At most of the sites, the bleached corals have recuperated, but some have died. The other threat is from the coral predator, the Crown of Thorns Starfish (*Acanthaster planci*), which feeds on corals and can cause damage to coral cover if found in large numbers. Anchors and use of nets also cause localised damage to corals.

The long-term monitoring data of the coral reef ecosystem carried out by the Fisheries Division of the Ministry of Fisheries and Rodrigues shows that the percentage of live coral cover in the back-reef stations (lagoon) is about 40% and about 30% in the fore reef (off-lagoon) stations. Juvenile coral recruitment is also being continuously observed.

⁷¹ Backfilling refers to refilling of the wetlands with materials

⁷² Coral bleaching (whitening of corals) occurs with a sudden rise in seawater temperature. In this process coral colonies lose their colour when microscopic algae (zooxanthellae), which live in symbiosis with their host organisms (polyps), are expelled.



Healthy Coral Reef



After an algal bloom (dead corals)



Totally bleached corals

Courtesy: Ministry of Fisheries and Rodrigues, Fisheries Division

6.1.8 Climate Change and Sea Level Rise

Climate change⁷³ and sea level rise are global problems that are also impacting on the coastal zone of Mauritius. Sea level rise is monitored at Trou Fanfaron-Port Louis since 1987 and between 1998 and 2007, local mean sea level rose by 2.1 mm per year. Overall, mean sea level rise for Mauritius during the past decade has been around 1.2 mm (Meteorological Services, 2009). It is expected that sea level rise will lead to saline intrusion and inundation of certain low-lying coastal areas, thereby affecting livelihoods, coastal wetlands and mangroves. In May 2007, inhabitants of Rivière des Galets village were affected by a storm surge, which flooded their houses. It is expected that coastal erosion will become more serious with sea level rise. In January 2009, cases of fish mortality were recorded in the region of Poudre d'Or. Surveys indicated that a sudden rise in sea water temperature (up to 31.5°C) resulted in a micro-algal bloom, which could have been the main cause of fish mortality.

6.1.9 Scattered Roles and Responsibilities

The principal ministries, authorities and organisations involved in coastal and marine issues are:

- Ministry of Energy and Public Utilities
- Ministry of Housing and Lands

- Ministry of Tourism and Leisure
- Ministry of Environment and Sustainable Development
- Ministry of Local Government and Outer Islands
- Ministry of Fisheries and Rodrigues
- Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping
- National Coast Guard
- Mauritius Port Authority
- Wastewater Management Authority
- Mauritius Oceanography Institute
- District Councils/Municipalities
- Beach Authority

Degradation of coastal and marine resources are aggravated in the absence of a proper monitoring and enforcement mechanism especially after working hours. At the same time, existing mechanism of coordination and communication in the various decisions and inter-linkages in the activities of the different stakeholders involved need to be strengthened.

⁷³ Climate change and sea level rise are dealt in more details in chapter 9 of the report.

6.1.10 Inadequate Management of Coastal Development

Unplanned construction and urbanisation around the northern and eastern tourist zones, land clearing and reclamation have contributed to the degradation of the coastal and marine environment. This degradation is associated to some extent to insufficient monitoring of compliance with licences and enforcement of laws due to a lack of capacity. Even where political will exists, ministries that are responsible for enforcement in the coastal zone are under-staffed and under-resourced. Therefore, the enforcement and monitoring processes need to be strengthened to ensure sustainable coastal development.

6.1.11 Marine Biodiversity

Marine biodiversity in Mauritian waters is rich with some 1,656 known species. A National Biodiversity Strategy and Action Plan (2006 - 2015), which includes coastal and marine biodiversity amongst others has been prepared and is being implemented. Table 6.2 shows marine biodiversity in Mauritian waters.

Table 6.2: Marine biodiversity in Mauritian waters

Coral Reefs	There are five types of reefs around Mauritius, namely fringing reefs, patch reefs, atolls, reef flats and barrier reefs. About 43 genera of hard corals are found on the reefs of Mauritius and a total of 159 species ⁷⁴ of scleractinian ⁷⁵ corals from 16 families have so far been recorded.
Fish	Out of 340 species of fish identified, 42 within the lagoon area are sold commercially. 7 species of <i>Penaeid shrimps</i> have been reported in Mauritian near shore waters as well as two species of deepwater shrimp and several species of sea stars and other echinoderms.
Algae	Over 160 genera of marine algae and a few species of seagrass have been observed in Mauritian waters.
Marine Mammals	17 marine mammal species have been recorded in Mauritian waters - mostly as they migrate to and from Antarctica to warm tropical waters for calving. Dolphins and whales are also encountered in Mauritian waters.
Sea Turtles	2 species of sea turtles are commonly encountered in the shallow coastal waters of Mauritius, the hawksbill, <i>Eretmochelys imbricata</i> and the green <i>Chelonia mydas</i> .
Shoreline Birds	The Rivulet Terre Rouge Estuary Bird Sanctuary located in the north east of the island, near Port Louis Harbour is a tidal mudflat that is used by migrating shorebirds. Around 1,000-1,200 migratory birds visit this site each year.

Source: ICZM Strategy Report, October 2009

⁷⁴ Species is a group of organisms capable of interbreeding and producing fertile offspring of both sexes (except in the case of asexually reproducing species), and separated from other such groups with which interbreeding does not normally happen.

⁷⁵ Scleractinian, also called stony corals, are exclusively marine animals. They are very similar to sea anemones but have a hard skeleton.

● 6.2 PROGRESS

◎ 6.2.1 Legal Framework

The legal framework for the management of the coastal zone is dispersed over many laws and regulations. The principal laws concerned with the management of the coastal zone are:

- Fisheries and Marine Resources Act 2007
- Environment Protection Act 2002, as amended in 2008
- Beach Authority Act 2002
- Tourism Act 2006
- Maritime Zones Act 2005
- Building Act 1919
- Town and Country Planning Act 1954
- Local Government Act 2003
- Planning and Development Act 2004

An analysis of the legal framework for the management of the coastal zone was carried out as part of the ICZM Framework project. It showed that the existing legal framework is sufficiently comprehensive to cope with current legal issues, but recognizes the crucial role of the EIA mechanism and the need to improve monitoring, evaluation and enforcement regimes currently in place.

◎ 6.2.2 Control of Development in the Coastal Zone

The management tool for regulating large scale development in the coastal zone is already in effect. Many coastal activities are regulated through the EIA/PER mechanism under the Environment Protection Act, while District Councils and Municipal Councils are responsible for issuing the Building and Land Use Permit. The EIA licence/PER approval as well as the Building and Land Use Permit requirements take into consideration the provisions of the Planning and Policy Guidance as well as the Outline Schemes on setbacks, plot coverage and development density of coastal development.

◎ 6.2.3 Integrated Coastal Zone Management (ICZM) Framework

The ICZM Framework was identified as a priority project in the 1999 National Environmental Strategies. In line with its recommendations, the ICZM Division was established within the Department of Environment in 2002 to spearhead the management of the coastal zone. The Division also has the task of developing an ICZM plan, guidelines for development permits within the coastal zone, surveying of coastal resources, identifying sources of pollution and their effects on the resources and secure the co-operation of numerous government agencies, the private sector, communities and NGOs and should strongly promote their active involvement. An ICZM Committee comprising: Government institutions, NGOs, parastatal and private organizations was set up in 2002 under the EPA 2002 to manage the coastal zone in an integrated and holistic manner. As per the second National Environmental Action Plan, several important projects have been commissioned to address various concerns within the coastal zone, namely:

- Bathymetry Maps and Habitat Resource Atlas for the Lagoon of Mauritius, 2004
- Study of Coastal Erosion in Mauritius, 2003 and
- Strategic Environmental Impact Assessment (SEA) for Identification of Potential Sites for Marinas, Ski Lanes and Bathing Areas for Mauritius.

In 2007, the Ministry of Environment commissioned a study to establish an ICZM framework for the Republic of Mauritius to effectively manage the valuable and pressurised resources through the:

- Development of an ICZM strategy for Mauritius
- Review and preparation of a national policy and comprehensive legislative framework
- Institutional strengthening and capacity building
- Preparation of Local Area Action Plans for six pressure zones, namely: Grand Baie, Le Morne, Ile D'Ambre, South Coast of Mauritius, Belle Mare and the East Coast of Rodrigues.

- Preparation of Environmental monitoring plan and good practice guidance for coastal activities.

The study has been completed and the ICZM framework has been adopted by Government in 2010 for implementation.

6.2.4 Environmentally Sensitive Areas Study for the Republic of Mauritius

A study of Environmentally Sensitive Areas (ESAs) in Mauritius & Rodrigues was approved by Cabinet in 2010 for implementation. It involved the demarcation of ESAs and a comprehensive policy and legislative framework for their protection and sustainable development. The ESA study has classified seven coastal ESAs⁷⁶ among fourteen types, assessed their relative importance and developed a comprehensive framework for protecting, managing and monitoring ESAs integrity in the long term. A series of management measures namely: buffer zones, access, improvement, mitigation, development design, information and public awareness are prescribed to deliver effective action. Implementation of the recommendations of the ESA study is linked to a three-tier system of categorising relative ESA-value to policy, legal and management instruments.

6.2.5 Shoreline Management

Some 4 km of coastal rehabilitation works, both in terms of soft measures (beach replenishment) and hard measures (rock revetments, gabions) have been carried out by the Ministry of Environment at eight sites, over the last five years and a further 3 km of shoreline are being monitored and assessed for future coastal protection works.

The recommendations made in the Baird Report with regards to replacement of filao trees, re-profiling of beaches and restoration of native vegetation are being implemented. The sites that were prioritised for action are Belle Mare, Flic en Flac, Rivière des Galets and Grand Baie. With a view to reduce the impact of erosion on the coastal zone, provision has been made in the National Development Strategy for all new developments to respect

a setback distance of 30 m from the high water mark for construction of hard structures and same has been included in Planning Policy Guidance, recommendations of which are being enforced legally. Levelling and removal of sand dunes have been prohibited as part of the coastal zone setback policy.

There is an ongoing programme to lay out vehicular parking at public beaches in order to protect sand dunes. Actions have already been initiated at Flic en Flac, Belle Mare, Mont Choisy and Le Morne public beaches.

6.2.6 Banning of Sand Mining

The banning of sand mining since 2001 was an effective decision taken to reduce coastal erosion. Following its ban, the Ministry of Environment and the Fisheries Division have monitored the former mining sites to assess recovery. Surveys carried out by the Fisheries Division have shown that there is regeneration of the marine ecosystem, with colonization of the sandy bottom by seagrasses, macro-algae and corals. An increase in fish abundance was noted together with colonisation from sea cucumbers and sea urchins.

6.2.7 Lagoon Water Quality Monitoring

Since 1991, the Fisheries Division has been assessing marine water quality to record levels of pollutants and to propose remedial measures. This long-term monitoring project includes the study of: physicochemical parameters at 23 established sites around the island, heavy metals at 8 major estuaries and coliform bacteria at 13 selected public beaches for the safeguard of public users from health hazards. In general, sea water quality around the island is good, confirming that the natural purification and flushing systems are efficient to maintain the environmental equilibrium.

The 23 established sites for physicochemical parameters also include the three major sewage sea outfalls at Baie du Tombeau, Montagne Jacquot and Pointe Moyenne.

⁷⁶ Coastal ESAs include coral reefs, islets, sea grass beds, mangroves, inter tidal mudflats, sand beach and dune and coastal freshwater marshland.

With the construction of the long sea outfalls, lagoonal water quality from Pointe aux Sables to Baie du Tombeau is showing signs of improvement and corals at Baie du Tombeau are now in better condition. The challenge for the coming years is to maintain an improved seawater quality.

In 2009, a Lagoonal Water Quality Index was developed to ease decision-making and policy implementation in addition to communicating lagoon water quality to the public in a simplified manner. In 2010, monitoring was conducted at Pereybère, Mont Choisy, Grand Baie and Trou aux Biches. For 2011, Flic-en-Flac, Albion, Bel-Ombre and Le Morne are targeted and the aim is to monitor 36 sites by 2013.

6.2.8 Creation of Marine Protected Areas (MPAs)

The Fisheries Division has proclaimed six fishing reserves and two marine parks, namely Balaclava (485 ha) and Blue Bay (353 ha). To protect, conserve and manage the marine parks, the Fisheries Division enforces measures prescribed in the Fisheries and Marine Resources (Marine Protected Areas) Regulations 2001 as amended in 2007.

The Blue Bay Marine Park was proclaimed a National Park in 1997, declared an MPA and designated as a Marine Park in 2000. In 2008, the Blue Bay Marine Park acquired the new status of Ramsar Site (marine wetland of international importance) owing to its marine biodiversity and critical ecological processes and functions. A visitors' centre was established in 2004 and the park is zoned for different activities and serves as a refuge, feeding, spawning and breeding ground to various species of marine organisms. 38 species of corals and 72 species of fish have been inventoried in the park.

The Indian Ocean Commission (IOC) has initiated a project entitled "Network of MPAs of the IOC Countries (2006-2010)", which aims at: developing a regional strategy for biodiversity and marine resources management through eco-regional analysis; creating new marine protected areas and supporting existing ones; developing a regional forum of MPA managers as well as an awareness and communication strategy.

Under this project, the biological inventory of Balaclava Marine Park was carried out and it is now envisaged to undertake the demarcation of the zones in the park.

A UNDP/GEF funded project is being implemented by the Fisheries Division and the Rodrigues Regional Assembly entitled "Partnerships for MPAs in Mauritius & Rodrigues", which aims at:

- Improving management and conservation practices for MPAs.
- Sharing equitably the benefits of MPAs to the local communities and economic operators.
- Developing enabling policies and institutional frameworks for the sustainable co-management of the MPAs, and the development of a model co-management for a proposed MPA in Rodrigues.

6.2.9 Aquaculture

Aquaculture has the potential to play a determining role in the fisheries sector of Mauritius. Fish farming has increased from 68.2 tonnes in 1991 to 430 tonnes in 2009. An Aquaculture Master Plan was approved by Government in 2007 and the 2008-2009 national budget made provision for its development. Aquaculture activities are regulated by the Fisheries and Marine Resources Act 2007, as amended in 2008. All marine fish farming projects in the fish farming zones have to comply with operational guidelines for responsible fish farming practices and require an EIA licence. Presently, there are two medium marine and freshwater aquaculture farms. In addition, there are a number of smaller freshwater fish farms.

6.2.10 Seafood Hub

The seafood hub⁷⁷ offers a diversified and fully integrated range of services. The present total supply of fish and fish products for direct consumption amounts to around 18,000 tonnes and around 90,000 tonnes of processed fish are exported.

⁷⁷ Sea Food Hub is defined as central facility or capacity providing a regional focus for the development of the sea food industry in an efficient and attractive environment and which supplies value added processes and services related to the sourcing, harvesting, storage, processing and marketing of sea food products.

6.2.11 Fisheries Management

Coastal Fishery

The following measures have been taken by the Fisheries Division to sustain fishery development:

- Banning of underwater fishing and fishing with explosives.
- Closed season for net fishing in the lagoon and regulations on undersized commercial fishes.
- Banning of fishing with cast nets since 1998.
- Reduction of fishing pressures in the lagoon by encouraging artisanal fishers to fish off-lagoon.
- Fishers were encouraged to surrender their large and gill nets against payment of compensation. From 1996 to April 2010, the number of nets operating decreased from 51 to 20.
- Setting up of Fish Aggregating Devices around Mauritius in order to relocate fishing effort to offshore areas.
- Regulations prescribed in 2006 to prohibit the removal of coral and sea shells.
- Creation of a Fishermen Training and Extension Centre to train fishers to fish off-lagoon.
- Loan facilities at very low interest rates through the Development Bank of Mauritius to registered fishers for purchase of boats for off lagoon fishing.
- Enforcement is effected through patrols by the Fisheries Protection Service in the lagoon and on land followed by legal proceedings.
- Regulations for the collection of sea cucumbers⁷⁸ were proclaimed in September 2008 and a two-year moratorium has been set from 1st October 2009 to conserve the stock and allow the sea cucumber population to recuperate.

Fishing Activities in the EEZ

Mauritius depends much on the exploitation of the fisheries resources in its EEZ and participates in the Indian Ocean Tuna Commission where sustainable tuna fisheries management measures are taken. To bring Mauritian legislation in line with the requirements of the Indian Ocean Tuna Commission, the Marine Resources (Vessel Monitoring System) Regulations was promulgated and a Vessel Monitoring System was installed in Mauritius in 2005. In this regard, fishing licences are issued only to vessels equipped with a functional Vessel Monitoring System on board.

Furthermore, fishing licences are issued to authorise local and foreign fishing vessels to fish in the EEZ, under the provisions of the Fisheries and Marine Resources Act 2007. In 2009, around ten countries were issued fishing licences. Mauritius signed fishing agreements with Seychelles in 2005 and the Japan Tuna Fisheries Cooperative Association in 2007. In 2009, the annual revenue from such licences and fishing agreements was around Rs. 40 million. In an effort to combat illegal, unreported and unregulated fishing in Mauritius, a National Plan of Action based on the International Plan of Action, has been developed with the assistance of the Government of Norway to prevent, deter and eliminate illegal, unreported and unregulated fishing.

⁷⁸ In Mauritius, sea cucumber fishing for export purposes started in 2006 and the total catch of sea cucumbers accounted to 493 tonnes live weight.

6.2.12 Mangroves

Mangrove⁷⁹ ecosystems constitute an important asset to fisheries and the marine environment. Mangroves are protected species under the Fisheries and Marine Resources Act 2007. Conscious of the constant pressure exerted on that ecosystem, a mangrove propagation programme was initiated in 1995 by the Fisheries Division and to date, around 220,000 mangrove seedlings have been 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 some 145 ha (ESA Classification Report, June 2009).

6.2.13 Coral Reef Monitoring and Protection

To better follow-up and build vital data sets on the health of coral reef ecosystems and to enhance resilience of the marine biota, a regular monitoring programme at 12 specific lagoon sites as well as 23 stations (both in the lagoon and off-lagoon) has been in operation for more than a decade. Data gathered on coral cover and abundance of fish and invertebrates are submitted to the Global Coral Reef Monitoring Network under the South West Indian Ocean Node.

Moreover, since the promulgation of the regulation prohibiting removal of coral and sea shells in 2006, no permits are issued, except for scientific purposes. In addition, some research and development projects are being run to protect coral reefs. These include:

- The Genetic Connectivity regional project, involving Eastern African countries and Indian Ocean Islands. The project is locally coordinated by the Mauritius Oceanography Institute and aims at investigating the genetic connectivity of some specific corals and reef across the region.
- The coral farming project jointly carried out by the Mauritius Oceanography Institute and the Fisheries Division aimed at propagating corals on land and in lagoon-based nurseries using simple and cost-effective infrastructure. Farmed corals will be used to rehabilitate the degraded habitats and create artificial reef environments.

6.2.14 Invasive Alien Species

An International Convention on Ballast Water Management for ships has been adopted by the International Maritime Organisation in 2004 and applies to any ship carrying ballast water. A port baseline survey, including an inventory of the fauna and flora is being carried out by the Mauritius Oceanography Institute in collaboration with the Shipping Division of the Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping.

6.2.15 Sensitization Programmes

Sensitisation programmes on the importance of the marine ecosystem and its protection are carried out by stakeholders involved in this field. Various target groups namely: students, fishermen, government and parastatal organizations and the public in general are sensitised.

6.2.16 Oil Spill Contingency Planning

Oil spills are a great threat to coastal biodiversity, fisheries and human health. Mauritius has prepared two contingency plans: the National Oil Spill Contingency Plan and the Port Louis Harbour Oil Spill Response Plan, which provide the framework for oil spill preparedness and response. A Coastal Sensitivity Atlas has also been prepared, which identifies the sensitive resources requiring special protection. Essential combat equipment, available at the National Coast Guard, Special Mobile Force and Mauritius Ports Authority, are adequate to deal with oil spills of less than 10 metric tonnes. In case of major spills either in the territorial waters of a single nation or in case of a transboundary spill affecting more than one nation, assistance can be obtained from Indian Ocean countries, through the Western Indian Ocean Sub Regional Oil Spill Contingency Plan or through international assistance from international oil spill response organisations.

⁷⁹ Two species of mangrove, *Rhizophora mucronata* and *Bruguiera gymnorhiza* grow around Mauritius. In the past, the extent of mangrove cover around the island decreased as these were used for firewood, construction and for providing passages to the sea.

6.2.17 Regional Initiatives

EU/IOC ReCoMaP project

ReCoMaP is a five-year regional programme (2006 - 2011) of the IOC for the Sustainable Management of the Coastal Zones of Indian Ocean Countries. It is funded by the EU and has an overall budget of 18 million Euros. It aims at improving the management of the natural coastal and marine resources with a view to reducing poverty amongst the coastal population of seven countries in the South West Indian Ocean region including Mauritius. Mauritius received support from ReCoMaP for:

- Various micro-projects that were implemented by NGOs.
- Sensitization of primary and secondary children on ICZM.
- Awareness raising and sensitization for a clean and green environment.
- Capacity building on ICZM principles, planning and policies, socio-economic monitoring programme, CoReMo Coral Reef Data Base and others.
- Development of a Tourism Development Strategy for Mauritius
- The feasibility study to start a small scale fish farming project

UNEP/GEF WIO-LaB Project

Mauritius participated in the UNEP/GEF WIO-LaB project 'Addressing land based activities in the Western Indian Ocean' under the Nairobi Convention from 2004 to 2010. Mauritius received US\$ 310,000 from the Nairobi Convention for the implementation of two demonstration projects, namely:

- Solid Waste Management in the Port Area, where an incinerator has been installed in the Port Louis Harbour for the safe disposal of ship-generated of quarantine wastes.
- Use of native species to control soil erosion in the Black River Gorges National Parks which aims at reducing the land based pollution in the form of terrigenous sediments that enter Le Morne lagoon through the Black River (Rivière Noire). In this context, a 10 ha plot of degraded land in the Black River Gorges National Parks has been restored by planting of native species to control soil erosion.

In addition, a number of national reports have been prepared under the project. These include:

- Status of Municipal Wastewater Management in Mauritius
- Assessment and monitoring of water, sediment and biota quality in Mauritius
- Preliminary assessment on status of marine litter problems in Mauritius
- Report on existing policy, legal and institutional frameworks with regard to management of land-based sources of pollution
- Report on the status of ratification of international conventions relevant to management of land-based sources of pollution

Capacity building of national stakeholders has also been carried out through a number of training workshops.

African Monitoring of Environment for Sustainable Development

Funded by the EU and coordinated by the African Union, the African Monitoring of Environment for Sustainable Development project aims at bringing earth observation data closer to the African community. All partners and stakeholders will gain access to near real-time marine and meteorological data through the acquisition of a satellite receiving station. This will enable fishing authorities identify and map potential fishing areas as well as develop a database on marine meteorology and physical models to help in the case of marine hazards.

● 6.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Inadequate management of the coastal zone	Implement recommendations of ICZM Framework	Better management of the coastal zone
Increasing beach erosion	Strengthen enforcement of laws	Beach erosion controlled
Maintaining good lagoonal water quality	Implement the Blue Flag programme	Good lagoonal water quality
Loss of marine biodiversity, wetlands, mangroves and increased coral bleaching	Implement recommendations of ESA Study	Ecological integrity of the coastal and marine ecosystems preserved
Overfishing	Strictly implement fisheries management measures	Fisheries exploited at sustainable level
Vulnerability of coastal and marine resources to climate change and sea level rise	Develop and implement climate change adaptation strategy	Coastal zone resilient to sea level rise and climate change
Lack of monitoring, enforcement, evaluation and research	Strengthen monitoring, data collection and develop professional management systems	Ecological assessment and monitoring of coastal and marine ecosystems improved
Construction pressure on the coastal belt	Ensure strict adherence of coastal development to Outline Planning Schemes and Planning Policy Guidance	Coastal development harmonised with surrounding environment

6.3.1 Policy Options for the Future

The will and capacity of Mauritius to manage its coastal and marine resources in ways that promote human wellbeing, for present and future generations, are important issues. In the Best Case Scenario, Mauritius recognizes the importance of its coastal and marine environments, not only for their intrinsic value but as valuable resources capable of transforming lives and economies. There is the realisation that coastal and marine environments are under stress and in need of an integrated and effective planning and management regime.

Government has identified key strategies for the proper and rational management of the coastal zone and the marine resources in the EEZ, targeting multiple objectives (e.g. tourism, fisheries, conservation). These include the NEP, ICZM Framework and ESA Study. The adoption of the Best Case Scenario for coastal and marine environments requires the effective and immediate implementation of the following policies as well as the support and commitment of various stakeholders and the local community.

Integrated Coastal Zone Management (ICZM) Framework for the Republic of Mauritius, 2010

The ICZM Framework presents a series of measures that address changes in policy, institutional integration and environmental management in three main priority areas:

(a) Improving Management of the Coastal Zone by:

1. Strengthening environmental management through:
 - Strict adherence of coastal development to Outline Planning Schemes and Planning Policy Guidance.
 - Implementation of a policy not to lease the first 30 m of the *pas géométriques*⁸⁰.
 - Establishment of Environmental Management Systems, audits and certification in hotels and IRS.
2. Protection of specific locations through the declaration of more MPAs.
3. Reduction of fishing pressure within the lagoons by gradual reduction of lagoonal fishing licenses.

4. Reduction of potential conflicts and access issues by halting all land appropriation of designated public beach areas for hotel or other private developments.

5. Implementation of Local Area Action Plans for six pressure zones, namely: Grand Baie, Ile D'Ambre, Le Morne, Belle Mare, South Coast of Mauritius & East Coast of Rodrigues.

(b) Institutional strengthening and capacity building by:

1. Increasing human resources and building capacity at central and local levels for monitoring and evaluation of project effectiveness, including empowerment of local community to monitor project outcomes and intervene on non-adherence to planned activities or ineffective project activities.

2. Establishment of an ICZM Institutional Framework with an executive level policy formulation body that integrates cross-sectoral policy; the setting up of a ICZM secretariat, with a scientific and technical advisory committee, that serves the executive body and develops programmes and projects in support of policy; and the development of local area planning groups to implement local projects. This three-tier system will be in line with existing government structures.

3. The re-engineering of the Department of Environment to consolidate compliance and enforcement activities into one unit and facilitate the eventual formation of an independent Environmental Enforcement Agency, which will take on the role of managing the EIA process and prosecution for non-compliance to all environmental laws.

4. Developing professional management systems by providing training in policy formulation, programme planning and project management.

(c) Provision of a Framework to Facilitate Data-sharing and Pooling of Resources through the:

1. Development of an inter-agency Geographical Information System and database, which is accessible to all major stakeholders.

2. Development of a monitoring strategy for Mauritius, which focuses on all key coastal ecosystems to support the decision-making process.

⁸⁰ The 'Pas Géométriques' are the reserved lands along the sea coast, the breadth of which is 81.2 metres measured from the high water mark. They form part of the 'domaine public' and are inalienable and imprescriptible.

○ Environmentally Sensitive Areas (ESA) Study for the Republic of Mauritius

The key to achieving ESAs protection and sustainable development rests with the effective implementation of the recommendations of the ESA study. As described in Table 6.3, the proposed policy is to restrict development in the following manner:

Table 6.3: Policy for protection of Environmentally Sensitive Areas

ESA CATEGORIES	POLICY FOR PROTECTION OF ESAs
CATEGORY 1	<ul style="list-style-type: none"> • All development in or on an ESA is prohibited. • Development outside an ESA that will adversely affect the ESA is prohibited; development outside the ESA may proceed provided that mitigation measures will prevent adverse affects on the ESA.
CATEGORY 2	<ul style="list-style-type: none"> • Any development that may adversely affect an ESA must be offset by projects on the same property that provides environmental benefits
CATEGORY 3	<ul style="list-style-type: none"> • Any development that causes significant adverse impacts is prohibited. Development is permitted and may degrade the ESA provided that mitigation measures prevent significant impacts and any net impacts are compensated.

Source: Report on Policy Guidance for ESAs in Mauritius, 2010

○ Africa Adaptation Programme

Mauritius is participating in the Africa Adaptation Programme supported by the Government of Japan. The programme aims at integrating and streamlining climate change adaptation considerations into the institutional framework and into core development policy, strategies and plans. Adaptation activities for the coastal zone will take more prominence with the forthcoming climate change adaptation strategy.

○ Implementation of Blue Flag Programme

Through the implementation of the Blue Flag programme, Mauritius will be recognized throughout the world as a symbol of high environmental standards. The Blue Flag⁸¹ Programme will be instrumental in improving compliance at the local level with national and regional environmental legislations and policies. This will help Mauritius to maintain a privileged place in the highly competitive tourism market.

⁸¹ The Blue Flag is a voluntary eco-label awarded to over 3,450 beaches and marinas in 41 countries across Europe, South Africa, Morocco, Tunisia, New Zealand, Brazil, Canada and the Caribbean. The Blue Flag works towards sustainable development at beaches/marinas through strict criteria dealing with water quality, environmental education and information, environmental management, safety and other services.

Chapter Summary

CHALLENGES

- ▶ Urban expansion, unplanned construction, land reclamation and clearing, tourism development, climate change and sea level rise are having negative impacts on the coastal zone.
- ▶ The main sources of pressure on the marine environment are effluents from households, industries, hotels and agriculture, which affect lagoonal water quality.
- ▶ Some 7 km of beach have been affected by erosion. This is being further exacerbated by hard structures on the beach.
- ▶ Between 1993 and 2009, total fish catch has decreased from 19,690 tonnes to 6,978 tonnes.
- ▶ Fragile coastal biodiversity (fish, corals, sea cucumber) and ecosystems (wetlands, mangroves, and coral reefs) are increasingly threatened by unsustainable practices.
- ▶ There is insufficient monitoring of compliance with licences and enforcement of laws.
- ▶ Poor mechanisms of communication, collaboration and coordination among the various agencies involved in coastal management.

PROGRESS

In order to promote sustainable use of the coastal resources and preservation of the marine biodiversity, the following initiatives have been undertaken:

- ▶ Comprehensive legal framework for coastal zone management in place.
- ▶ Many coastal activities are controlled by the EIA/PER mechanism.
- ▶ Development of an ICZM Framework and a Study on ESAs for better management of the coastal zone.
- ▶ Banning of sand mining and coastal rehabilitation works carried out over the last ten years to reduce coastal erosion.
- ▶ Systematic long-term lagoonal water quality monitoring at established sites around the island.
- ▶ Regular monitoring programme for coral reef ecosystem at specific lagoon sites.
- ▶ Proclamation of six fishing reserves and two marine parks.
- ▶ Implementation of management measures for a sustainable fisheries sector.
- ▶ Development of Oil Spill Contingency Plans to provide the framework for oil spill response.

PROSPECTS

Much remains to be done to prevent further degradation of coastal and marine resources. Main actions to be considered are to:

- ▶ Implement recommendations of the ESA Study and the ICZM Framework.
- ▶ Promote sound development practices in the coastal zone by strict adherence of coastal development to Outline Planning Schemes and Planning Policy Guidance.
- ▶ Develop and implement a climate change adaptation strategy to increase resilience to climate change and sea level rise
- ▶ Implement the Blue Flag programme for beaches.
- ▶ Strictly implement fisheries management measures in the lagoon and in the EEZ.
- ▶ Strengthen monitoring, data collection and ensure professional development.

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- **Ministry of Environment & NDU, 2010**, “Mauritius Strategy for Implementation, National Assessment Report 2010, Republic of Mauritius”.
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- **Central Statistics Office, 2009**, “Digest of Environment Statistics”
- **Ministry of Environment & Sustainable Development, 2010**, “Environmentally Sensitive Areas Classification Report”
- **Ministry of Environment & Sustainable Development, 2010**, “Technical Report on Freshwater Wetlands”
- **Ministry of Environment & Sustainable Development, 2010**, “Policy Guidance for Environmentally Sensitive Areas in Mauritius”
- **Ministry of Environment & NDU, 2007**, “National Environment Policy”
- **Mauritius Meteorological Services, 2008**, “Climate Change Impacts in Mauritius”

Inland Biodiversity

The native biodiversity⁸² of Mauritius⁸³ is unique and diverse due to several factors, namely its volcanic origin, age and isolation. Mauritius is characterised by a high level of endemism and species diversity⁸⁴. There are 691 species⁸⁵ of indigenous⁸⁶ flowering plant, of which 273 are endemic⁸⁷. The only native mammals are bats and to-date nine endemic species of land bird and eleven endemic reptile species exist on the island. Of the invertebrate fauna, only butterflies and land snails have been studied. However, Mauritius has a highly modified ecosystem, due to pressures from human activities and natural factors.

BOX 7.1: IMPORTANCE OF BIODIVERSITY

Biodiversity contributes directly and indirectly to the provision of ecosystem goods and services. These are divided into four main categories:

- **Goods (provisioning services)** are the products obtained from ecosystems.
- **Cultural services** represent non-material benefits delivered by ecosystems.
- **Regulating services** are the benefits obtained from regulating ecosystem processes.
- **Supporting services** are those necessary for the production of all other ecosystem services.

ECOSYSTEM GOODS & SERVICES

■ Goods (provisioning services)	■ Regulating Services	■ Cultural Services	■ Supporting Services
<ul style="list-style-type: none"> ▶ Food, fibers and fuel ▶ Genetic resources ▶ Biochemicals ▶ Fresh water 	<ul style="list-style-type: none"> ▶ Invasion resistance ▶ Herbivory ▶ Pollination ▶ Seed dispersal ▶ Climate regulation ▶ Pest regulation ▶ Disease regulation ▶ Natural hazard protection ▶ Erosion regulation ▶ Water purification 	<ul style="list-style-type: none"> ▶ Spiritual and Religious values ▶ Knowledge system ▶ Education and inspiration ▶ Recreation and aesthetic values 	<ul style="list-style-type: none"> ▶ Primary production ▶ Provision of habitat ▶ Nutrient cycling ▶ Soil formation and retention ▶ Production of atmospheric oxygen ▶ Water cycling

Biodiversity plays an important role in human wellbeing. Its loss has many negative effects in terms of food security, vulnerability to climate change, energy security, access to water and to critical raw materials and recreational activities. Biodiversity loss also undermines water treatment and recycling, the conservation of productive land, resistance to invasive pests, pollination, the reproduction of fish stocks and climate regulation, among others. (Source: *Global Biodiversity Outlook 2*)

⁸² Biodiversity is the term given to the variety of life on earth. It includes the number of different species of plants, animals and microorganisms in existence and also encompasses the specific genetic variations within species. At the ecosystem level, biodiversity refers to the varied assemblages of species that characterise deserts, forests, wetlands, grasslands, lakes, rivers, agricultural and other landscapes (Global Biodiversity Outlook 2, 2006).

⁸³ Chapter 7 focuses only on terrestrial, freshwater and agricultural biodiversity. Coastal and Marine Biodiversity are discussed in Chapter 6: Coastal and Marine Resources.

⁸⁴ Species diversity refers to the number and variety of species found in a given area in a region.

⁸⁵ Species refer to a group of organisms capable of interbreeding freely with each other but not with members of other species.

⁸⁶ Native or belonging naturally to a place.

⁸⁷ An endemic species is restricted to a particular geographical region, for example, an island or river basin (source: http://www.iucn.org/iyb/about/bio_glossary/).

● 7.1 CHALLENGES

◎ 7.1.1 Land Conversion and Habitat Destruction

The increase in population and economic growth are contributing to the loss, degradation and reduction of ecosystems, species and genetic diversity. Economic development has induced forest clearance for settlement, industries and agriculture as well as encroachment on environmentally sensitive areas, such as: mountains and forested areas, hence resulting in biodiversity loss. The gradual conversion of the small remnants of native vegetation to cater for grasslands, pastures and hunting grounds for deer ranching constitute further threats to biodiversity. Large infrastructural projects such as construction of buildings, roads, dams, residential estates, Integrated Resorts Scheme (IRS) and Real Estates Scheme (RES) also negatively impact on biodiversity. Such land use patterns continue to intrude on ecosystems with depletion and irreversible degradation of resources.

According to the National Development Strategy, some 12,000 ha of land may need to be released from the agricultural and forestry (including native forests) sectors to meet the projected needs for development of housing and social amenities over the next ten years.

◎ 7.1.2 Natural Disasters and Climate Change

Natural disasters, namely cyclones and droughts are important pressures to native biodiversity as the latter is highly fragmented and populations are small, thus decreasing their resilience to weather fluctuations. For instance, cyclonic gusts of up to 285 km/h and accompanying torrential rainfall damage native forests and habitats. Droughts add to pressure on mountains and marginal ecosystems. It is expected that these negative impacts will be further accentuated by global warming, climate change and extreme weather events.

◎ 7.1.3 Invasive Alien Species

Invasive alien species⁸⁸ are one of the most serious threats to Mauritian native terrestrial biodiversity. There are dozens of aggressive invasive alien weeds threatening biodiversity from coastal habitats to the highest mountains. The negative effect of competition for light, water and nutrients with native plants is massive, leading to major reductions in reproductive output, increased mortality and reduced growth rate. This further contributes to the gradual replacement of native communities by alien plants, which in turn constitute poor habitats for most native animals. Table 7.1 shows some invasive alien plants and animal species.

Invasive alien species like privet, goyave de chine and liane cerf have been a major problem to native and planted forests at large. Many invasive alien animals also present a major threat to both native fauna and flora. For example, monkeys, rats, pigs, Rusa deer and to a lesser extent the Indian mongoose are detrimental to the native vegetation, while rats and tenrecs pose a serious threat to the survival of endemic snails (4th National Report on the Convention on Biological Diversity, 2010). Pink Pigeons are constantly at risk of predation by feral⁸⁹ cats and rats can destroy up to 60% of seeds of the endemic Bois Colophane (*Canarium paniculatum*) thus contributing to the poor regeneration of the tree despite in-situ conservation⁹⁰ management (Auchoybur, 2003). Introduced species of mammals and reptiles are now naturalised in Mauritius.

⁸⁸ Invasive Alien Species occur in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. While a small percentage of organisms transported to new environments become invasive, the negative impacts can be extensive and over time, these additions become substantial. A species introduction is usually vectored by human transportation and trade. If a species' new habitat is similar enough to its native range, it may survive and reproduce. For a species to become invasive, it must successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range. To summarize, for an alien species to become invasive, it must arrive, survive and thrive (<http://www.cbd.int/invasive/WhatareIAS.shtml>).

⁸⁹ Feral refers to a domesticated species that has adapted to existence in the wild state but remains distinct from other wild species (<http://sea.unep-wcmc.org/reception/glossaryF-L.htm>).

⁹⁰ In-situ conservation is the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings (<http://data.iucn.org/dbtw-wpd/html/PAPS-016/Appendix.html>).

Table 7.1: Invasive alien plant and animal species

INVASIVE ALIEN SPECIES		REMARKS
INVASIVE ALIEN PLANTS SPECIES	<ul style="list-style-type: none"> ▪ Goyave de Chine (<i>Psidium cattleianum</i>) 	<ul style="list-style-type: none"> ▪ These species and many more out-compete native plants for space, light and nutrients and quickly come to dominate the forests throughout the island. ▪ Goyave de Chine can reach densities of up to about seven million stems at or above 1.3 m (in height)/km² (Ramlugun, 2003).
	<ul style="list-style-type: none"> ▪ Privet (<i>Ligustrum robustum subsp. walkeri</i>) 	
	<ul style="list-style-type: none"> ▪ Liane cerf (<i>Hiptage benghalensis</i>) 	
INVASIVE ALIEN ANIMALS	<ul style="list-style-type: none"> ▪ Rusa deer (<i>Cervus timorensis rusa</i>) 	<ul style="list-style-type: none"> ▪ Browse native shrubs, saplings and seedling. ▪ Disturb soil, disperse seeds of alien plants and have negative effects on native plant regeneration. ▪ Damage unripe native fruits. ▪ Predate on eggs and chicks of native birds. ▪ Rats are notable seed and fruit predators.
	<ul style="list-style-type: none"> ▪ Feral pigs (<i>Sus scrofa</i>) 	
	<ul style="list-style-type: none"> ▪ Monkeys (<i>Macaca fascicularis</i>) 	
	<ul style="list-style-type: none"> ▪ Rats (<i>Rattus rattus</i> and <i>Rattus norvegicus</i>) 	
	<ul style="list-style-type: none"> ▪ Feral cats (<i>Felis catus</i>) 	
INTRODUCED REPTILES	<ul style="list-style-type: none"> ▪ Common House gecko (<i>Hemidactylus frenatus</i>) 	<ul style="list-style-type: none"> ▪ They compete with and transmit parasites to the native day gecko <i>Phelsuma ornate</i>.
	<ul style="list-style-type: none"> ▪ Indian Wolf snake (<i>Lycodon aulicus</i>) 	

7.1.4 Pests & Diseases

Very little information exists on the impact of pests and diseases on Mauritian biodiversity, but it is likely that their effect on ecosystem degradation has been underestimated. Insect introductions to Mauritius accelerated considerably in the late 20th century with increased international traffic. Of the 22 significant pests to have entered Mauritius, 14 arrived after 1975. For example, an introduced coffee pest severely reduces the reproductive output of native species (Kaiser et al., 2008).

Invasive alien species such as pigeons, crows, parrots are also known to harbour and transmit diseases to which native bird species such as the Pink Pigeon, Echo Parakeet and Mauritius Fody are highly vulnerable. Pink pigeons for example are affected by three serious pathogens: *Trichomonas*, a protozoan transmitted directly or via contaminated food or drinking water; *Leucocytozoon marchouxi* a protozoan transmitted by blackfly, and avian pox, a virus spread by contact, contaminated surfaces or insect vectors. Echo Parakeets are also affected by the psittacine beak and feather disease thus impacting on the recovery programme. There may also be plant diseases that are transferable to native species but these are not well studied.

7.1.5 Deer Ranching

The introduced *Rusa* deer from Java is reared on extensive farms and estates for hunting purposes. It is estimated that there are about 70,000 heads on some 25,000 ha (15,000 ha in private ownership and 10,000 ha in state-leased land ownership) of semi-natural forest areas at a stocking rate of approximately 2.8 deer/ha. Deer ranching in privately owned land remains largely unregulated, with large proportions of native forest habitats being transformed to pasture lands. All privately owned mountain and river reserves have legal protection under the Forest and Reserves Act (1983) but nevertheless they are heavily impacted by *Rusa* deer and other invasive plant and animal species (4th National Report on the Convention on Biological Diversity, 2010).

7.1.6 Terrestrial Biodiversity

Flora

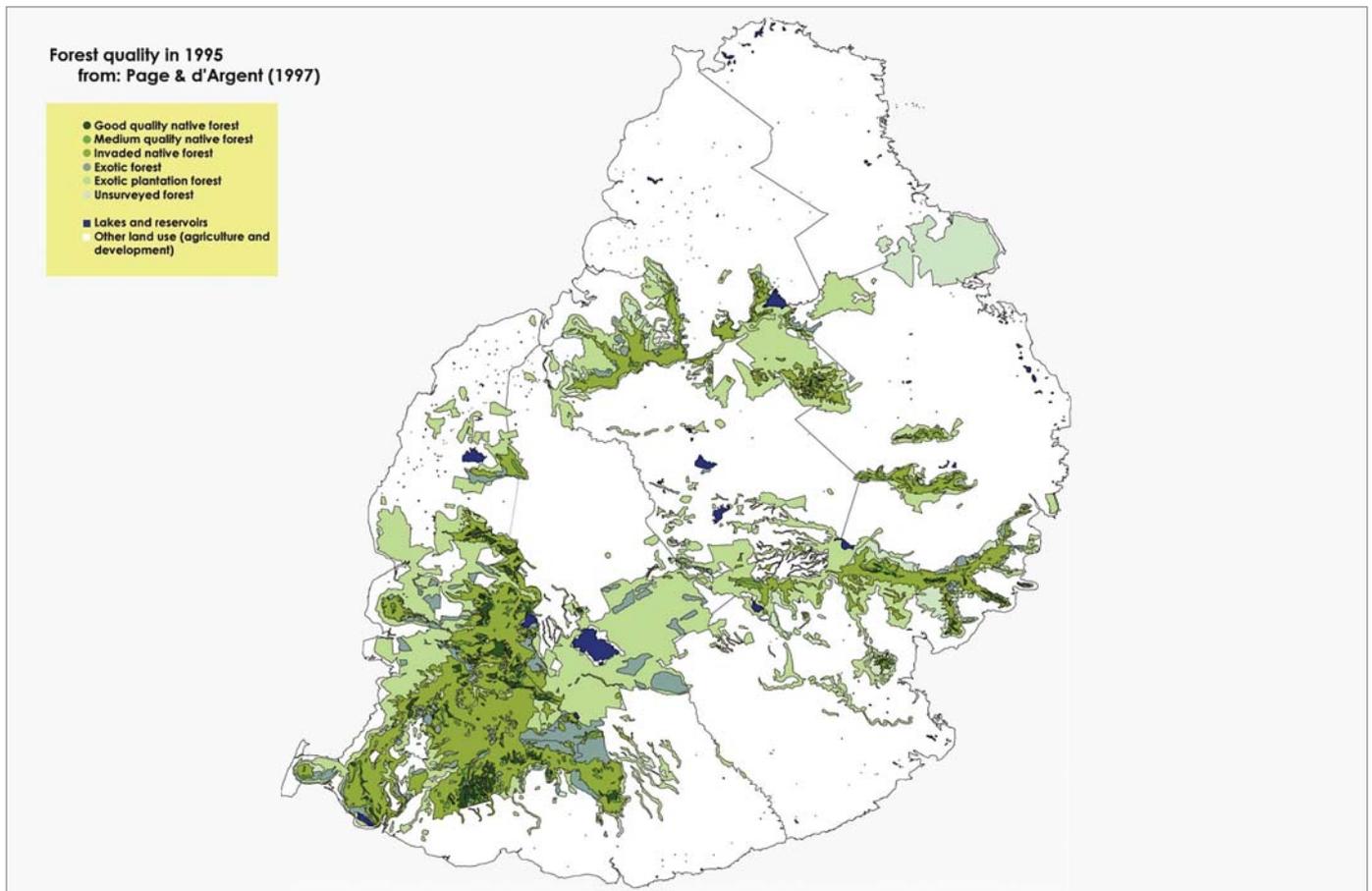
The total forest land in Mauritius is 47,181 ha and includes: 3,800 ha mountain reserves, 2,740 ha river reserves, 13 ha private reserves, 2,600 ha plantation forest as well as 15,847 ha of forest scrub and grazing areas. 47% of this forested land is state owned, while the remainder is under private management (i.e. leased from the state) or freehold title. 22,181 ha of state forest lands in Mauritius comprise: 11,848 ha planted forests, 6,574 ha National Parks and 134 ha Islet National Park⁹¹. The extent of native forest of reasonable quality (i.e. with more than 50% native plant cover) is currently estimated at approximately 2,600 ha that is, less than 2% of the total area of the island.

Fifteen different native vegetation types have been classified, which vary in species composition and structure. These range from coastal sand dune vegetation to cloud forests. Remnants of some vegetation types are concentrated in the Black River Gorges National Park in the South West, the Bambous Mountain Range in the South East and the Port Louis-Moka Range in the North West. Some isolated mountains such as Corps de Garde, Trois Mamelles and Le Morne Brabant and offshore islets like Round Island and Ile aux Aigrettes have remnants of mainland and coastal biodiversity, respectively (4th National Report on the Convention on Biological Diversity, 2010).

⁹¹ Islets National Parks are further discussed in Chapter 10: Offshore Islets.

According to the International Union for the Conservation of Nature (IUCN), Mauritius has the third most endangered terrestrial flora in the world, with around 691 species of indigenous flowering plant, of which 273 are endemic. 89% of the Mauritius endemic flora is considered threatened as several endemic plant species are classified as 'Critically Endangered'⁹², 'Endangered'⁹³ and 'Vulnerable'⁹⁴. There are 207 taxa⁹⁵ of lower plants consisting of 89 genera⁹⁶ of mosses⁹⁷ and 59 genera of hepatics⁹⁸ and about 200 species, subspecies and varieties of pteridophytes⁹⁹, 13 of which are endemic (4th National Report on the Convention on Biological Diversity, 2010). Table 7.2 shows the number of flowering plants existing in Mauritius.

Figure 7.1 Forest cover in Mauritius



Source: National Biodiversity Strategy and Action plan, 2006

⁹² A taxon is 'Critically Endangered' when the best available evidence (severe population decline, very small population, very small geographic area occupied, or if the calculated probability of extinction during the next 10 years is >50%) indicates that it is facing an extremely high risk of extinction in the wild (<http://www.iucnredlist.org/initiatives/mammals/description/glossary>).

⁹³ A taxon is 'Endangered' when the best available evidence (large population decline, small population, small geographic area occupied, or if the calculated probability of extinction during the next 20 years is >20%) indicates that it is considered to be facing a very high risk of extinction in the wild (<http://www.iucnredlist.org/initiatives/mammals/description/glossary>).

⁹⁴ A taxon is 'Vulnerable' when the best available evidence (large population decline, small population, small geographic area occupied, or if the calculated probability of extinction during the next 20 years is at least 10%) indicates that it is considered to be facing a very high risk of extinction in the wild (<http://www.iucnredlist.org/initiatives/mammals/description/glossary>).

⁹⁵ A taxon (plural: taxa) is the named classification unit (e.g. *Homo sapiens*, *Hominidae* or *Mammalia*) to which individuals, or sets of species, are assigned.

⁹⁶ Genera refer to categories of biological classification ranking between the family and the species, comprising related species or an isolated species exhibiting unusual differentiation (<http://sea.unep-wcmc.org/reception/glossaryF-L.htm>).

⁹⁷ Mosses are tiny (typically 1-10 cm) leafy-stemmed flowerless plants.

⁹⁸ Hepatics are small green nonvascular plants growing in wet places.

⁹⁹ The pteridophytes are a collection of several major groups, which include ferns.

Table 7.2: Number of flowering plant species in Mauritius

SPECIES	NUMBER OF NATIVE SPECIES		NUMBER OF EXTINCT SPECIES		NUMBER OF EXISTING SPECIES	
	Total	Endemic	Total	Endemic	Total	Endemic
Flowering Plants	691	273	61	29	630	244

Source: Baider et al., 2010

Rodrigues has three endemic genera of plants and 133 indigenous plant species have been recorded, out of which 47 are endemic. Nine of the endemic species are comprised of less than ten mature individuals in the wild. These include three species, which are known from just a single individual (*Ramosmania rodriguesii*, *Dombeya rodriguesiana* and *Gouania leguatii*) (4th National Report on the Convention on Biological Diversity, 2010).

○ Fauna

Bats are the only native mammal in Mauritius and Rodrigues. Of the three species of fruit bat known to have occurred, only one (*Pteropus niger*) remains in Mauritius and is still locally common, while *Pteropus rodricensis* still occurs on Rodrigues. There were twelve endemic bird species, out of which nine are threatened. Table 7.3 shows the evolution of the nine threatened endemic birds' population from 1975 to 2009.

Table 7.3: Evolution of the population of endemic birds (1975-2009)

SPECIES	1975	2000	DECEMBER 2009
Mauritius Kestrel	2 pairs	700 individuals	About 600 individuals
Pink Pigeon	18-20 individuals	400 individuals	About 450 individuals
Mauritius Echo Parakeet	50 individuals	120 individuals	About 440 individuals
Mauritius Cuckoo-Shrike	210-220 individuals	300-350 pairs	>350 pairs; no new surveys conducted, but thought to have increased
Mauritius Black Bulbul	200 pairs	225-340 pairs	225-340 pairs, probably increasing
Mauritius Paradise Flycatcher	250 pairs	250 pairs	>250 pairs some increases noted
Mauritius Grey White-Eye	34,000-68,000 pairs	34,000-68,000 pairs	34,000-68,000 pairs
Mauritius Olive White-Eye	350 pairs	<100 pairs	<100 pairs in Black River Gorges National Park and surrounding areas. 20 individuals on Ile aux Aigrettes
Mauritius Fody	250 pairs	105-125 pairs	Black River Gorges National Park population stable at 105-125 pairs, about 160-170 individuals on Ile aux Aigrettes

Source: Mauritian Wildlife Foundation and the 4th National Report on the Convention on Biological Diversity, 2010

Table 7.4: Fauna in Mauritius

SPECIES	NUMBER OF NATIVE SPECIES		NUMBER OF EXTINCT SPECIES		NUMBER OF EXISTING SPECIES	
	Total	Endemic	Total	Endemic	Total	Endemic
Mammals	5	2	2	1	3	1
Birds	30	24	18	15	12	9
Reptiles	17	16	5	5	12	11
Butterflies	37	5	4	1	33	4
Snails	125	81	43	36	82	45

Source: 4th National Report on the Convention on Biological Diversity, 2010

There are 12 native reptile species on Mauritius and 11 are endemic. Seven of these are restricted to remnant populations on the northern offshore islets. The burrowing boa (*Bolyeria multicaerinata*) was last seen in 1975 and it is probably extinct. There are 39 native species of butterfly, of which five are endemic and 125 known native species of land snail of which 43 are already extinct. However to date, there is no conservation strategy for any invertebrate group and there is a general lack of expertise in this field. Table 7.4 shows the fauna population in Mauritius.



7.1.7 Agro Biodiversity

Agro biodiversity¹⁰⁰ is directly linked to food security and broadly categorized into two main groups: sugar and non-sugar (i.e. vegetables, fruit, medicinal plants and livestock). The key threat to agricultural biodiversity is the loss of plant genetic resources as emphasis is being placed on a relatively small number of high yielding varieties and breeds and that field station lands for plant genetic resources activities¹⁰¹ are being released for development. These field stations contain valuable species and varieties and their release for development, may lead to the extinction of valuable genetic resources. Similarly, the introduction of Living Modified Organisms in the future could contribute to genetic erosion and loss of traditional crops. Furthermore, limited area and capacity, incomplete inventories and research, lack of inter-institutional communication and collaboration are also jeopardising agro biodiversity.

Round Island Petrel

Courtesy: National Parks and Conservation Service

¹⁰⁰ Agro biodiversity is the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems (source: http://www.fao.org/sd/links/documents_download/FS1WhatIsAgrobiodiversity.pdf).

¹⁰¹ Plant genetic resources activities include: selection exercises, regeneration, multiplication, characterisation of accessions, and rescue of important genetic material.

All cultivated crops and animals reared have been introduced. During the past two decades, many new varieties have been introduced by individuals, farmers' organisations and institutions to obtain higher-yielding varieties with better resistance and tolerance to diseases and longer shelf-life, with the possibility of transformation or processing into value-added products. For example, the Agricultural Research and Extension Unit has introduced 686 varieties of different species of vegetables, fruits and ornamentals for testing and recommendation to farmers. All these imported varieties are screened for diseases and sometimes grown under quarantine conditions at the National Plant Protection Office. However, some have done harm to existing open-pollinated long-established varieties of crops such as pumpkins. The wide adoption of newly-introduced higher-yielding varieties tends to displace old locally-adapted varieties. All farm animal genetic resources were introduced to Mauritius during the period of colonisation. The 'local' breeds found in Mauritius originate from these introductions.

Furthermore, a major drawback in the management of freshwater biodiversity is that responsibilities are fragmented. For example, the Wildlife and National Parks Act 1993 regulates the protection and management of the following crustaceans: 'camarons' and 'shrimps'. On the other hand, the Fisheries and Marine Resources Act 2007 provides for the protection of aquatic ecosystems, whereby it is prescribed that "No person shall place, throw, discharge or cause to be placed, thrown or discharged into the maritime zones or into a river, lake, pond, canal, stream, tributary or wetland any poisonous substance".

7.1.8 Freshwater Biodiversity

The freshwater biodiversity of Mauritius is contained within 92 rivers and 232 rivulets, several manmade reservoirs, natural lakes and marshy areas. Following a survey carried out in 2002, 18 species of fish and 10 crustacean species were recorded in the main rivers of Mauritius. Three endemic crustacean species were also inventoried: *Cardina mauritii*, *Cardina spathulorostris* and *Cardina richtersi* (petite chevrette). However, most of those species are few in number.

Many of the watercourses in Mauritius become overgrown with invasive plant species while in many cases, discharge and leaching of agrochemicals have promoted algae proliferation thus causing eutrophication. The Mauritian Wildlife Foundation also conducted a survey on existing vegetation along riverbanks and riversides (January-February 2004). It was found that watercourses and riversides have become degraded by invasive alien species, which have infested about 95% of river banks.

● 7.2 PROGRESS

Biodiversity is one of the national priorities of Government. Conservation, protection and management of native biodiversity as well as offshore islets' management are being done through collaboration and partnerships by Government departments, private sector organisations, academic institutions, research organizations and NGOs. According to the National Biodiversity Strategy and Action Plan, it is estimated that Rs. 200 million is spent annually, in addition to external funding, on the conservation of forests and terrestrial biodiversity.

◎ 7.2.1 Institutional & Legal Framework

The main institutions responsible for the safeguard and management of biodiversity are:

- Ministry of Agro Industry and Food Security
- Ministry of Environment and Sustainable Development
- Mauritius Sugar Industry Research Institute
- Mauritian Wildlife Foundation

The Ministry of Agro Industry and Food Security is the lead Ministry for the protection and management of biodiversity. It executes its functions through a number of institutions as shown in Table 7.5 below

○ Mauritian Wildlife Foundation

The Mauritian Wildlife Foundation is an NGO, which is actively involved in islet restoration (in particular Ile aux Aigrettes and Round Island), eco-tourism on Ile aux Aigrettes, species recovery management for rare birds together with the NPCCS, development of protocols for the rescue of native plant species, restoration of the fauna and flora and replanting the native forest in Rodrigues, forest surveys, rare plant propagation and public education and awareness.

○ The Mauritius Herbarium

The Mauritius Herbarium at the Mauritius Sugar Industry Research Institute is a regional herbarium for the Mascarene Islands and some other countries. It has a small living collection of native plants and also carries out research on ecology and conservation of native species. To protect native flora and fauna, the following regulations have been promulgated:

○ Legal Framework

- Environment Protection Act 2002, as amended in 2008
- Fisheries and Marine Resources Act 1998
- Forests and Reserves Act 1983
- Plant Protection Act 2006
- Wildlife and National Parks Act 1993
- National Parks and Reserves Regulations 1996
- Wildlife Regulations 1998

Table 7.5: Institutions involved in biodiversity conservation

INSTITUTIONS	MANDATE
	PROTECTION OF TERRESTRIAL BIODIVERSITY
National Parks and Conservation Service (NPCS)	Responsible for the conservation of native biodiversity and manages the Black River Gorges National Park, Islet National Parks and the Ramsar site at Terre Rouge.
Forestry Service	Responsible for the protection and enhancement of forests, nature reserves, soil and water conservation, watershed management and other environmentally sensitive areas in Mauritius and Rodrigues.
	PROTECTION OF AGRO BIODIVERSITY
National Plant Protection Office	Protects the country's agricultural economy and natural resources from the introduction and spread of exotic pests.
Division of Veterinary Services	Regulates and monitors all activities concerning the transboundary movements of animal and animal products including seafood products.

7.2.2 Biodiversity-Related International Agreements

The Government of Mauritius is signatory to a number of biodiversity-related international conventions. The most important conventions are shown in Box 7.2.

BOX 7.2 : BIODIVERSITY-RELATED CONVENTIONS	
▶ Convention on Biological Diversity	▶ The objectives of the Convention on Biological Diversity are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.
▶ The Cartagena Protocol on Biosafety	▶ The Cartagena Protocol on Biosafety to the Convention on Biological Diversity is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms resulting from modern biotechnology, taking into account risks to human health.
▶ The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar)	▶ The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
▶ The Convention on International Trade in Endangered Species of Wild Fauna and Flora	▶ The Convention on International Trade in Endangered Species of Wild Fauna and Flora is an international agreement between Governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
▶ The Convention on Migratory Species of Wild Animals	▶ The Convention on the Conservation of Migratory Species of Wild Animals aims to conserve terrestrial, marine and avian migratory species throughout their range.

7.2.3 Policies and Strategies

A number of policies and strategies have been adopted by Government for conservation and sustainable use of biodiversity. These include the National Environment Policy (2007), National Biodiversity Strategy and Action Plan (2006-2015), National Invasive Alien Species Strategy and Action Plan (2010), Non-Sugar Sector Strategic Plan (2003-2007), Strategic Options in Crop and Livestock Sector¹⁰² (2007-2015) and Study on Environmentally Sensitive Areas.

National Environment Policy and National Environmental Strategies

The National Environment Policy has set objectives, national targets and future strategies for the conservation of habitats and ecosystems, protection of native fauna and flora and enhancement of crop and animal production to meet food, health and other socio-economic needs of the growing population. The National Environmental Strategies has also identified a priority project on the ecological assessment of freshwater bodies.

¹⁰² The Strategic Options in Crop and Livestock Sector Programme takes into account Government policy for promoting access to agricultural land, agribusiness, good agricultural practice, improving food quality and safety, reducing dependency on import, promoting export, and ensuring food security. The overall goal of the programme is to significantly increase food and agricultural production in a competitive and sustainable manner by 2015 through innovative production methods, novel product development while opening access to new markets.

○ National Biodiversity Strategy and Action Plan

The National Biodiversity Strategy and Action Plan (2006 – 2015) is the main policy and strategy document relating to biodiversity protection in Mauritius. It includes the following thematic areas: forest, terrestrial, freshwater, coastal, marine and agricultural biodiversity as well as biotechnology and biosafety. The plans have an inbuilt independent review mechanism to enable adaptive utilisation of effort and resources to meet strategic objectives, which are as follows:

- Establishment of a representative and viable Protected Area Networks.
- Management of key components of biodiversity and enabling their sustainable use.
- Maintaining ecosystem services and managing biotechnology and its products.

Priorities to attain the objectives for the conservation of natural resources include:

- Avoiding extinction of endangered and threatened species of flora and fauna by providing sound planning, allocation and management of land and water use, supported by on-site preservation in protected areas and off-site protection such as zoos and botanical gardens.
- Preserving as wide a genetic diversity as possible of many varieties of the same plants and animals.
- Preserving as many habitats as possible.
- Expanding large conservation management areas to other key biodiversity hotspots areas and priority management of the parks.
- Encouraging the protection of wetlands and river reserves.

○ National Forest Policy

The National Forest Policy was adopted in 2006 and is a statement of Government's intentions for the development of the forest sector. It is designed to protect and enhance the country's natural environment, biodiversity and national heritage, while at the same time promoting recreation and tourism. A National Forest Action Programme is under preparation to implement the national policy. This is expected to include actions to:

- Enhance national efforts in carrying out applied research, forest inventory and assessment as well as international exchange of information on forests.
- Regulate and ensure equitable leasing of state-owned eco-tourism sites to tour operators and train public and private sector personnel in eco-tourism management.
- Contribute to poverty alleviation through developing small-scale forest-based businesses.
- Establish a highly technical, efficient and effective public forestry administration which is capable of promoting the sustainable management of forest resources to meet societal demands for products, forest resource conservation, recreation and environmental services.

○ National Invasive Alien Species Strategy and Action Plan

In line with the Convention on Biological Diversity, a National Invasive Alien Species Strategy and Action Plan (2010-2019) was adopted. It provides a comprehensive and coordinated approach in the management of invasive alien species with a view to minimizing the negative economic, environmental and human health impacts of the species that threaten the ecosystem

○ Study on Environmentally Sensitive Areas¹⁰³

The Study on Environmentally Sensitive Areas (ESAs) has identified the following terrestrial and freshwater ESAs: marshlands, forests with native content, steep slopes, freshwater wells (boreholes), rivers and streams, lakes and reservoirs and caves. A comprehensive framework for their conservation has been developed.

¹⁰³ More Information in Chapter 6: Coastal and Marine Resources

7.2.4 Projects and Programmes for Terrestrial Biodiversity Conservation

Management of Nature Reserves, National Park and Botanical Gardens

Mauritius has 12 legally proclaimed protected areas: one National Park¹⁰⁴, seven Nature Reserves¹⁰⁵ and four reserves¹⁰⁶, covering a total area of 7,292 ha. Sixteen offshore islets are also formal state protected areas and include eight islets National Park¹⁰⁷, seven Nature Reserves¹⁰⁸ and one Ancient Monument¹⁰⁹ - covering a total area of 735 ha. Forty three areas of native vegetation have been listed as priority areas for conservation management, whilst twenty areas of lowland native vegetation have been identified as requiring urgent conservation management and additional vegetation surveys.

Botanical gardens also play an important role in biodiversity protection. Government created the Vallée D'Osterlog Endemic Garden in 2007, which covers 275 ha and is located on the Grand Port Mountain Range at Le Val, Saint Hubert. The objectives are to conserve, preserve and protect the environment, flora and fauna of the garden.

Propagation of Endangered Plant Species

There are seven nurseries for the propagation of native species, which are managed by Government and the Mauritian Wildlife Foundation. These nurseries propagate Critically Endangered species for species recovery programmes and also mass produce common native plants for restoration projects. The NPCS with the collaboration of the Royal Botanic Gardens (Edinburgh) has set up a fern propagation facility in 2007 as part of the 'Mauritian Rare Fern project'. Some 50 species of ferns are being propagated at present. The Forestry Service has also set up a fernery and orchid garden at Monvert Nature Walk. 250 species of ferns and 86 species of orchids, which are critically endangered, are propagated and displayed to visitors.

¹⁰⁴ Black River Gorges National Park

¹⁰⁵ Perrier, Les Mares, Gouly Père, Cabinet, Bois Sec, Pouce, Corps de Garde

¹⁰⁶ Bois Sarcelles, Bras d'Eau, Poste La Fayette & Rivulet Terre Rouge Estuary Bird Sanctuary

¹⁰⁷ Pigeon Rock, Ile D'Ambre, Rocher des Oiseaux, Ile au Fous, Ile aux Vacoas, Ile aux Fouquets, Iles Flamants, Ile aux Oiseaux

¹⁰⁸ Round Island, Ile aux Serpents, Flat Island, Gabriel Island, Gunner's Quoin, Ilot Mariannes, Ile aux Aigrettes

¹⁰⁹ Ile de la Passe

Box 7.3: INITIATIVES FOR PROTECTING NATIVE BIODIVERSITY

Black River Gorges National Park

The Black River Gorges National Park is located in the South West of the island and covers an area of 6,574 ha. It was proclaimed the first National Park of the island on 15th June 1994. The creation of the park stopped further deforestation, thus decreasing more species loss.

The park is managed through Conservation Management Areas, which cover 62 ha.

These areas are fenced to exclude deer, wild pigs and exotic invasive weeds like Goyage de Chine, Privet and Liane Cerf and to allow natural regeneration of the native forest. The extension of the existing Conservation Management Areas is continuing with new projects at Fixon, in Bel Ombre and at Plateau Remusse in the Lower Gorges. The target is to increase the area to over 200 hectares.

Vallée de Ferney

The Vallée de Ferney is an area of native forest home to at least 140 species of fern and higher plants and several native animal species including the best population of Mauritius Kestrel (*Falco punctatus*). The Vallée de Ferney was recognised as an important biodiversity spot during the construction of the South Eastern Highway, where two species of *Pandanus* were rediscovered after being thought extinct. Given Government's committed to biodiversity protection, construction of the highway was halted in 2005 and Government entered into a private partnership scheme with the land owners to create the Vallée de Ferney Conservation Trust. The latter aims at using local and international funding for weeding and restoring some 200 hectares of native forest under its hold.

The Mauritius Seed Bank Project started in 2006 under the Millennium Seed Bank Project and with the collaboration of the Royal Botanic Gardens (Kew), the NPCS and the Mauritius Herbarium (MSIRI). The objectives of the project are to conserve 300 native species, carry out germination tests of rarest native species and train stakeholders on seed collection and storage techniques. Up to 2009, 250 native species have been conserved. A second phase of the project is now underway where the number of species will be increased and will include a collection of seeds from Rodrigues.

○ Reforestation Programmes

The following reforestation activities were undertaken by the Forestry Service:

- 408 ha of new forest plantations have been created on State Forest Lands.
- 1,158 ha of young forest plantations have been tendered and 2.3 million seedlings of forest and ornamental species have been produced.
- 10% of annual plantation is planted with indigenous plant species and up to now some 25 ha have been reforested.

○ Species Recovery Programmes for Critically Endangered Birds

Captive breeding programmes were established since 1976 to save the Mauritian Kestrel, Pink pigeon and Echo parakeet. Most of the work carried out has been successful and populations of each of the three species have been re-established in the wild. Breeding work has been successfully completed for the Mauritius Fody and the Olive White Eye. A population of around 160 Mauritius Fody and some 20 Olive White Eye have been established on Ile aux Aigrettes. The Mauritius Fody is planned to be released on Round Island.

The Echo Parakeet is the last surviving parrot in the Mascarenes. It was considered the rarest parrot in the world, with only about 12 individuals known in 1987 due to nest predation by invasive species and habitat loss. An intensive captive breeding and release programme, supplementary feeding, provision and monitoring of predator-proof nest boxes and predator control have increased the population of Echo Parakeets (Malham, 2005).



Elaeocarpus bojeri (Bois dentelle)

Courtesy: S.Seeruttun

The Pink Pigeon now numbers around 450 birds, compared to a population of about 25 birds in the 1970s. There are now five managed populations, four in the Black River Gorges National Park and one on Ile aux Aigrettes. A recovery programme was initiated in 2003 to establish a population of the Mauritius Fody on Ile aux Aigrettes. None of the following endemic bird species: Mauritius Cuckoo shrike, Mauritius black bulbul, Mauritius olive white eye and Mascarene paradise flycatcher receive any active management.

○ Translocation of Reptile Project

Efforts are being made to conserve rare endemic reptile species currently confined to offshore islets. In 2006, the NPCS in collaboration with Durrell Wildlife Conservation Trust and Mauritian Wildlife Foundation started a programme of translocation of reptiles from Round Island and other rodent-free islets around Mauritius.

Between 2006 and 2009, 250 Telfair skinks were translocated to Ile aux Aigrettes and Gunners Quoin. Bojers skinks from Ilot Vacoas were reintroduced on Ile aux Fouquets and orange-tailed skinks from Flat Island were introduced on Gunners Quoin. The project is ongoing (2009-2011) and aims at translocating Gunther's geckos onto Ile aux Aigrettes, Bojer's skinks on Ile aux Fouquets and Ile de la Passe, Nactus from Ilot Vacoas and Round Island onto Ile aux Mariannes and captive breeding of Nactus geckos.

○ Restoration Projects in Rodrigues

The Mauritian Wildlife Foundation has conducted restoration projects at 16 degraded areas around the island. Some of these projects are ongoing. In collaboration with the Forestry Department, a nursery has been set up to produce native plants for restoration projects. The Rodrigues Fody, Warbler and Fruit Bat as well as a host of rare plants have been rescued from extinction.

● 7.2.5 Projects and Programmes for Agro Biodiversity Conservation

○ Integrated Pest Management

Since 1997, the Agricultural Research and Extension Unit has been conducting research to develop and implement Integrated Pest Management packages against key pests of priority crops: crucifers, onion, bean, banana and litchi. The Mauritian fruit bat, *Pteropus niger*, is a protected species and causes serious damage to litchi, longane and mango fruits. The Agricultural Research and Extension Unit has promoted the use of bird nets to protect fruits from damage.

○ Fruit Village

The Agricultural Research and Extension Unit, the Agricultural Services of the Ministry of Agro Industry and Food Security and the Forestry Service have collaborated fully to implement the fruit village concept, already in place in thirteen villages in Mauritius. This initiative is to enhance the availability and promote the use of under-utilised fruit species for agro-processing. This concept was further extended under the National Tree Planting Campaign, whereby fruit trees and ornamental trees were distributed in 82 localities.

○ Biosafety

An Institutional Biosafety Committee was constituted at the MSIRI in 1996 to review all projects regarding Genetically Modified technology. In 1999, through a pilot project with the assistance of UNEP/GEF, National Biosafety Guidelines for the 'Safe Development and Introduction of Genetically Modified Organisms (GMOs) in Mauritius' were prepared. In 2006, a follow up of the pilot project resulted in the UNEP/GEF "Implementation of National Biosafety Framework" project for a four year duration. This is currently being implemented by the Ministry of Agro-Industry and Food Security.

Seven sections of the GMO Act, 2004 came into force on 1st January 2005 to "regulate the responsible planning, development, use, marketing and application of genetically modified organisms". It also ensures that all activities involving the use of GMOs and products thereof are carried out in such a way to limit damage to the environment and risks to human health. A National Biosafety Committee has been set up under the Act to advise on all aspects concerning the importation, exportation, transit, development, research, production and use of GMOs.

○ Gene Banks

Sustainable farming practices, including organic farming and biological control, are being encouraged by Government. Plant gene banks are also managed by the Plant Genetic Resources Unit of the Ministry of Agro Industry and Food Security and Agricultural Research and Extension Unit (cultivated varieties). The University of Mauritius also has a crop museum containing plant species of agricultural importance.

○ Seed Bill

The Ministry of Agro-Industry and Food Security is trying to move out of seed production towards a more regulatory role, by training and encouraging the private sector to produce seeds. It will continue to maintain seeds of traditional and rare varieties and reserves of strategic seeds for prompt supply after calamities like cyclones. A Seed Bill is being finalised. This concerns regulation of production, processing, marketing import and export of seeds.

● 7.2.6 Sensitisation and Awareness Programmes

To sensitise all target groups on the critical importance of biodiversity, the NPCCS, the Forestry Service and the Ministry of Environment and Sustainable Development carry out regular public awareness programmes. For instance, at school level, nature/endemic corners have been created and talks are delivered. Furthermore, Visitors Centres and guided tours in nature parks also raise awareness on biodiversity. Recently, nature walks have been set up by the Forestry Service to offer scope for recreational, environmental education and for raising awareness on the native fauna and flora and the importance of conservation of biodiversity.

● 7.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Land conversion and habitat destruction	Implement the National Biodiversity Strategy & Action Plan and the Invasive Alien Species Strategy and Action Plan	Conservation of biodiversity for continued provision of ecosystem goods and services Invasive Alien Species population under control
Climate change and natural disasters	Implement all biodiversity related conventions and protocols Develop management plans for protected areas and threatened species	Placement of 25% of Mauritian terrestrial area within a Protected Area Network by 2030
Invasive Alien Species and deer ranching	Develop National Strategy for conservation of agro-biodiversity Implement the National Forest Policy	Population of threatened plant and animal species stabilised
Pests and diseases	Harmonise mandates of authorities involved in biodiversity protection and management Develop and implement an Eco-tourism Strategy Enact/review legislation related to biodiversity	Effective coordination of biodiversity protection and management

7.3.1 Policy Options for the Future

In the Best Case Scenario, the following actions must be undertaken for sustainable biodiversity protection and management:

○ Institutional and Legislative Review

- Review institutional and legislative frameworks to identify gaps, streamline management procedures, harmonise laws and propose amendments to existing legislation or formulate new legislation to strengthen protection and conservation of biodiversity.

○ Terrestrial Biodiversity

~ Protected Area Network

- Re-evaluate status of forestlands (private & state).
- Develop and manage Protected Area Network.
- Select priority areas for intensive management.

~ Flora Conservation and Management

- Assess conservation status of species as per IUCN criteria and protect threatened species.
- Prepare and implement management plans for flora conservation.
- Raise awareness on the use of native plants (instead of exotics) in landscaping.

~ Fauna Conservation and Management

- Assess conservation status of and establish monitoring programmes for endemic birds.
- Develop and implement conservation plans for threatened species.
- Identify and control predators on outer islands.
- Assess abundance and distribution of fruit bats and micro-bats and establish population monitoring protocols.
- Carry out research on the ecology of fruit bats, including movement and feeding habits.
- Review and enhance conservation of reptiles.

~ Invasive Alien Species

- Implement the Invasive Alien Species Strategy and Action Plan.
- Introduce legislation to prevent entry of invasive alien species and for effective border control and inter-island quarantine.

~ Eco-tourism Development

- Develop a comprehensive eco-tourism strategy.
- Establish an eco-tourism bureau to oversee coordination/implementation of the strategy.

~ Forest Management

- Develop a national action programme to implement the National Forest Policy.
- Maintain forests with regard to existing catchments and areas at high risk of erosion.
- Increase capacity to produce plants (seedlings, layers, grafts or tissue culture plantlets) of appropriate species.
- Extend forest cover by reforestation of strategically selected areas.
- Replace exotic plantations by native species up to 50%.

○ Freshwater Biodiversity

- Undertake ecological assessment of freshwater bodies.
- Establish a database of biodiversity in rivers, reservoirs and other freshwater systems.

○ Agro biodiversity

- Undertake stocktaking and characterisation of local plant and animal agro-biodiversity.
- Develop a national strategy for conservation of agro-biodiversity and medicinal plants.
- Enhance breeding programmes for producing new varieties.

Chapter Summary

CHALLENGES

- ▶ Even though Mauritius is characterised by a high level of endemism and species diversity, it has a highly modified ecosystem, due to pressures from human activities and natural factors. Mauritius has the third most endangered terrestrial flora in the world.
- ▶ Invasive alien species are among the most serious threats to native biodiversity.
- ▶ Very little information exists on the impact of pests and diseases on Mauritian biodiversity, and it is likely that their effect on ecosystem degradation has been underestimated.
- ▶ The extent of native forest of reasonable quality is currently estimated at approximately 2,600 ha that is, less than 2% of the total area of the island.
- ▶ The key threat to agricultural biodiversity is the loss of Plant Genetic Resources.
- ▶ Many of the watercourses in Mauritius are overgrown with invasive plant species and it is estimated that 95% of river banks are infested.
- ▶ A major drawback in the management of freshwater biodiversity is that responsibilities are fragmented.

PROGRESS

- ▶ A number of institutions, including NGOs, are responsible for the safeguard and management of biodiversity.
- ▶ Government is signatory to a number of biodiversity-related international conventions.
- ▶ Policies and strategies for the conservation and sustainable use of biodiversity have been adopted and are at various stages of implementation. These include: National Environment Policy, National Biodiversity Strategy and Action Plan, National Invasive Alien Species Strategy and Action Plan, Non-Sugar Sector Strategic Plan, Strategic Options in Crop and Livestock Sector and Study on Environmentally Sensitive Areas.
- ▶ Projects and programmes for the conservation of terrestrial biodiversity include the management of nature reserves, national park and botanical gardens, propagation of endangered plant species, reforestation, species recovery for critically endangered birds and translocation of reptiles.
- ▶ The Black River Gorges National Park is the first National Park of the island and is managed through Conservation Management Areas, which cover an area of 62 ha.
- ▶ Programmes for the conservation and management of agro-biodiversity comprise integrated pest management, creation of a fruit village, implementation of the National Biosafety Framework and management of gene banks, among others.
- ▶ Measures have been taken for restoration of degraded areas in Rodrigues and to prevent species extinction.

PROSPECTS

- ▶ Implement the National Biodiversity Strategy and Action Plan and the Invasive Alien Species Strategy and Action Plan.
- ▶ Develop management plans for protected areas and threatened species.
- ▶ Develop National Strategy for conservation of agro-biodiversity.
- ▶ Implement the National Forest Policy.

Chapter Summary

PROSPECTS

- ▶ Harmonise mandates of authorities involved in biodiversity protection and management.
- ▶ Develop and implement an Eco-tourism Strategy.
- ▶ Enact/review legislation related to biodiversity.
- ▶ Implement all biodiversity related conventions and protocols.

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Energy

Energy is key to development as it powers the economy and contributes to improve the quality of life of the population. In Mauritius, fossil fuels remain the dominant source of primary energy to generate electricity and drive the transportation and manufacturing sectors. Reliable and affordable energy production is now more than ever central to achieve sustained economic growth, social development, and environmental protection. Presently, the focus for the energy sector is to further diversify supply, improve efficiency, address environmental and climate changes and modernise the country's energy infrastructure in order to meet the challenges ahead.

● 8.1 CHALLENGES

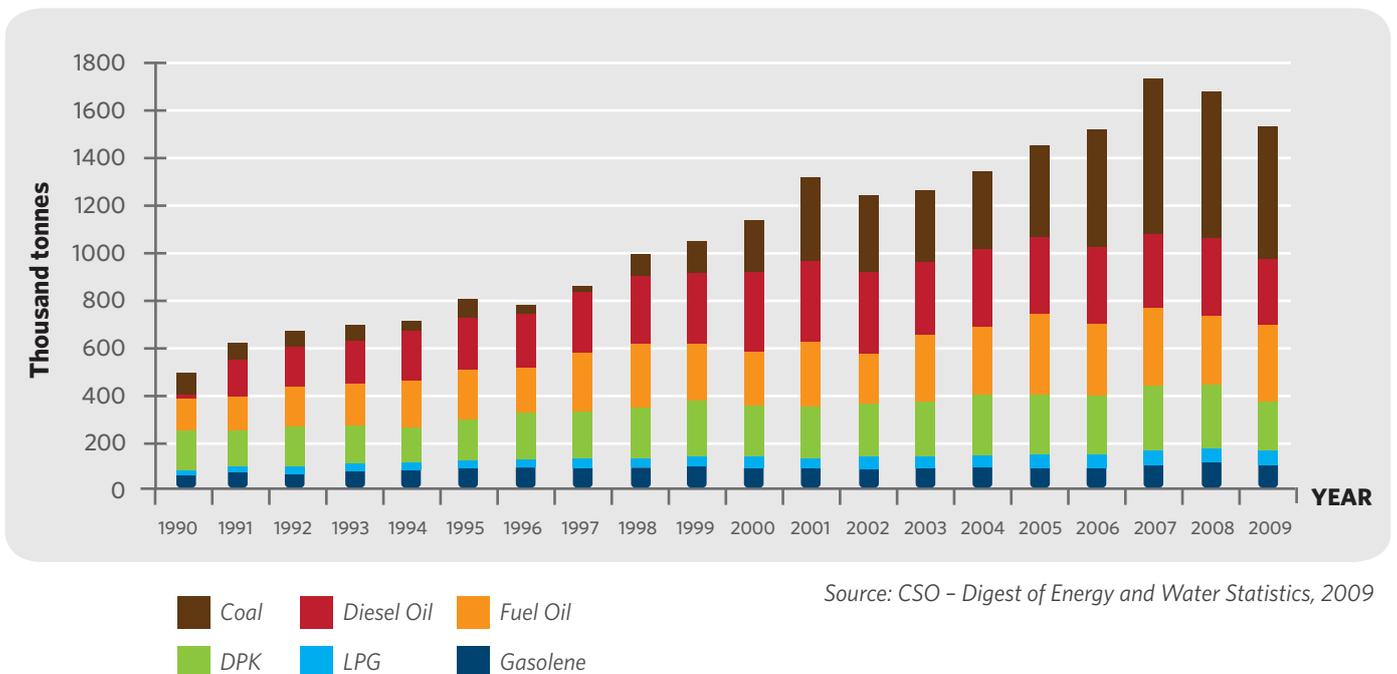
◎ 8.1.1 A Fossil Fuel Intensive Economy

Following completion of the national rural electrification programme in 1981, the objectives of successive national energy strategies have been to guarantee the security and reliability of energy supply and to optimise the contribution of the energy sector to the national economy.

In pursuing these objectives, Mauritius has become heavily reliant on the use of fossil fuels. As shown in Figure 8.1, since 1990, fossil fuel imports have increased from 481 thousand tonnes to 1,523 thousand tonnes in 2009.

However, as use of fossil fuel increased, so did the emission of air pollutants, such as: particulate matter, sulphur dioxide, oxides of nitrogen and carbon monoxide among others. Furthermore, fossil fuel combustion for electricity generation, industrial processes and transport are the main emitters of greenhouse gases (GHG), which contribute to global warming and climate change. Sectoral data¹¹¹ show that electricity generation, transport and manufacturing industries contribute to 58%, 23% and 13% of GHGs emissions, respectively.

Figure 8.1: Imports of fossil fuels (1990 - 2009)¹¹⁰



¹¹⁰ DPK: Dual Purpose Kerosene comprises kerosene and aviation fuel
LPG: Liquefied Petroleum Gas

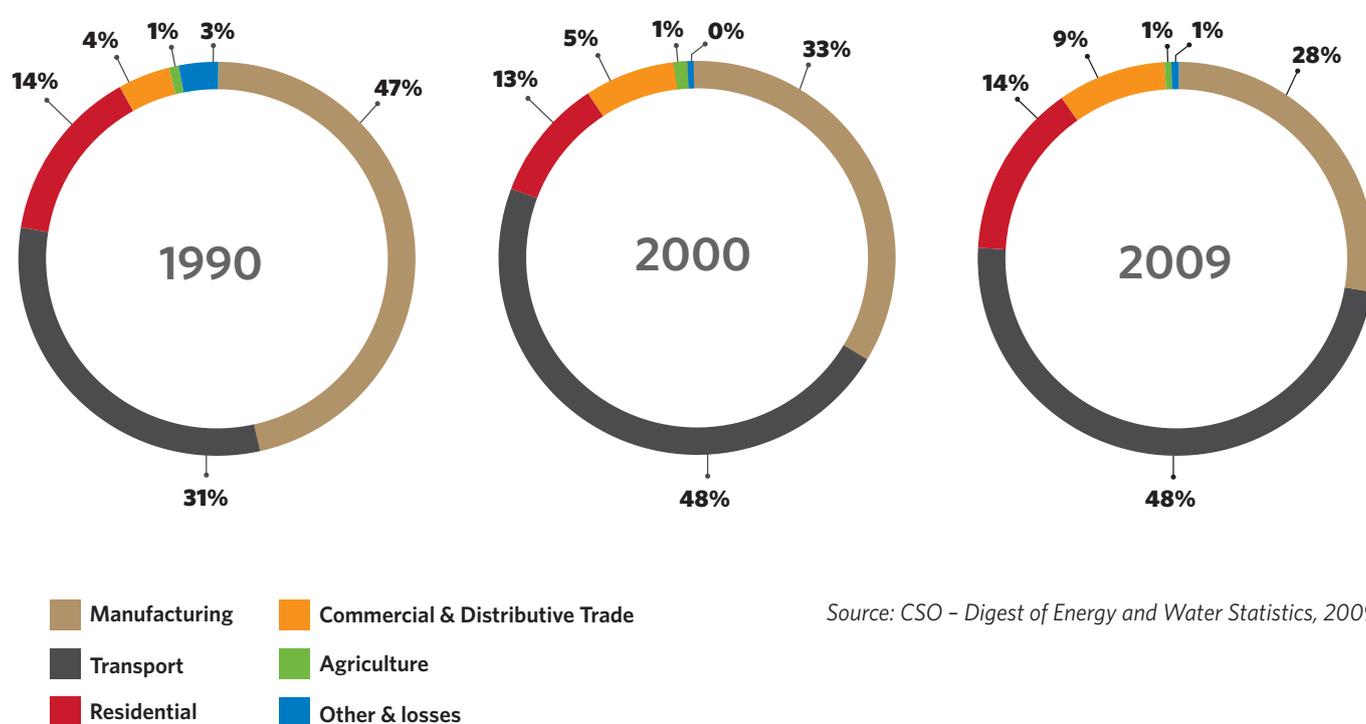
¹¹¹ See Figure 9.1: Sectoral Emissions of GHGs in 2008 (Chapter 9: Climate Change)

8.1.2 Rising Electricity Demand

In the 1990s, the manufacturing sector was by far the greatest consumer of electrical energy followed by the residential and commercial sectors. By 2009, the profile had changed with all the three sectors being almost at par. This is attributed to the fact that there has been a general improvement in the standards of living of the population, with greater use of electrical appliances especially air conditioners. Moreover, major developments in the commercial sector such as the opening of shopping centres and super and hyper markets, has increased the energy needs for lighting, air conditioning and refrigeration. Figure 8.2 compares sectoral energy consumption in 1990, 2000 and 2009.

In the future, the prospect of two million tourist arrivals by 2015 and major economic investment programmes such as the Mauritius-Jin Fei Economic Trade and Cooperation Zone Project¹¹² and the construction of new hotels and IRS will place additional demands for electricity. As the economy develops and dependence on fossil fuel increases, so does the emission of air pollutants and greenhouse gases. However, the practice of Demand Side Management¹¹³, though a cost effective measure to reduce electricity demand, is still at its infancy. Demand side management entails burning less fossil fuel for electricity generation, the conservation of non-renewable fossil fuels and an improvement in the environment and quality of life.

Figure 8.2: Sectoral energy consumption in 1990, 2000 and 2009



¹¹² Refer to footnote on the Jin Fei Economic Trade and Cooperation Zone Project in Chapter 1: Drivers of Environmental Change.

¹¹³ Demand Side Management (DSM) is the process of managing the consumption of energy and generally to optimize its use by encouraging efficiency both at customer's and utility's levels. DSM has several benefits. From a utility perspective, existing infrastructure are used more efficiently and productively, thus deferring future infrastructural investments. On the customer's side, the wise utilisation of electricity implies lower electricity bills.

8.1.3 Electricity Generation

From 2007 to 2008, fuel input for electricity generation increased by 6.2%. However a decrease by 2.9% was noted between 2008 and 2009. The major components of fuel inputs in 2009 were as follows: coal (48.9%), bagasse (24.9%) and fuel oil (25.1%).

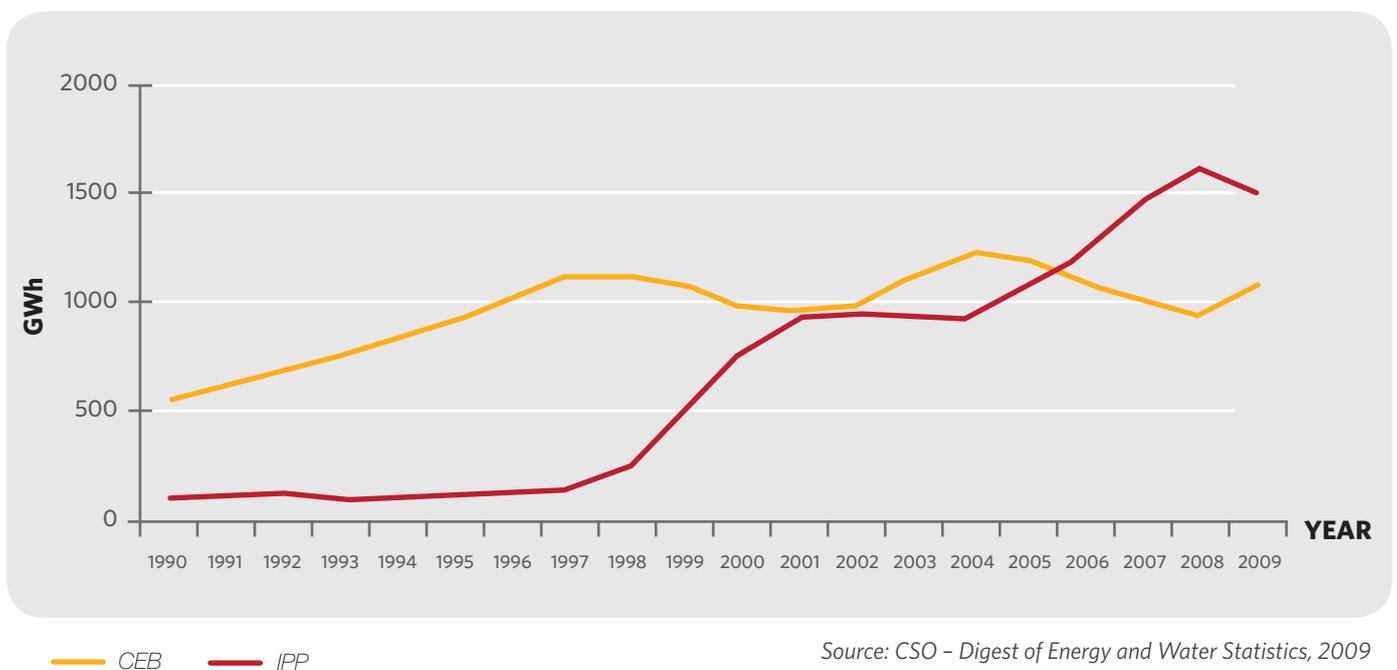
Over the past 20 years, energy generated by the national power utility, Central Electricity Board (CEB) has decreased from 85.4% of total energy produced in 1990 to 41.8% in 2009, whereas production from Independent Power Producers¹¹⁴ (IPPs) has increased from 14.6% in 1990 to 58.2% in 2009. Figure 8.3 shows the evolution of electricity generation by CEB and IPPs since 1990. A gradual shift in the energy mix has also been noted with the increasing use of coal by IPPs. Coal is a cheaper alternative compared to diesel and fuel oil, which are used by the CEB. Consequently, between 1990 and 2009, coal imports soared from 80,000 tonnes to 559,900 tonnes as shown in Figure 8.1.

8.1.4 Impacts of Coal Combustion

Coal is used for electricity production by IPPs¹¹⁵, but also to a lesser extent for steam generation in the textile and food production sectors. Coal combustion for electricity generation also generates coal combustion by-products such as fly ash and bottom ash. Following a survey carried out in 2007, it was estimated that around 105,000 tonnes of coal ash were generated, which contain varying levels of heavy metals (lead, nickel, cadmium, chromium, copper, zinc, cobalt and mercury). Presently, coal ash is disposed of by the IPPs in sugar cane fields.

A study was undertaken by the Ministry of Environment and Sustainable Development in 2007 on coal ash management and its recommendations are under implementation. Coal ash characterisation and its leaching properties are being investigated to determine any environmental impacts along with options for coal ash reuse. Regarding emissions from coal combustion, IPPs are already equipped with air pollution control devices and their emissions are closely monitored by the Ministry of Environment and Sustainable Development.

Figure 8.3: Electricity generation by CEB and IPPs (1990 - 2009)



¹¹⁴ Independent Power Producers is a class of privately owned, non-utility generator that builds power plants mainly to supply and sell power to electric utilities.

¹¹⁵ The following IPPs use coal for electricity production: Omnicane Thermal Energy Operations (La Baraque) Ltd., Compagnie Thermique de Belle Vue, Consolidated Energy Limited, FUEL Steam and Power Generation and Omnicane Thermal Energy Operations (St. Aubin) Ltd.

8.1.5 Low Penetration of Renewable Energy

Mauritius generated some 23.6% of electricity from renewable sources in 2009, but it has significant renewable energy potential. However, an important structural barrier to the widespread use of renewable energy in Mauritius is the high initial investment costs. Additionally, the fact that energy pricing does not reflect full production, maintenance and environmental costs and that electricity is affordable and readily available have also been a disincentive to the adoption and use of local energy sources by households.

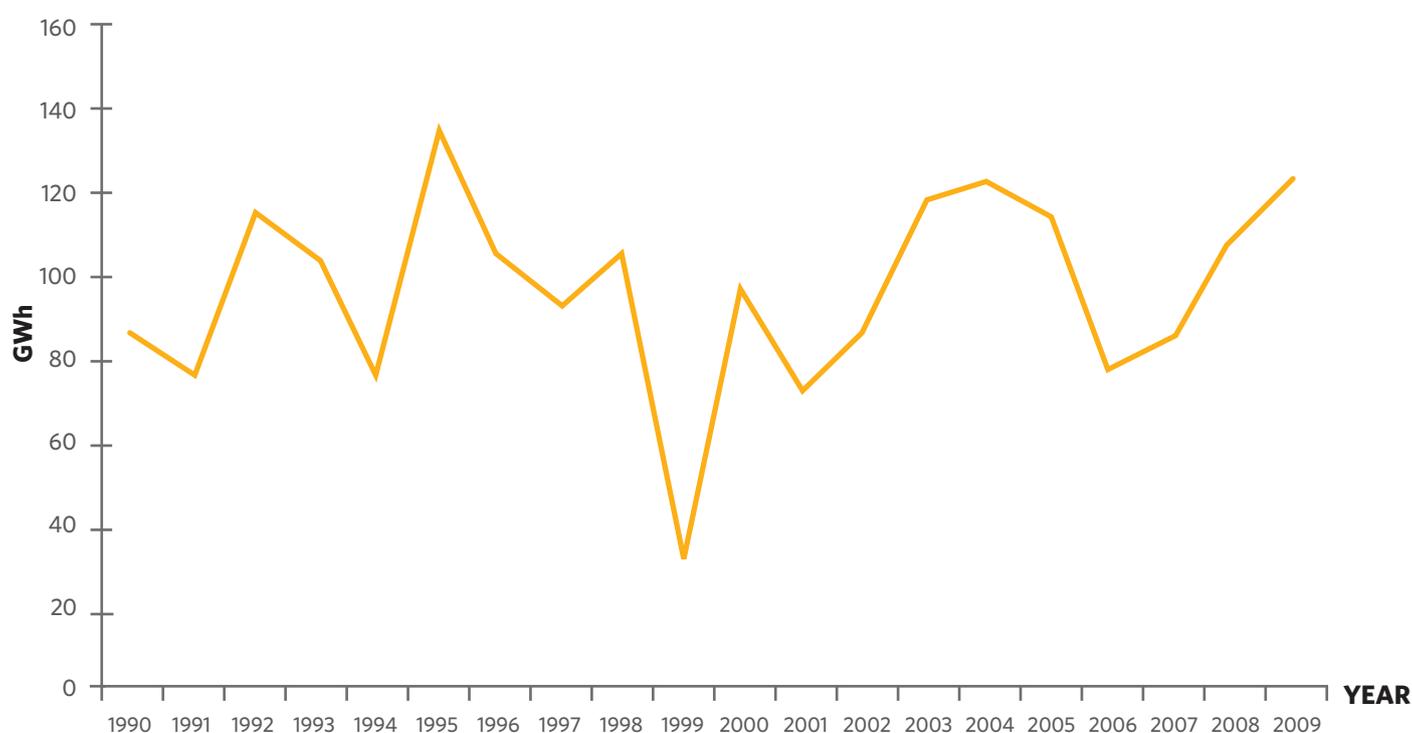
Solar and Wind Energy

Mauritius enjoys more than 2,900 hours of sunshine yearly and is exposed to windy conditions of the South East Trades for the major part of the year. However, their use is not widespread, due to a number of factors such as: high investment and installation costs, the extended period of return on investment and the impact of cyclones.

Hydropower

Exploitation of hydropower potential in Mauritius has been almost fully tapped. In fact as shown in figure 8.4, the amount of energy generated from local hydro power stations varies significantly. For instance, in 1999 when Mauritius experienced a severe drought only 30 GWh electricity were produced compared to 122.4 GWh in 2009 or 134 GWh in 1995. Furthermore, it has also been observed that with climate change, the amount of rainfall over Mauritius has been decreasing since the last century, thus constituting a limiting factor for the expansion of this sector.

Figure 8.4: Hydroelectric production (1990 - 2009)¹¹⁶



Source: CSO – Digest of Energy and Water Statistics, 2009

¹¹⁶ The drastic drop in electricity generation from hydro in 1999 was due to the severe drought faced by the country.

8.1.6 Transport Sector

The transport sector is the heaviest consumer of fossil fuels in Mauritius. As shown in Figure 8.5, since 1990, the total number of registered vehicles increased from 123,545 vehicles to 366,520 in 2009 with a similar rise in fuel consumption. From 1990 to 2009, gasoline consumption rose from 55.97 thousand tonnes to 111.7 thousand tonnes. Similarly, the use of diesel increased from 75.95 thousand tonnes to 153.7 thousand tonnes from 1990 to 2009. However between 2007 and 2009, there was a decline in the use of diesel and this could be attributed to the increase in its retail price and the replacement of older and less efficient vehicles. Today, the challenge lies in providing access to environmentally friendly and fairly priced transport, with increasing interest being given to the introduction of other alternative modes of transportation.

8.1.7 Promoting Energy Efficiency and Conservation

Energy-saving activities constitute the most effective means for a sustainable energy future. However, both energy efficiency and energy conservation are in their infancy in Mauritius, despite the rapid growth in electricity demand during the last 20 years. This can be attributed to a number of interrelated market, policy, finance, business management, information, awareness as well as technology barriers.

8.2 PROGRESS

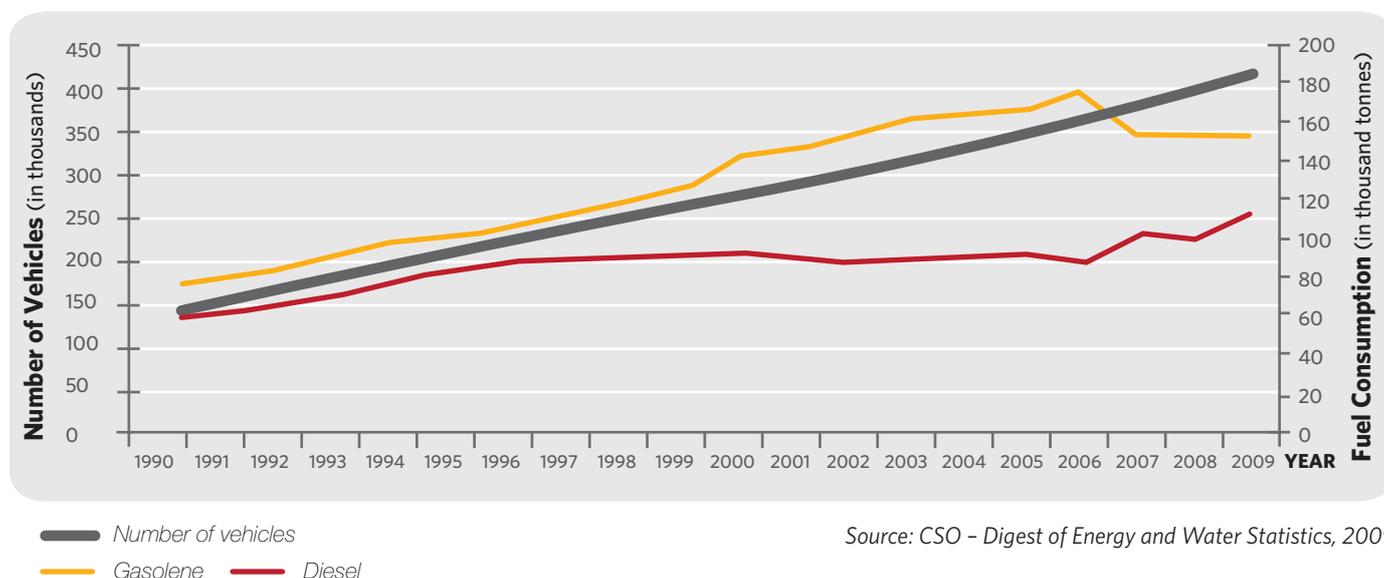
Access to modern, reliable and secured energy services is at the forefront for increasing productivity, enhancing competitiveness and promoting economic growth. Indeed, the development and expansion of energy services has enabled Mauritius to evolve from a mono-crop economy to one which now offers significant opportunity for diversified economic development.

8.2.1 Policies and Strategies

Long Term Energy Strategy (2009-2025)

In 2008, Government adopted a long term energy strategy for the period 2009-2025. Central themes in the policy are the expected demand for energy for the medium to long term, economic reforms, the need to attract Foreign Direct Investment, environmental considerations and carbon financing, sugar sector reforms as well as links between transportation and industrial development policies and energy use. The environmental dimension has been integrated in the energy strategy in view of the country's vulnerability as a SIDS. Box 8.1 outlines the objectives of the Long Term Energy Strategy.

Figure 8.5: Increasing use of diesel and gasoline in the transportation sector (1990 - 2009)



Box 8.1: OBJECTIVES OF THE LONG TERM ENERGY STRATEGY

- ▶ Reduce the country's vulnerability with regard to imported fossil fuels and their volatile prices
- ▶ Promote economic growth and job creation
- ▶ Democratise energy supply with a more transparent and fair regulatory environment
- ▶ Secure affordable energy to consumers
- ▶ Ensure the financial sustainability of the electricity utility and
- ▶ Promote long-term sustainable development in line with the concept of "Maurice Ile Durable"

Basically, the strategy is to address the energy problem in three ways. The first is energy conservation, through the use of more efficient appliances, devices, equipment, lamps and vehicles. The second involves enhancing security of supply, weighing the costs and benefits of using fossil fuels and renewable energy. The third is sustainable living, involving a reduction in the need for energy services by changing commercial and domestic behaviour.

○ Maurice Ile Durable

The rising demand in energy and the volatility in the prices of oil urged Government to adopt the strategy of building a green future for Mauritius through the Maurice Ile Durable (MID) concept, thus promoting the shift from imported fossil fuel to local renewable sources. A fee of 30 cents/L on all petroleum products, 30 cents/kg on LPG and 30 cents/kg of coal has been introduced. This levy is currently being paid into the MID Fund for the financing of sustainable development projects. A number of initiatives have been implemented through the MID Fund. Box 8.2 below shows some of the projects financed.

Box 8.2: PROJECTS UNDERTAKEN WITH FINANCING FROM THE MAURICE ILE DURABLE FUND

Project	Project description	Cost (Rs)	Proponent
ENERGY EFFICIENCY			
▶ Solar water heater (SWH) scheme 2008/2009	Grants of 10,000 rupees for every solar water heater purchased by 31 December 2009. This project has been reinstated in the November 2010 budget.	290 M	Initially the MEPU ¹¹⁷ , now the MoESD
▶ Compact Fluorescent Lamps (CFL Phase 1)	Sale of 1 Million CFL at a subsidized price (Rs. 40 for 3 lamps) to CEB residential consumers	20 M	CEB
▶ Energy audits in government buildings¹¹⁸	Energy audits in 4 government buildings - June 2009	1.4 M	MEPU
▶ Lighting in public buildings and SWH in hospitals	Replacement of conventional lightings in public buildings, schools, hospitals by CFLs	5 M	MEPU
▶ Light Emitting Diode (LED) for Traffic Signal Equipment	Replacement of conventional lights for traffic signal equipment by 1,450 LED lights	13 M	MPI ¹¹⁹
RENEWABLE ENERGY			
▶ Midlands Dam/La Nicolière Feeder Canal micro hydro Power project	Installation of 2 micro hydro power plants of 375 kW each. One plant was commissioned in 2010, while the second one will be commissioned in 2012. The MIDF is meeting 50% of the cost	30 M	CEB

¹¹⁷ MEPU: Ministry of Energy and Public Utilities / MoESD: Ministry of Environment and Sustainable Development

¹¹⁸ Recommendations have been made by the consultant for energy saving in the 4 buildings. Actions are being taken for the implementation of these recommendations. Also staffs were given preliminary training in carrying out energy audits.

¹¹⁹ MPI: Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping

BOX 8.2: PROJECTS UNDERTAKEN WITH FINANCING FROM THE MAURICE ILE DURABLE FUND

Project	Project description	Cost (Rs)	Proponent
RENEWABLE ENERGY			
▶ Wind farm in Rodrigues	Installation of 5 wind turbines of 275 kWh	49 M	CEB
PUBLIC AWARENESS			
▶ Promoting renewable energy awareness among the Primary School Children in Mauritius	Provision of Renewable Energy kits, comprising 3 working models of a solar water heater, a wind turbine and a photo-electric system.	Rs 750,000	RGSC ¹²⁰

○ Renewable Energy Development Strategy and Implementation Plan (2010-2025)

A Renewable Energy Development Strategy and Implementation Plan is under preparation and will pave the way for the country to achieve the target of 35% of total electricity generation from renewable energy sources by 2025. The study will assess the economic viability of renewable energy technologies, as compared to their conventional alternatives and identify barriers and policy impediments to their development. It will then make recommendations on renewable energy development priorities and strategies.

○ 8.2.2 Renewable Energy

The use of renewable energy improves security of supply as it is locally produced and may generate little or no greenhouse gases thereby bringing in benefits in terms of air quality and carbon credits to the country. Notwithstanding the preparation of the Renewable Energy Development Strategy and Implementation Plan, Government is already promoting the use of renewable energy in the country.

○ Increasing the Share of Renewable Energy

In line with the MID vision, the target share of renewables in the energy mix is to achieve by 2025 about 35% self-sufficiency in terms of electricity supply through a progressive increase in the use of renewable energies, depending on breakthrough in technologies such as sea-wave energy, geothermal, Ocean Thermal Energy Conversion and others. Table 8.1 below shows the forecast energy mix for 2010 to 2025 on the basis of Government's Long Term Energy Strategy. The assumptions were that

a 110 MW coal-fired power plant and 20 MW waste-to-energy projects would be operational by 2013 and that more affordable photovoltaic technology would be available. The targets are ambitious and will pose a number of challenges to decision makers in their future strategic choices.

Table 8.1: Forecast Energy mix from 2010 to 2025

FUEL SOURCE		PERCENTAGE OF TOTAL ELECTRICITY GENERATION			
		2010	2015	2020	2025
RENEWABLE	Bagasse	16%	13%	14%	17%
	Hydro	4%	3%	3%	2%
	Waste to energy	0	5%	4%	4%
	Wind	0	2%	6%	8%
	Solar photovoltaic	0	1%	1%	2%
	Geothermal	0	0	0	2%
	Sub-Total	20%	24%	28%	35%
	NON-RENEWABLE	Fuel Oil	37%	31%	28%
Coal		43%	45%	44%	40%
Sub-Total		80%	76%	72%	65%
TOTAL		100%	100%	100%	100%

Source: Long term energy strategy (2009 -2025)

¹²⁰ RGSC: Rajiv Gandhi Science Centre

○ Small Independent Power Producers

To further promote the use of renewable energy and democratise the renewable electricity sector, Government's strategy is to allow Small Independent Power Producers (SIPPs) from the domestic, industrial and commercial sectors to setup renewable generating units of not more than 50 kW¹²¹. The latter will produce electricity with technologies such as: photovoltaic, micro hydro and wind turbines. In this regard, a feed-in tariff/net metering has been developed to allow SIPPs sell any excess electricity to the grid at a premium rate. The scheme is ongoing.

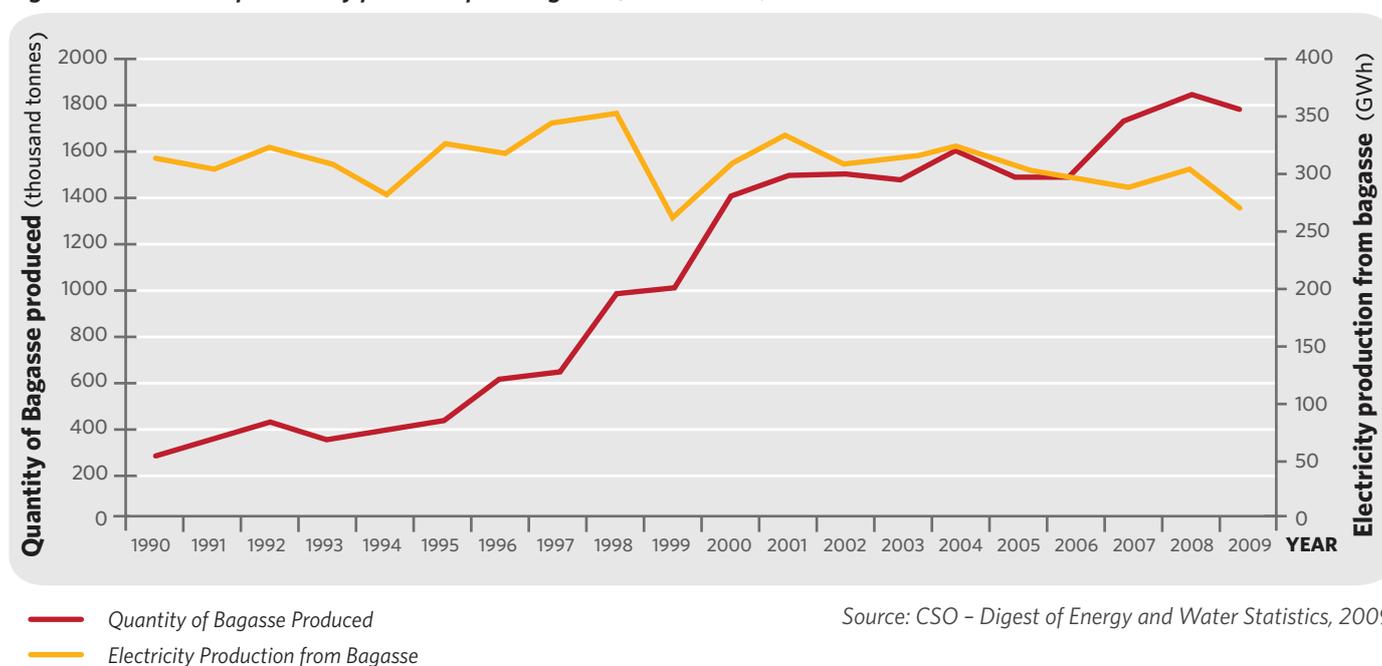
○ Bagasse Energy Strategy

Bagasse is a valuable energy asset for Mauritius and since 1990, the contribution of bagasse in electricity production has increased from 52.5 GWh in 1990 to 353.6 GWh in 2009. Figure 8.6 compares the quantity of bagasse produced and electricity production from bagasse since 1990.

The increasing energy yield is essentially due to the coming into operation of bagasse-cum-coal power plants in 1995, 1999 and 2000.

Government's strategy is to use bagasse more efficiently in order to increase the contribution of bagasse based electricity¹²³. To achieve maximum efficiency, the present level of 350 GWh electricity generated from bagasse can be increased further to 520 GWh annually in the medium/long term. Similarly since 2007, a new variety of sugar cane, producing between 15 - 25% more fibre than current commercial varieties, has been developed by the MSIRI. The Strategy is therefore to encourage the development and use of such variety of sugarcane to increase the amount of electricity produced from bagasse.

Figure 8.6: Amount of electricity produced from bagasse (1990 - 2009)¹²²



¹²¹ SIPPs exceeding 50 kW will be considered under a separate grid code (electrical transmission system network) and pricing policy.

¹²² The drop in bagasse production in 1999 was due to the severe drought faced by the country.

¹²³ In 2005 the EU introduced a sugar sector reform programme with a phased reduction of the price of sugar paid to ACP countries (starting with 5% in 2006 to culminate to 36% in 2009). In this context, Government elaborated the Multi-Annual Adaptation Strategy (MAAS) in order to establish a more competitive sugar sector through a number of programmes. These include: factory centralisation, reduction in labour force and increasing use of sugarcane by-products for production of energy, ethanol, refined sugar, rum and other products.

○ Solar Power

Government introduced a scheme to promote the use of solar water heaters in 2009 under the MID Fund, whereby a grant¹²⁴ of Rs.10,000 was provided to households for the purchase of solar water heaters by December 2009, as shown in Table 8.2. The aim of doubling the number of solar water heaters in Mauritius and Rodrigues was thus achieved. To further boost the sales of solar water heaters in the country, the 15% import duty on such units and all duties on their spare parts have been removed by Government. Following the success of the programme, Government has reinstated the Rs. 10,000 grant for the purchase of solar water heaters.

Given that photovoltaic technology is evolving at a fast rate, it is expected that it will have an impact on the energy mix of the country. With new technological advancement, the price of photovoltaic¹²⁵ modules is expected to drop in the long-term, thus making photovoltaic a viable option. Nonetheless, Government has devised a scheme for the gradual penetration of photovoltaic technology through feed-in tariffs for the purchase of photovoltaic electricity from producers.

○ Wind Energy

Currently, wind power development is considered a priority by Government. In 2005, a pilot project was implemented in Rodrigues, comprising three wind turbines each of a capacity of 60 kilowatts per hour. In view of its success, two other wind turbines of 275 kW each were commissioned on the island in 2009 and two additional units of similar size are envisaged. All the wind turbines in Rodrigues can be tilted to ground level during cyclones to reduce damage by cyclonic gusts.

Given the considerable progress achieved in the design of wind turbines, Government is now reconsidering its use on a larger scale in Mauritius. A feasibility study has already been carried out for the setting up of a 20-30 MW Wind Park on a Build-Own-Operate basis at Curepipe Point. Moreover, the CEB is also planning to set up a small wind park at Bigara. The wind park will comprise four wind turbines of 275 kW each. If these work well, it will tentatively be followed by four additional units of similar capacity. Furthermore, two private sector operators have expressed their interest to set up wind farms at Plaines des Roches and Britannia with a minimum of 10 MW installed capacity each.



Wind farm at Grenade, Rodrigues

Courtesy: V. Tatayah

¹²⁴ The amount of Rs. 10,000 was based on the assumption that a solar water heater costs around Rs. 25,000 and that Government will partially contribute to the cost.

¹²⁵ In 2008, the world production of photovoltaic modules increased to some 170 MW as compared to some 100 MW ten years earlier. Over the same period, the average module price has decreased from 5 € / Watt to 3 € / Watt.

○ Hydroelectric Power

The CEB operates eight hydroelectric stations¹²⁶ with a total installed capacity of 59 MW, which can only be fully exploited in periods of heavy rainfall. During the driest period, some 5 GWh or less may be generated per month whereas during the rainy season monthly generation may increase to 15 GWh. For an average year, some 90 GWh is generated from the eight hydro power plants.

Government is also focusing on the setting up of mini and micro hydro plants, wherever practical and economically feasible. A mini hydropower plant of 375 kW was commissioned in 2010 and the setting up of another mini hydro plant of similar capacity is in the pipeline at the CEB, to be operational in 2012. Altogether, the two plants are expected to generate some 3.2 GWh electricity yearly, while allowing for the saving of 5 million rupees per year on fossil fuels and reducing CO₂ emissions by 1800 metric tonnes annually.

○ Landfill Gas

Another opportunity of tapping renewable sources of energy exists in the form of the landfill gas at the landfill site. A proposal for the setting-up of a 3 MW Gas-to-Energy unit with an annual electricity generation of 20 GWh is scheduled for operation by mid-2011 by a private promoter.

○ 8.2.3 Energy Efficiency and Conservation

The potential for energy efficiency in all sectors of the economy has been acknowledged by Government and in this regard, the removal of barriers for developing an energy efficient economy is being pursued. As lead agency for energy matters, the Ministry of Energy and Public Utilities is taking a range of measures and these are outlined below.

○ Removal of Barriers to Energy Efficiency and Conservation in Buildings Project

The Ministry of Energy and Public Utilities in collaboration with the United Nations Development Programme and relevant stakeholders is currently embarked on a three year "Removal of Barriers to Energy Efficiency and Energy

Conservation in Buildings" project. The objective of the project is to overcome barriers to energy efficiency in buildings in Mauritius and to stimulate the development of a market for residential and non-residential building energy efficiency in both existing stock and future buildings. In setting out to do so, the project activities will ensure that energy is used cost-effectively and rationally throughout the island. The project tackles market barriers in all three areas of a buildings energy use: building fabric, equipment and people. These are outlined in Box 8.3:

The deliverables of the project will generally be implemented by the Energy Efficiency Management Office, which will be shortly set up at the Ministry of Energy and Public Utilities. The Energy Efficiency Management Office will promote, coordinate policies and establish procedures to measure, monitor and verify energy efficiency across all sectors. Additionally, the Energy Efficiency Management Office is expected to become a centre of excellence in the fields of renewable energy, energy efficiency, clean energy financing, programme management, promotion and awareness-raising.

○ Energy Audits in Public Buildings

In as far as the public sector is concerned, energy saving is being promoted. Pre-audits of some Government buildings have been undertaken in order to identify areas for energy conservation and this exercise is being extended to other Government buildings. Conventional and/or incandescent lamps are systematically replaced by energy saving ones while energy efficiency is now an essential criterion in the purchase of equipment. The electricity bills of all Government buildings are also closely monitored to ensure effectiveness of the energy saving measures being implemented.

¹²⁶ The power stations at Champagne, Tamarind, Magenta and Le Val are run with dam storage facilities. The remaining stations at Ferney, Réduit, Cascade Cécile, and La Ferme are of the run-of-river type and these run on a daily basis to provide minimum water flows to downstream users for irrigation purposes.

BOX 8.3: IMPORTANT MILESTONES OF THE "REMOVAL OF BARRIERS TO ENERGY EFFICIENCY AND ENERGY CONSERVATION IN BUILDINGS" PROJECT

DEVELOPMENT OF BUILDING REGULATIONS AND CODES	STATUS
▶ Promulgation of Energy Efficiency Bill	Completed
▶ Setting up of the Energy Efficiency Management Office	2011
▶ Development and enactment of the Building Control Bill	2011
▶ Development of a grid-code and feed-in tariffs for SIPPs	Completed
DEMAND AND SUPPLY OF ENERGY SAVING SERVICES AND TECHNOLOGY	
▶ Preparation of an Energy Audit Management Scheme	2011
▶ Creation of an energy audit databank	2011
▶ Development of professional courses in energy auditing, energy management	2011 - 2015
▶ Development of sustainable building design code for low and middle income housing, schools and other buildings	2011
CAPACITY BUILDING AND SENSITISATION OF STAKEHOLDERS	
▶ Training of professionals (engineers, architects) and decision-makers in the cost-benefit of energy efficiency and demand side management	2011

○ Demand Side Management

Government has embarked on a series of programmes aimed at electricity end-users. In 2008, the CEB, with the financial assistance of the MIDF, embarked on the sale of one million compact fluorescent lamps at heavily discounted prices to all its customers, in exchange for incandescent bulbs. This initiative reduced evening peak demand by about 14 MW and enabled the average customer to save Rs 5.59 per kWh - a saving enabling its customers to recover their investment within a one year period. It is estimated that energy demand will decrease by 12 million KWh per year, save 52 million rupees per year in fossil fuels and reduce CO₂ emission by 26,000 metric tonnes. Summertime was introduced on

a pilot basis from 1st November 2008 to 31st March 2009. However, given that the desired energy savings were not achieved and the low acceptability rate among the population, Government took the decision of not going ahead with the programme.

On the other hand, the Energy Efficiency Act 2011 provides for energy auditing targeted at all energy consumers. As a result, operators will have to undertake regular energy audits and improve energy consumption on their premises.

○ Product Labelling and Efficiency Standards

Product labelling and energy efficiency standards will be introduced with the Energy Efficiency Act 2011. As such, the Energy Efficiency Management Office is responsible to devise labelling requirements and specifications regarding any equipment, machine or appliance which is imported, manufactured or sold in Mauritius. Government intends to set a minimum energy performance standard for households and non-household, electrical appliances and equipment. At present, standards and labels have already been prepared for refrigerators and air conditioning units. Standards and labels for other products such as, washing machines, compact fluorescent lamps, dishwashers, ovens, microwaves and their combinations are also intended to be prepared.

Government also intends to lead the way regarding procurement of energy efficient appliances and equipment. Government is developing a Sustainable Procurement Policy and Action Plan in collaboration with UNEP to mainstream best procurement practices at national level. Therefore, besides the pricing factor, life-cycle costs and efficiency will also be considered as important criteria for the purchase of equipment.

○ Sustainable Buildings

Buildings use energy, materials and natural resources and it is now increasingly recognised that sustainable buildings and construction can cut down by about one-third, the world's GHG emissions, hence playing a key role in combating and addressing climate change.

By mid-2011, the Ministry of Environment and Sustainable Development with the financial support of European Union will launch a project on the development of a policy and guidelines on sustainable buildings as well as a building rating system. The main objective of the project will be to establish a comprehensive framework to promote sustainable buildings in the Republic of Mauritius. Simultaneously, a new Building Control Bill with specific regulations and codes pertaining to energy efficiency is under preparation at the Ministry of Public Infrastructure, National Development Unit, Land Transport and Shipping. The Building Control Act will replace the existing Act of 1918.

○ Energy and Tourism

While tourism contributes significantly to the economic development of Mauritius, it is also a large consumer of energy resources. Moreover, with a target of 2 million tourists by 2015, the tourism industry also needs to participate in energy efficiency and conservation programmes. Hotels have started to improve their operations through energy efficient measures and the use of renewable energy. The Association des Hôteliers et Restaurateurs de l'Île Maurice in collaboration with Enterprise Mauritius has piloted this project targeted to quality restaurants of more than 40 covers and individual hotels of less than 60 rooms.

○ 8.2.4 Transport

The current energy strategy for the transport sector is to encourage the use of more efficient and lower emission vehicles. As from 1st July 2008, excise duties, road tax and registration fees on hybrid vehicles have been halved by Government. Similarly, customs duty on all tyres with energy saving and emission reducing certification have been eliminated. Presently, Government intends to diversify fuel supplies by introducing a gasoline-ethanol mix at the pump. Initially E10, a mix comprising 10% ethanol, may be introduced in 2011, which will be followed by E20 in mid 2014. With the availability of around 150,000 tonne of molasses annually on a renewable basis, up to 120,000 tonnes can serve for the production of some 25 million litres of ethanol. Furthermore, the long term construction of new roads is expected to ease congestion at the entrance of Port Louis and consequently, fuel will be more efficiently used.

● 8.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
<p>Electricity generation in Mauritius is fossil fuel intensive</p>	<p>Power sector reform with a diversification of the energy base</p>	<p>Diversified energy base</p>
<p>Electricity and transport account for 80% of greenhouse gas emissions</p>	<p>Increase in the use of renewable energy to produce electricity</p>	<p>More than 35% of energy derived from renewable sources</p>
<p>Barriers to the use of renewable energy</p>	<p>Investigate the use of innovative renewable energy technologies (e.g. Ocean Thermal Energy Conversion)</p>	<p>Increased use of renewable energy makes Mauritius less dependent on fossil fuel imports</p>
<p>Energy efficiency and energy conservation are still in their infancy</p>	<p>Operationalisation of the Energy Efficiency Management Office</p>	<p>Energy efficiency and Demand Side Management are mandatory in all sectors: sustainable buildings, cleaner production and even at household level</p>
<p>The transport sector is the largest consumer of fossil fuels</p>	<p>Promote the use of more energy efficient & hybrid cars</p> <p>Introduce E10 & E20</p> <p>Alternative transport: Light Rail Transit</p>	<p>Reformed transport sector with efficient modes of transport</p> <p>Locally produced ethanol used</p> <p>Improved air quality</p>

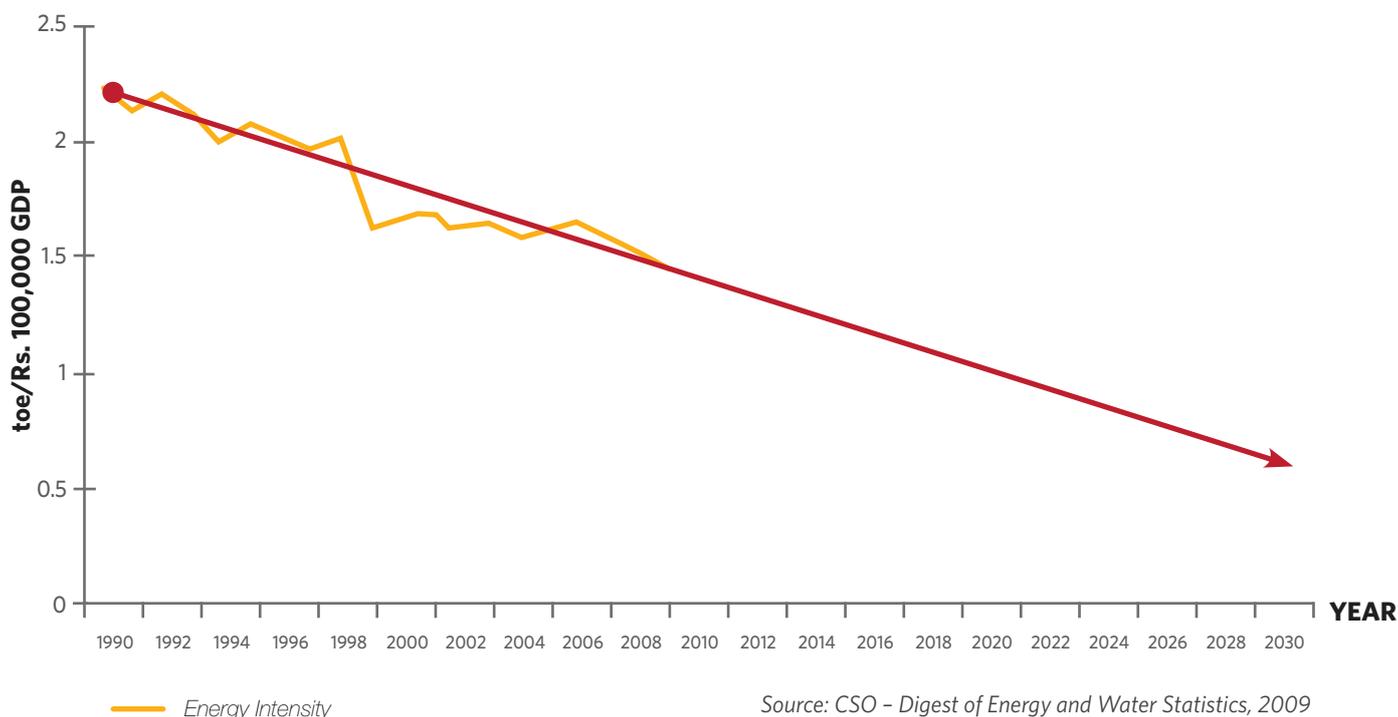
8.3.1 Policy Options for the Future

As the economy matures, the supply of reliable and competitively priced energy is more than ever fundamental. In the Best Case Scenario, judicious use of fossil fuels is made and the exploitation of local sources of energy and the investigation and application of innovative technologies are also pursued through the sustained implementation of the Long Term Energy Strategy (2009 - 2025). Figure 8.7 shows the energy intensity¹²⁷ since 1990 decreasing per unit GDP, a trend showing the economy is becoming more energy efficient. The target is now to maintain decreasing energy intensity by 2030 and it is imperative that energy efficiency measures are mainstreamed across all sectors.

Mauritius has shown keen interest to promote the development of new indigenous and renewable sources of energy in addition to promoting demand side management. In so doing, the focus will now be on those options that have proved to hold promise from a technical, economic and financial point of view.

With the implementation of the Renewable Energy Development Strategy, Government will be able to achieve its policy objectives and goals with respect to renewable energy. While emphasis is being laid on wind and solar, other options such as Ocean Thermal Energy Conversion¹²⁸ technology must also be considered in the long term.

Figure 8.7: Energy intensity (1990 - 2009) (toe/Rs. 100,000 GDP) with projections to 2030



¹²⁷ Energy intensity provides a measure of the energy efficiency of a nation's economy. High energy intensities indicate a high cost of converting energy into GDP. Low energy intensity indicates a lower cost of converting energy into GDP. Higher energy intensity can increase the impact of energy use on climate change and contribute to depletion of natural resources.

¹²⁸ Ocean thermal energy conversion uses the temperature difference that exists between deep and shallow waters to run an engine for electricity generation.

Furthermore, although all the bagasse produced during sugarcane milling is fully used, the potential exists for increasing the amount of energy generated from bagasse to some 520 GWh annually in the medium/long term, provided there is no decrease in the area of cane cultivated. This will require the use of more efficient boilers. Moreover, research is ongoing for the cultivation of new varieties of sugar cane with higher fibre content to generate more bagasse for conversion into electrical energy.

To date, conversion of solar energy to heat energy is best known in the country through the use of solar water heaters. The use of such units displaces energy that would have otherwise been used for heating water, namely kerosene, LPG or electricity. For an island having 8 hours sunshine daily, the use of photovoltaic technology may be more beneficial. It is therefore helpful to remove the barriers impeding its development.

In line with Government's policy to use renewable and innovative technologies, the use of deep sea water for air conditioning in Disaster Recovery Centres is being envisaged. Deep sea water at 1,000 meters beneath the ocean surface has an average temperature of around 5°C. The cold water can be used for air conditioning in Disaster Recovery Centres' cooling system, thus reducing the use of electricity to power chillers. The application of this technology is a pioneer innovation in this field of operation.

Geothermal energy is also being considered as geothermal reservoirs are often associated with volcanoes and volcanic regions. As a recent island in geological terms, located near one of the most active hotspots known in the Indian Ocean, there is a high probability of a good geothermal reservoir in Mauritius. The geothermal potential of Mauritius should be assessed and sites for the development of geothermal resources for power generation be identified. Further integration of renewable electricity from individuals to the grid can be made by allowing plant sizes larger than 50 kW and up to about 400 kW. This will require the development of the appropriate feed in tariff and financial incentive schemes.

Chapter Summary

CHALLENGES

- ▶ Mauritius is heavily dependent on fossil fuels. Their imports have soared from 481,000 tonnes in 1990 to 1,523,000 tonnes in 2009.
- ▶ Electricity generation increased from 667 GWh in 1990 to 2,546 GWh in 2009. A gradual shift in the energy mix has been noted with the increasing use of coal.
- ▶ Demand side management, though a cost effective measure to reduce electricity demand, is still at an infancy stage.
- ▶ Fossil fuel combustion for electricity generation, industrial processes and transport are the main emitters of greenhouse gases.
- ▶ Coal combustion for electricity production generates large amounts of fly ash and bottom ash.
- ▶ Mauritius has significant renewable energy potential, but important structural barriers limit their widespread use.
- ▶ Energy efficiency and energy conservation measures are limited.
- ▶ The transport sector is the heaviest consumer of fossil fuels in Mauritius.

PROGRESS

- ▶ The Long Term Energy Strategy (2009 - 2025) is being implemented. The strategy aims at reducing the country's dependence on fossil fuels, increasing the share of renewable energy and democratising energy supply amongst others.
- ▶ The Maurice Ile Durable Fund has financed a number of projects to promote the use of renewable energy and encourage energy efficiency and conservation.
- ▶ A Renewable Energy Development Strategy is being developed to promote renewable energy use.
- ▶ Incentives, through feed-in-tariffs, are being provided to households, industries and other sectors to setup small renewable generating units for electricity production.
- ▶ Development of a policy and guidelines on sustainable buildings and a building rating system are in the pipeline.
- ▶ To reduce environmental impacts of coal combustion by-products, coal ash characterisation, its leaching properties and options for coal ash reuse are being investigated
- ▶ The use of more efficient and lower emissions vehicles is being encouraged through a series of fiscal measures.

PROSPECTS

- ▶ Fully implement the recommendations of the Long Term Energy Strategy (2009 - 2025) and the Renewable Energy Development Strategy.
- ▶ Set up the Energy Efficiency Management Office, which will promote, coordinate policies and establish procedures to measure, monitor and verify energy efficiency across all sectors.
- ▶ Vulgarise product labelling and energy efficiency standards.
- ▶ Increase the share of renewable energy to 35% or more by 2025.
- ▶ Remove structural barriers impeding the development of renewable energy.

Chapter Summary

PROSPECTS

- ▶ Investigate and consider the use of innovative renewable energy technologies such as sea wave energy, geothermal energy and Ocean Thermal Energy Conversion
- ▶ Optimise bagasse use for electricity production
- ▶ Further develop the SIPPs Programme and update electricity production up to 400 kW

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Climate Change

Climate change is one of the principal planetary challenges that humankind is facing today with wide-ranging effects not only on the environment but also on the social and economic prospects of the world. Small Island Developing States (SIDS) like Mauritius as isolated and highly vulnerable nations, are already experiencing the effects and impacts of climate change and many are taking action to mitigate the impacts and adapt to the future risks which are too important to be ignored.

● 9.1 CHALLENGES

In Mauritius, the impacts of climate change are already apparent through rising sea levels, beach erosion, an increase in frequency and intensity of extreme weather events, as well as recurrent floods and droughts. The principal areas of economic and environmental vulnerability to climate change include tourism, agriculture, fisheries, health and freshwater. The coastal zone also faces much pressure with impacts on strategic infrastructure such as hotels, restaurants and residential buildings, roads and public utilities, especially during cyclones and sea surges.

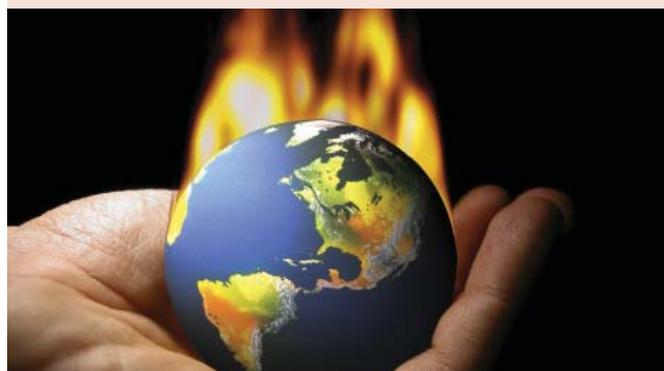
◎ 9.1.1 Greenhouse Gases Emissions

In Mauritius, the main GHG emitted is carbon dioxide (CO₂), which arises from the combustion of fossil fuels for electricity production, industrial processes and transport as shown in Figure 9.1. Land use changes, agricultural practices and waste also generate GHGs such as methane and nitrous oxides. Since the publication of the Initial National Communication by the National Climate Committee in 1999, carbon dioxide, methane and nitrous oxide are inventoried along with other gases such as: oxides of nitrogen, carbon monoxide, non-methane volatile organic compounds (NMVOC) and sulphur dioxide, which indirectly contribute to global warming¹³⁰.

BOX 9.1: THE SCIENCE OF CLIMATE CHANGE

The Earth has a natural climate control system in which certain atmospheric gases play a critical role. These gases trap heat radiated from the sun to produce a natural greenhouse effect that keeps the planet some 30°C warmer than it would otherwise be. However, the Greenhouse Gas (GHG) layer, which consisted primarily of water vapour, is now joined by other gases produced through human activities. These gases mainly carbon dioxide, methane, nitrous oxide, sulphur hexafluoride and halocarbons in turn increase the density and the heat retention capacity of the GHG layer, thereby causing accelerated global warming.

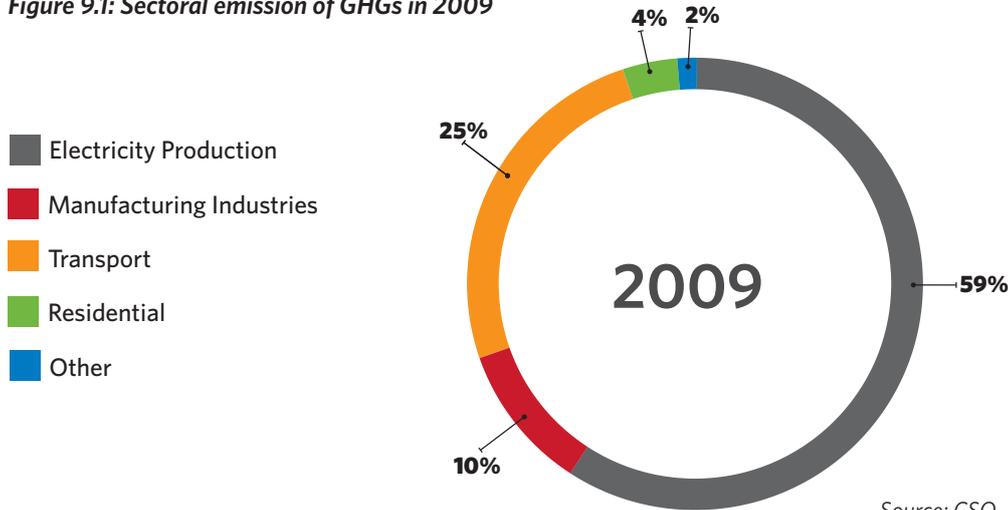
According to the Intergovernmental Panel on Climate Change (IPCC)¹²⁹, from 1970 to 2004, the growth in GHG emissions has come principally from energy production, transport and industry and many of these GHG-emitting activities now form a basic part of modern life. Changes in the atmospheric concentration of GHGs and aerosols, forests and other land cover and radiation from the sun, alter the energy balance of the climate system and are drivers of climate change.



¹²⁹ Established in 1988, the role of the IPCC is to assess scientific information on climate change, evaluate its environmental and socio-economic impacts, formulate rational response strategies and assist governments to adopt and implement climate change mitigation and adaptation policies. Many Assessment Reports, Special Reports and Technical Papers, have been published by the IPCC and these are widely used by policymakers, experts, scientists and students. In its 4th Assessment Report, the vulnerability of SIDS was reviewed and adaptation measures proposed (IPCC-AR4, 2007). The 4th Assessment Report is available on the following website: <http://www.ipcc.ch/>.

¹³⁰ Emissions of GHGs are compiled yearly in the Digest of Environment Statistics by the Central Statistics Office. These are available on the following URL: http://www.gov.mu/portal/goc/cso/list_1.htm

Figure 9.1: Sectoral emission of GHGs in 2009



Source: CSO - Digest of Environment Statistics, 2009

Figure 9.2 shows the total emissions of CO₂ and non-CO₂ (namely: methane, oxides of nitrogen, nitrous oxide, carbon monoxide, NMVOC and Sulphur Dioxide) from 2002 to 2009¹³¹. Since that period, a 40% increase in CO₂ emissions has been recorded. Carbon monoxide and sulphur dioxide, which are the most common non-CO₂ GHGs, contributed to 64 thousand metric tonnes and 33.6 thousand metric tonnes emissions in 2009 respectively.

Figure 9.2: Total CO₂ and Non-CO₂ emissions (1990 - 2009)

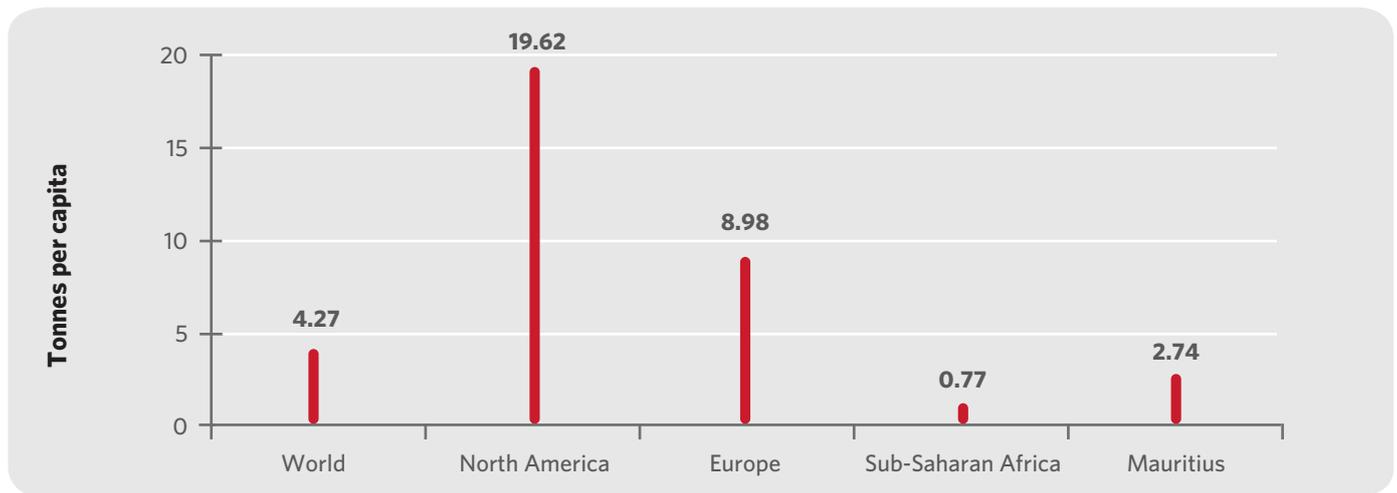


Source: CSO - Digest of Environment Statistics, 2009

¹³¹ Yearly inventory of human induced emissions and removals of GHGs are carried out by the Central Statistics Office using guidelines and inventory software developed by the IPCC. Calculation of emissions is as follows: E = AD x EF
 E: Emissions, Removals or uptake by vegetation
 AD: Activity Data (e.g. tonnes of fuel burnt)
 EF: Emission Factor (e.g. tonnes of carbon per tonne of fuel burnt)

CO₂ emissions in Mauritius are still low as compared to big emitters like North American and European countries as shown in Figure 9.3

Figure 9.3: Carbon dioxide emissions per capita (2005)

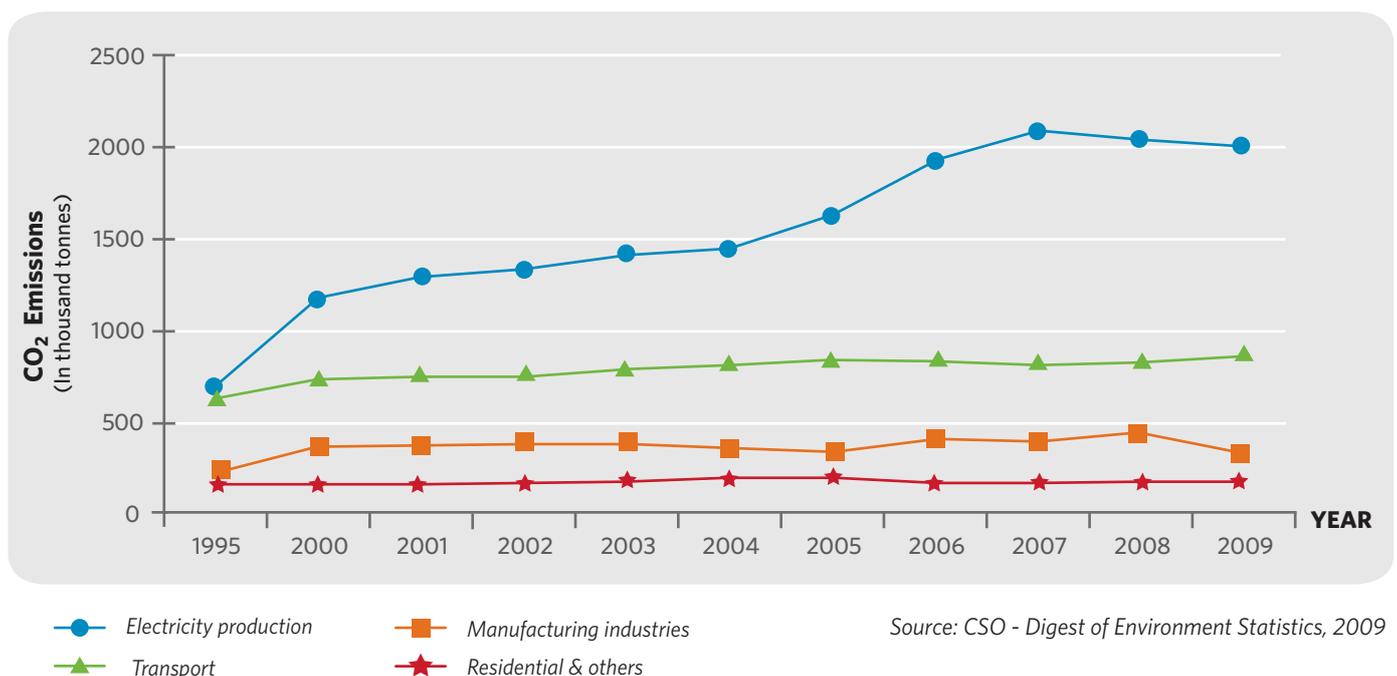


Source: World Resources Institute, 2005

○ Sectoral Emissions of GHGs

The proportional contributions of the main sectoral CO₂ emissions from 2003 to 2009 are presented in Figure 9.4. The electricity sector is the main contributor of GHG emissions. In 2003, electricity generation contributed 51% of the national CO₂-equivalent emissions, which increased to 59.3% in 2009. Increasing CO₂ emissions are due to the energy intensive Mauritian economy, which depends to a large extent on fossil fuel combustion for electricity generation.

Figure 9.4: Sectoral CO₂ emissions (2003 - 2009)



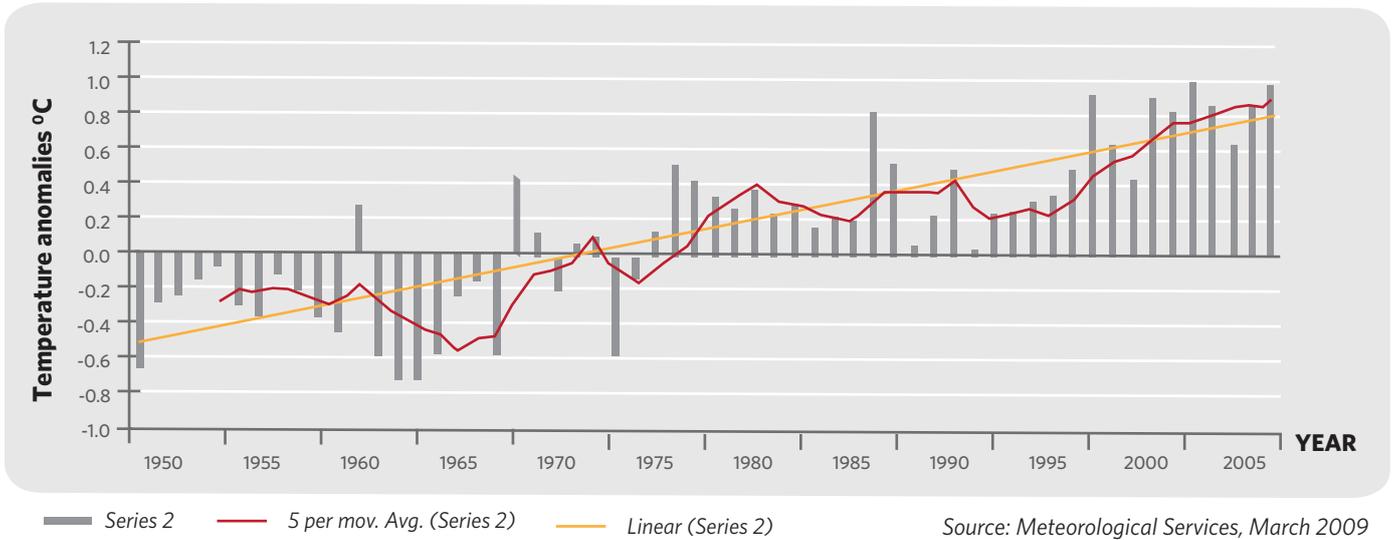
Source: CSO - Digest of Environment Statistics, 2009

9.1.2 Trends in Climate Change

Temperature Trends

Analysis of temperature recordings carried out by the Mauritius Meteorological Services over the last 50 years indicates a definite warming trend. The average temperatures have increased by 0.74°C at Vacoas (high grounds) and by 1.1°C at Plaisance (coastal areas), when compared to the 1961 - 1990 long term mean, as shown in Figure 9.5. Similar warming trends have been observed for Rodrigues, St Brandon and Agalega, where the temperature rise was between 0.5-1.0 °C.

Figure 9.5: Temperature variation at Plaisance

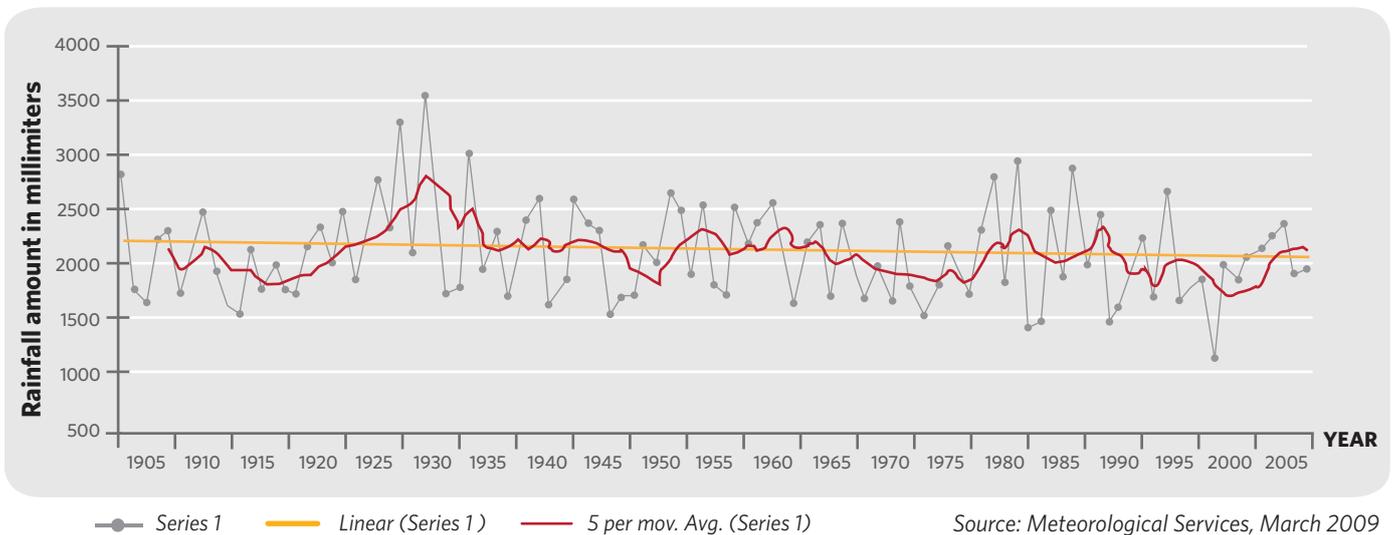


The seven warmest years have been recorded between 1997 and 2009 and are as follows: 1998, 2001, 2002, 2003, 2004, 2005 and 2006. Furthermore, temperature analysis at Vacoas between 1950 and 2007 shows an increase in the annual number of hot days and warm nights. During the last ten years summer maximum temperatures (that is daytime temperatures) became warmer by an average of 1.0 °C.

Rainfall Patterns

A decreasing trend in annual rainfall has been recorded between 1905 and 2007, as shown in Figure 9.6. This decrease has been accompanied by increasing numbers of consecutive dry days and decreasing numbers of rainy days.

Figure 9.6: Mean annual rainfall over Mauritius



○ Sea Level Rise and Increase in Sea Surface Temperatures

Sea level rise is monitored at Trou Fanfaron - Port Louis. Between 1998 and 2007, local mean sea level¹³² rose by 2.1 mm per year. Overall, the mean sea level rise for Mauritius during the past decade has been around 1.2 mm (Meteorological Services, 2009). As per the National Climate Change Action Plan, coastal areas in the following regions will be the most affected by sea-level rise: Mon Choisy, Cap Malheureux, Grand Gaube, Roches Noires, Poste de Flacq, Trou d'Eau Douce, Grande Rivière Sud Est, Anse Bambous, Anse Jonchée, Blue Bay, La Cambuse, Souffleur, Bénarès, Gris-Gris, Rivière des Galets, Baie du Cap, Macondé and Le Morne.

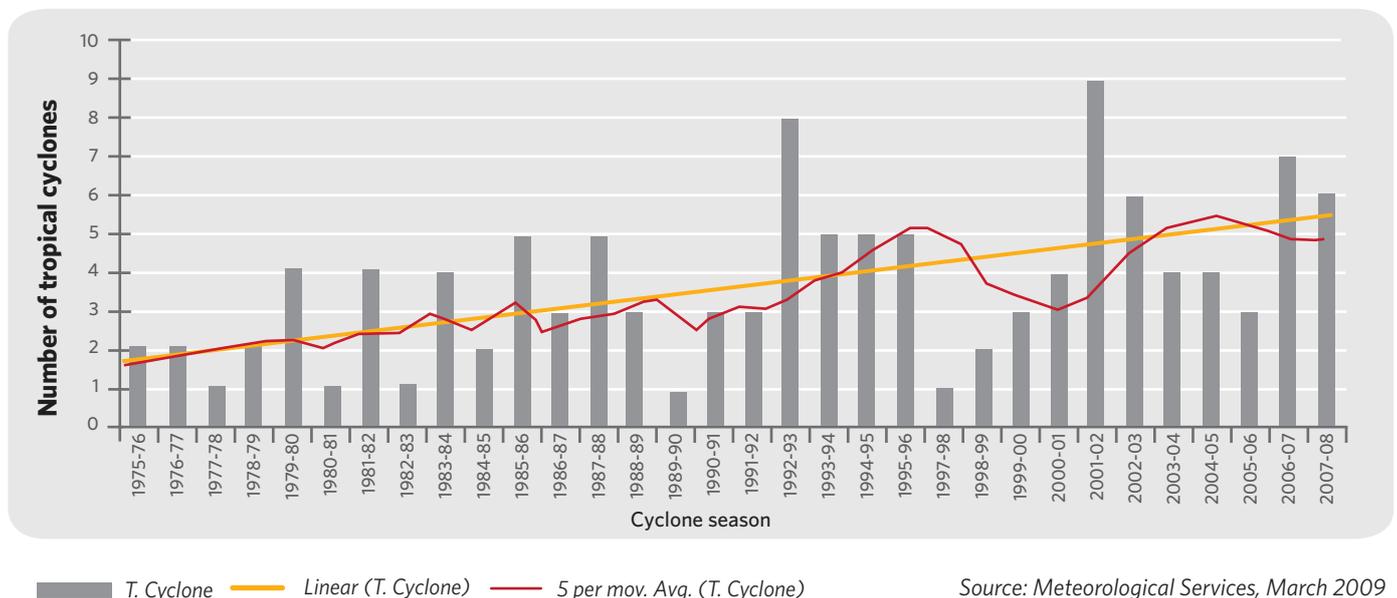
Furthermore, according to the AR4, a steady warming of sea surface of 0.4 - 0.6 °C has been recorded in the Indian Ocean thus contributing to sea level rise over the South West Indian Ocean (SWIO). This warming is amplified by

the El Niño Southern Oscillation¹³³ events (IPCC-AR4, 2007). In 1998, up to 95% of corals in some areas of the Western Indian Ocean region died following the episode of rapid warming associated with the El Niño phenomenon.

○ Trends in Extreme Events

Since 1975 to date, an increasing trend in the number of intense cyclone (gusts above 165 km/hr) has been noted. According to the AR4, increases in sea surface temperatures favour the development of more and stronger tropical cyclones. Indeed, as observed by the Mauritius Meteorological Services, since the last decade, there has been rapid intensification of tropical storms in the SWIO, although Mauritius has not been directly affected by these. Figure 9.7 shows the trend in the number of tropical cyclones from 1975 to 2008.

Figure 9.7: Trend in number of tropical cyclones with gusts above 165 km/hr (1975 - 2008) in the SWIO



¹³² Mean sea level is defined as the height of the sea with respect to a land benchmark, averaged over a period of time (such as a month or a year) long enough that fluctuations caused by waves and tides are smoothed out. Data on sea level monitoring for Port Louis, Blue Bay and Agalega are available on the following website: <http://www.vliz.be/vmdcdata/iode/blist.php>.

¹³³ El Niño is a warm-water current that periodically flows along the coasts of Ecuador and Peru. This oceanic event is associated with fluctuations of the inter-tropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. The coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. The El Niño event has an impact on the wind, sea surface temperature, and precipitation patterns in many other parts of the world.

9.1.3 Impacts of Climate Change

Based on century-long meteorological observational records, its experiences with current patterns and impacts of climate variability and climate projections undertaken, Mauritius has justifiable concern about its future, especially with regard to its vulnerability to climate change and adaptive capacity¹³⁴. Indeed, the country has witnessed a series of extreme weather events that have disrupted socio-economic activities. For instance, in January 2002 following cyclone Dina, 15% of sugar cane and almost 100% of the non-sugar agricultural sector were affected. On the economic front post-Dina, textile and manufacturing industries closed down for four days due to power disruption, hotels along the coasts suffered infrastructural damage and the insurance sector disbursed Rs. 400 million due to losses incurred (Joint Economic Council, 2002).

Coastal Zone

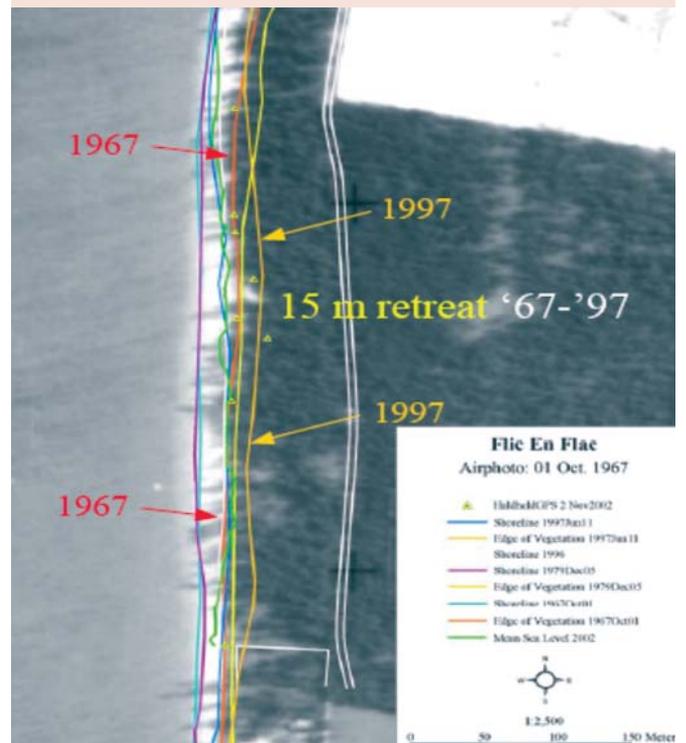
Locally, coastal areas are already affected by sea-level rise and extreme weather events. Besides inundation and erosion of the shoreline, coastal ecosystems such as: coral reefs and mangroves are also being negatively affected. However, climate change impacts are further exacerbated by human induced pressures such as infrastructural development along the coasts and by pollution.

While the coastal zone has been used for the economic development of the island, it is most vulnerable to compounding climate change factors. For instance, accelerated rise in sea level of 0.2 to 0.6 m or more by 2100 (IPCC-AR4), more intense cyclones, frequent tidal surges and altered precipitation can contribute to disrupt settlements, the tourism industry and other associated economic activities and damage coastal infrastructure such as roads, bridges, electricity supply, sanitation and agriculture.

BOX 9.2: THE FLIC EN FLAC – WOLMAR SHORELINE - A CASE STUDY

The Flic en Flac – Wolmar sandy shoreline has been the focus of several coastal erosion studies. GIS analysis of aerial photographs (1967 & 1997) has enabled the comparison of both water and vegetation lines. A 15 m of retreat of the vegetation line between 1967 and 1997 has been observed with most of it occurring between 1979 and 1995.

The 15 m retreat over approximately 500 m of shoreline and 4 m height (from the beach toe to the beach crest) amounts to approximately 7,500 m² of coastal land and 30,000 m³ of sand being lost from the beach at Wolmar.



Source: Ministry of Environment and NDU, 2003 (Baird's Report)

¹³⁴ To assess vulnerability and increase preparedness of Mauritius to the impacts of climate change; economic risks, vulnerable areas and ecosystem services assessments are being conducted. Inventories of high risk flooding and inundation areas will culminate in the development of a comprehensive risk profile for the island.

Box 9.3: COASTAL AND MARINE RESOURCES AT RISK**▶ CORAL BLEACHING**

Coral reefs function as natural breakwaters along our coastline. They are vital for sand generation, provide habitats to marine animals, while concurrently generating revenues through tourist activities and fishing. Coral reefs have narrow temperature tolerances (between 26 – 27 °C) and as a result, live at or near their thermal limits.

During the last decade, coral reefs have been affected by abnormal maximum sea water temperatures, leading to coral bleaching¹³⁵ in the coastal zone. In 1998, 39% of corals in Balaclava Marine Park and 31% in Blue Bay Marine Park were affected by coral bleaching.

It is projected that higher water temperatures and rising sea levels will increase the incidence of bleaching.

▶ MANGROVES

Mangroves have essential ecological and socio-economic functions. They provide protection against cyclones and tidal surges as well as prevent the introduction of pests and insects. Mangroves provide habitats for juvenile fish and other invertebrates, function as nutrient sinks for animal and plant productivity and act as soil stabilisation forces.

At present, the total mangrove cover in Mauritius, including the islets is estimated at around 145 ha, while for Rodrigues, mangrove cover is around 24 ha (Ministry of Environment & SD, 2010). Since 1998, mangroves are protected by law¹³⁶ under the Fisheries and Marine Resources Act. According to McLeod and Salm (2006), rising temperatures¹³⁷ due to climate change will affect mangroves' photosynthesis, water loss, transpiration and salt loss.

Source: Albion Fisheries Research Centre

○ Biodiversity

The rich biodiversity of the island, especially that in the coastal and marine areas is the most threatened by climate change (see Box 9.3) and this is further accentuated by human-induced pressures. Increasing CO₂ emissions causes ocean acidification, thus altering the diversity of marine ecosystems.

○ Water Resources

Rainfall is the primary source of water supply for Mauritius. However between 1905 and 2007, a decrease of 8% in rainfall, along with more frequent and severe droughts has been noted. Additionally, the topography and hydro-geological condition of Mauritius do not allow for maximum collection of rainwater. Therefore, Mauritius will be further water stressed as a result of climate change. The island depends on groundwater for 12% of its water supply. As a result, boreholes located on the coastal zone are more prone to salt water intrusion with sea level rise.

○ Agriculture, Fisheries and Food Security

In Mauritius, the agricultural sector is already being impacted by climate change, namely through: altered rainfall patterns, prolonged droughts or flash floods, extreme weather events such as cyclones, decreased water availability and the increased incidence of agricultural pests and crop diseases. Other likely impacts of climate change include: change in soil moisture, cropping pattern and crop cycle as well as decrease in crop and livestock productivity.

For instance, the severe drought recorded in 1999, resulted in a 40.6% drop in sugar production that is, from 628,588 tonnes in 1998 to 373,294 tonnes in 1999 (Digest of Agricultural Statistics, 2001). Moreover, agricultural land located in low lying areas¹³⁸ such as: Palmar, Belle Mare, Bel Ombre, are prone to inundation as a result of sea level rise.

¹³⁵ Coral bleaching is the whitening of corals and results when a coral loses its symbiotic energy-providing algae-like organisms (zooxanthellae). Furthermore, once bleaching begins, it tends to continue even without continuing stress. If the coral colony survives the stress period, zooxanthellae often require weeks to months to return to normal density.

¹³⁶ The Fisheries and Marine Resources Act stipulates that: "no person shall cut, remove, damage or exploit a mangrove plant or part of a mangrove plant except with the written approval of the Permanent Secretary".

¹³⁷ Temperatures above 35°C will lead to thermal stress affecting mangrove root structures and establishment of mangrove seedlings, while at temperatures above 25°C, some species show declining leaf formation. However, the extent to which mangroves will be affected by climate change in Mauritius needs to be investigated (McLeod and Salm, 2006).

¹³⁸ Mapping of inundation-prone areas will be undertaken by MOI

Consequently, climate change presents a risk not only for food security, but also to small holder farmers who contribute to national production. Additionally, even if climate change-related studies published in Mauritius have covered a wide array of topics and priority sectors, the specific relationship between food security and varying climatic conditions needs further research.

Climate change is also impacting on the fisheries sector with modified fisheries productivity and availability. For instance, between 2009 and 2010, fish production fell by 19.1%, from 6,978 tonnes to 5,647 tonnes. Fresh coastal fish catch and other catch (such as bank fishing) decreased by 2.6% and 26.5% respectively. Additionally, it is predicted that as the El Niño phenomenon becomes more frequent, intense and of longer duration, the size and location of fish stocks and fish migration patterns will be affected (IPCC-AR4, 2007). Indeed on two occasions, between 1997 and 2008, tuna catch declined in the Western Indian Ocean due to above average sea surface temperatures, a deeper than average thermocline¹³⁹ and low chlorophyll concentrations. Furthermore, in January 2009, cases of fish mortality were reported at Poudre d'Or. Surveys indicated that a sudden rise in the sea surface temperature (up to 31.5 °C) resulted in a micro algal bloom, which could have been the main cause of fish mortality.

○ Human Health and Wellbeing

Elderly persons, children and infants are the most vulnerable groups to be affected by increases in temperature coupled with high levels of humidity. Moreover, Mauritius' tropical climate and rising temperatures encourage the proliferation and transmission of tropical vector borne diseases, while flash floods favour outbreaks of water borne diseases. For instance, the 36% rise in mean monthly rainfall, the 0.2 °C rise in maximum temperatures and higher humidity rates from December 2005 to March 2006 was accompanied by an outbreak in Chikungunya (Ramchurn et al., 2008) a disease transmitted by mosquitoes.

Between the first case of Chikungunya in 2005 and till August 2006, some 14,500 cases of the disease were reported. Moreover, 208 cases of Dengue Fever also transmitted by mosquitoes were recorded in June 2009. According to Ramchurn et al., (2009) the outbreak of the disease at the beginning of winter in Mauritius is surprising and highlights higher risks for the propagation of dengue viruses in summer.

However, while the number of rainy days has decreased, the frequency of heavy rainfall events accompanied by flash floods has increased. For instance, in May 2007, the southern part of the island (from Grand Port, Gris-Gris to Flic-en-Flac) was affected by tidal surges¹⁴⁰ with waves to the order of 6 - 10 metres (Mauritius Meteorological Services, 2007). One person died during this incident and 10 fishing boats were damaged, while 15 houses were inundated by sea water. Similarly, in March 2008, torrential rainfall resulted in flash floods in the northern and eastern part of Mauritius. Four persons died during this event, 22 vehicles were recovered from floods, while the Fire Services recorded more than 2,000 requests for assistance and intervention in about 50 areas. Because of the intensity of the flooding event, some 280 heads of households received as flooding allowance the day following the floods amounting to Rs. 305,500 (Cabinet Decision, 28 March 2008).

○ 9.1.4 Effectiveness of Policies and Strategies

Since 1991, Government has supported the integration of climate change mitigation and adaptation measures into core development processes. While a Climate Change Action Plan was developed in 1998, follow-up of the proposed action plan was fragmented and uncoordinated due to a lack of technical, human and institutional capacity. Furthermore budgetary, policy, development and implementation gaps also acted as barriers in implementation of the Climate Change Action Plan.

¹³⁹ The thermocline is the transition layer between the mixed layer at the surface and deep water layers. Definitions of these layers are based on temperature. In the thermocline, the temperature decreases rapidly from the mixed layer temperature, which is roughly that of surface water to the much colder deep water temperature.

¹⁴⁰ Tidal surges arise from strong winds in low pressure atmospheric systems. These generate high amplitude waves, which move equator-ward after acquiring enough energy from the wind.

Furthermore, other *ad hoc* mitigation and adaptation projects have been implemented in areas such as: ecosystem restoration and addressing sea level rise. Nevertheless, the scope and magnitude of these projects are limited and isolated. As a result, their outcomes are far from being necessarily sustainable. Furthermore, since the scale of Clean Development Mechanism projects in Mauritius is small, a clustering of small activities or the setting up of a programme of action for the region or for SIDS will enable Mauritius participate in such projects.

● 9.2 PROGRESS

As a developing country party to the United Nations Framework Convention on Climate Change (UNFCCC)¹⁴¹ and the Kyoto Protocol¹⁴², Mauritius has no obligations to reduce its greenhouse gas emissions, but like all signatories of the UNFCCC, Government has taken a series of climate change mitigation and adaptation measures and is encouraging further research and observation of the climate system. The Ministry of Environment and Sustainable Development is the focal point for the UNFCCC and the Kyoto Protocol.

◎ 9.2.1 Institutional Framework

○ National Climate Committee

The National Climate Committee was set up under the aegis of the Prime Minister's Office in June 1991. Co-chaired

¹⁴¹ The UNFCCC was signed at the 1992 Earth Summit in Rio de Janeiro by 194 countries. Mauritius ratified the UNFCCC on 4 September 1992. The objective of the Convention is to 'stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.

¹⁴² The Kyoto Protocol was adopted on 11 December 1997 and it entered into force on 16 February 2005. Mauritius acceded to the Kyoto Protocol on 9 May 2001. Although the Kyoto Protocol shares the UNFCCC objectives and principles, it significantly strengthens the Convention by committing Parties (i.e. Developed Countries, Countries of the European Union and Countries in Transition) to individual, legally binding targets to limit or reduce their greenhouse gas emissions. As a developing country, Mauritius has no legally-binding emission reduction targets.

¹⁴³ The Conference of Parties (COP) is a policy-making body that meets periodically to take stock of implementation of legally binding agreements and adopt decisions, resolutions or recommendations for the future implementation of these agreements

¹⁴⁴ The Bali Action Plan was adopted by the 13th Conference of Parties (COP 13) of the UNFCCC in 2007. The purpose of the Bali Action Plan was to enable full, effective and sustained implementation of the Framework Climate Change Convention. It also called for the articulation of a shared vision for long term cooperative action and included a goal for reducing GHG emissions. The Bali Action Plan also set a deadline for concluding climate negotiations during the 2009 COP 15 in Copenhagen.

¹⁴⁵ The Copenhagen Accord is the outcome of the 15th Conference of Parties (COP 15) to the United Nations Climate Change Conference, which took place from 7 - 18 December 2009 in Copenhagen Denmark. The Accord is a three-page, non-binding expression of political intent. Some of the elements included in the Copenhagen Accord are: long term goals to limit the increase of global temperatures to below 2°C; support adaptation in developing countries by providing adequate and sustainable financial resources, technology and capacity building; emissions reductions amongst others.

¹⁴⁶ The Cancun Agreements are the outcome of the 2010 United Nations Climate Change Conference (COP 16) held in Cancun, Mexico, from 29 November to 10 December 2010. The Cancun Agreements include a comprehensive package agreed by governments to help developing nations deal with climate change, including new institutions, funding channels and a technology transfer mechanism to help the developing world build its own sustainable, low-emissions future, adapt more effectively to climate change and preserve and protect its forests for the good of all nations. The Agreements also call for countries to list under the UNFCCC the emission reduction targets and actions which they announced in 2010.

by the Mauritius Meteorological Services, the National Climate Committee is responsible for developing national GHG inventories, evaluating climate change impacts, formulating climate change mitigation and adaptation programmes and promoting research, education and awareness on climate change.

○ Climate Change Division

Taking into account our growing vulnerabilities to climate change, a Climate Change Division has been set up at Ministry of Environment and Sustainable Development on 1st March 2010 following the 2010 budget recommendations. The division is responsible for implementing international climate change agreements (i.e. UNFCCC, Kyoto Protocol, Conference of Parties¹⁴³ decisions, Bali Action Plan¹⁴⁴, Copenhagen Accord¹⁴⁵ and Cancun Agreements¹⁴⁶), preparing, monitoring and implementing the national climate change adaptation plan and mitigation strategy, undertaking GHG inventories, developing economic instruments and exploring potential funding opportunities to facilitate climate practices.

Mauritius is actively participating at the international level in high level climate negotiation and making its voice heard through the Alliance of Small Island States, the Africa Group and the Group of G77 and China.

9.2.2 Current Policies and Programmes

National Climate Change Action Plan

The first Climate Change Action Plan was developed in 1998, detailing sectoral responses for water resources, waste management, agriculture and forestry, fisheries, coastal zone management, energy planning and transportation. Other cross-cutting actions included: education and awareness campaigns, data collection, monitoring programmes, regional and national climate modelling, improving technical capacity and providing institutional support. This was followed by the publication of the Initial National Communication under the UNFCCC in 1999. The Second National Communication is currently under finalisation.

Maurice Ile Durable

Since 2007, "Maurice Ile Durable" (MID) has been adopted as the long-term vision for promoting sustainable development in Mauritius. The MID Fund established in June 2008, provides the financing mechanism for the preservation of local natural resources, for the promotion of renewable energies, including the use of local renewable sources, the encouragement of waste minimization and recycling, and for public-private partnerships as well as local and international networking for the promotion of renewable energies, energy conservation and efficiency.

Clean Development Mechanism Projects

Mauritius presents many possibilities for Clean Development Mechanism projects. The Energy Policy for the Republic of Mauritius has identified potential of energy-related Clean Development Mechanism¹⁴⁷ projects for Mauritius. These have been estimated to be around 1.8 million tonnes of CO₂ reductions per year.

All countries wishing to participate in the Clean Development Mechanism have to set up a Designated National Authority¹⁴⁸. In Mauritius, the Designated National Authority is hosted at the Ministry of Environment and Sustainable Development and to fast track Clean

Development Mechanism procedures, the Environment Protection (Designated National Authority) Regulations 2010 have been promulgated. The said regulations provide a formalised structure for Clean Development Mechanism applications against National Sustainable Development Criteria that have been developed.

As at to-date, the Ministry of Environment and Sustainable Development has considered the following projects for carbon credits: waste incineration project, bagasse based energy project, wind farms at Britannia, Curepipe Point and Plaine des Roches and gas-to-energy project at the Mare Chicose Landfill. However, no Clean Development Mechanism project from Mauritius has yet been registered with the Clean Development Mechanism Executive Board of the UNFCCC. For instance, the bagasse-fuelled cogeneration project was not approved by the Clean Development Mechanism Executive Board because the time boundary over which bagasse was used for co-generation could not be applied to the entire project duration. Furthermore, an inherent problem to SIDS is the scale of the projects implemented, which are usually small.

Technology Needs Assessment

Mauritius is also implementing the 2nd Technology Needs Assessment. The key aim of this second round of Technology Needs Assessment is to bridge the gap between identification of appropriate technologies and design of action plans that would enable Mauritius to reduce greenhouse gas emissions and support adaptation to climate change. The project is scheduled for completion by June 2012.

¹⁴⁷ Clean Development Mechanism, one of the provisions of the Kyoto Protocol, is a means of promoting sustainable development in developing countries through carbon trading. For each tonne of Carbon Dioxide (CO₂) equivalent that is reduced as a result of a Clean Development Mechanism project, a 'carbon credit' is issued and can be purchased by industrialised countries for the fulfilment of their commitments to the Kyoto Protocol. In 2007, the value of the Clean Development Mechanism market totalled €12 billion

¹⁴⁸ In Developing Countries, Designated National Authorities are responsible for the evaluation of proposed Clean Development Mechanism projects and to issue letters of approval confirming that the project activity is implemented voluntarily and contributes to sustainable development in the host country.

Box 9.4: ESTIMATED TOTAL ANNUAL CO₂ REDUCTION FROM ENERGY PROJECTS

OPTION	POTENTIAL EMISSION REDUCTIONS (ktCO ₂ /year)
▶ Incineration of municipal solid waste	200
▶ Landfill gas	363
▶ Solar water heaters	75.5
▶ Wind power in Mauritius	175
▶ Sugar cane / bagasse	715
▶ Use of ethanol in transport	37.5
▶ Efficient appliances - Households	40.5

Source: Energy Policy for the Republic of Mauritius, January 2008

○ Africa Adaptation Programme

Mauritius has also embarked on the Africa Adaptation Programme, which aims at establishing an enabling environment to design, finance, implement and monitor long-term and cost-effective adaptation policies and plans. In addition, the Africa Adaptation Programme will integrate and streamline climate change adaptation considerations into core development policies, strategies and plans. The key sectors under consideration include: disaster risk reduction, agriculture, environment, fisheries, tourism, water, education and finance. By the end of the programme in December 2012, Mauritius will be able

to develop long term planning mechanisms, leadership capacities and institutional frameworks to manage climate change risks and opportunities, implement climate-resilient policies and measures in priority sectors, devise the necessary financing options for national adaptation and strengthen knowledge and capacities on climate change.

○ Sustainable Consumption and Production

The 2008 National Programme on Sustainable Consumption and Production¹⁴⁹ encompass 44 projects to be implemented within a period of five years. These projects focus on: sustainable energy consumption; sustainable water consumption; sustainable buildings and construction; integrated waste management and recycling; sustainable public service practices; improved market supply of sustainable products and education and communication for sustainable lifestyles. If implemented, many of these projects can contribute to decrease GHG emissions.

○ 9.2.3 Mitigation Measures to Climate Change

A series of sectoral measures have been undertaken to mitigate¹⁵⁰ climate change. These include use of renewable energy sources (bagasse, hydropower, wind and solar), energy-efficient vehicles, reforestation programmes to increase carbon dioxide capture, recycling and waste minimization and phasing out of ozone depleting substances.

¹⁴⁹ The National Programme on SCP is available on the following URL: <http://www.gov.mu/portal/goc/menv/files/SCP/SCP.pdf>

¹⁵⁰ Climate change mitigation involves the use of a mix of policies as well as technological change, substitution and innovation to reduce GHG emissions.

BOX 9.5: ACTIONS TAKEN TO REDUCE GHG EMISSIONS**USE OF RENEWABLE ENERGY:**

- ▶ In 2009, Government introduced a scheme to promote the use of solar water heaters. A grant of Rs. 10,000 was provided to households for the purchase of solar water heaters. The MID Fund disbursed Rs. 290 million for 29,000 solar water heaters. Following the success of the initial programme, Government has reinstated the programme in the 2010 Budget.
- ▶ Optimum use of bagasse to produce electricity.
- ▶ A mini hydropower plant of 375 kW was commissioned in 2010.
- ▶ Government is encouraging innovation by households as well as businesses to produce electricity using renewable energy technologies. Small Independent Power Producers (SIPPs) can now produce up to 50 kW of electricity from photovoltaic, micro-hydro and wind turbines and sell the electricity to the grid.

ENERGY EFFICIENCY:

- ▶ In 2008, the CEB embarked on the sale of one million compact fluorescent lamps to all residential customers in Mauritius and Rodrigues at heavily discounted prices. The aim of this project was to reduce electricity consumption during peak demand: that is during afternoons and at night. The MID Fund supported the project with an initial grant of up to Rs. 20 million (*Central Electricity Board, 2008*)
- ▶ Promulgation of the Energy Efficiency Act 2011.

FORTHCOMING PROJECTS:

- ▶ The Central Electricity Board is investigating the possibility of allowing SIPPs with capacity of up to 400 kW to feed into the grid.
- ▶ A feasibility study has already been carried out for the setting up of a 20-30 MW Wind Park on a Build-Own-Operate basis at Curepipe Point. Moreover, the CEB is also planning to set up a small wind park at Bigara. The wind park will comprise four wind turbines of 275 kW each. If these work well, it will tentatively be followed by four additional units of similar capacity.
- ▶ Two private sector operators have expressed their interest to set up wind farms at Plaines des Roches and Britannia with a minimum of 10 MW installed capacity each.
- ▶ Setting up of a mini hydropower plant of 375 kW to be operational in 2012.
- ▶ A 3 MW landfill gas to energy project at Mare Chicose Landfill for power generation is planned.
- ▶ Setting up the Energy Efficiency Management Office, which will promote, coordinate policies and establish procedures to measure, monitor and verify energy efficiency across all sectors.

9.2.4 Adaptation Measures to Climate Change

Mauritius has also taken adaptation measures to reduce human and natural vulnerabilities against the actual or expected impacts of climate change.

BOX 9.6: ADAPTATION MEASURES TO CLIMATE CHANGE

COASTAL AND MARINE RESOURCES:

- ▶ To minimize the impacts of erosion, coastal rehabilitation works have been undertaken along the coastal zone. These include the installation of gabions (in places with higher wave strengths), rock revetment, mangrove propagation in risk areas, beach replenishment and management. The banning of coral sand extraction since 2001 has also contributed to reducing the impacts of beach erosion.
- ▶ To promote sustainable coastal development, the set back distance from the high-water mark has been increased to 30 m.
- ▶ An artificial coral growth programme has been carried out on a pilot basis with the aim of maintaining an on-land stock of corals for onward propagation at sea. To protect fragile and biodiversity-rich ecosystems, marine parks and fisheries reserves have been proclaimed. Similarly, the Albion Fisheries Research Centre monitors coral reefs in the shore-reef, back-reef and fore-reef stations around Mauritius.
- ▶ To assess vulnerability and increase preparedness of Mauritius to the impacts of climate change; economic risks, vulnerable areas and ecosystem services assessments are being conducted. Inventories of high risk flooding and inundation areas will culminate in the development of a comprehensive risk profile for the island.

AGRICULTURE & FOOD SECURITY:

- ▶ Cultivation of more drought and heat resistant varieties
- ▶ Practice of trash blanketing of sugarcane fields
- ▶ Further investment in protected cultures, soilless cultures and sheltered farming
- ▶ Improved livestock housing and breed
- ▶ Reduction in the use of irrigation water and fertilizer, through improved techniques e.g. pivot and drip irrigation systems and fertilisation technology
- ▶ Creation of a Food Security Fund to increase the resilience of Mauritius towards food self-sufficiency by increasing production of foodstuff locally and at the regional level by partnering with neighbouring countries.

BIODIVERSITY:

- ▶ Ongoing reforestation programmes
- ▶ Forest Policy for sustainable forest management and promoting soil conservation
- ▶ Proclamation of nature reserves
- ▶ Conservation of plant genetic resources

Box 9.6: ADAPTATION MEASURES TO CLIMATE CHANGE**WATER RESOURCES:**

- ▶ An integrated plan for water resources development up to year 2040 has been prepared
- ▶ Surface water storage has been increased
- ▶ Existing storage dams and feeder/irrigation canals have been rehabilitated to minimize seepage losses
- ▶ Capacity of potable water treatment plants has been extended

○ Regional Projects

Besides national measures, various regional programmes on climate change adaptation and mitigation have been developed. Mauritius is participating in the following:

- The “*Adaptation au Changement Climatique dans les Etats de la Commission de l’Océan Indien*” project which aims at establishing effective regional cooperation between Indian Ocean Commission member states in adapting to the impacts of climate change.
- The “*L’Adaptation de la Petite Agriculture au Changement Climatique dans les Iles de L’Océan Indien pour la diffusion de l’Agro-Ecologie*” project, which aims at supporting small farmers and improving their quality of life through the adoption of sustainable agricultural practices.
- Regional Strategy for Addressing Climate Change Impacts in Coastal and Marine Areas of the Western Indian Ocean Region

● 9.3 PROSPECTS

BUSINESS AS USUAL SCENARIO

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
GHG emissions	Sustained use of fossil fuel and numerous barriers to the use of renewable energy	Steady increase in GHG emissions as fossil fuel use continues to rise
Impacts on the climate system	Implementation of ad hoc sectoral mitigation and adaptation programmes	Less than 25% of electricity generated from renewable sources
Impacts of climate change on the various sectors	Implementation of the recommendations in the 1998 National Climate Change Action Plan (NCCAP).	Temperature increases, rainfall decreases, sea level rise increases, longer droughts and cyclones more frequent
Coordination at national level	No improvement in coordination for the implementation of climate change action plans	Moderate resilience as the NCCAP remained unreviewed and hence current climate challenges under-estimated <i>Remedial action taken at critical sites only -inundation of coastal areas accentuated or persists at other locations</i> <i>Coral bleaching persists</i> <i>Water stress reduced to some extent construction of new dams and 20% decrease in unaccounted for water</i>
Global climate change negotiations	Limited funding available to support climate change national programmes	<i>Agro industry sector affected by sporadic outbreaks in plant and livestock diseases</i> <i>Fish catch affected as rising sea surface temperatures affect the migratory path of pelagic fish and lagoonal catch decreases because of coral bleaching</i> <i>Sporadic but high impact outbreaks in water-borne and vector-borne diseases</i> <i>Coastal infrastructure at risk in several areas</i>

RISK OF FAILURE (WORST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
GHG emissions	Increased use of fossil fuels with no further exploration for using renewable sources of energy	<p>Increasing GHG emissions</p> <hr/> <p>Renewable energy options abandoned after damage by cyclones and bagasse use decreases drastically as sugar cane is affected by drought and disease</p>
Impacts on the climate system	Absence of a climate change mitigation and adaptation plan. Previous plans never updated nor implemented	<hr/> <p>Sharp temperature rise, long dry spells, sea level rises by 60 cm, more destructive cyclones</p>
Impacts of climate change on the various sectors	No vulnerability and socio-economic assessments of climate change impacts	<hr/> <p>No resilience to climate change</p> <p><i>Land loss due to beach erosion and inundation</i></p> <p><i>Biodiversity loss due to temperature rise, proliferation of invasive species and diseases</i></p> <p><i>Water stress and scarcity</i></p>
Coordination at national level	Fragmented or no coordination at institutional level	<p><i>Agriculture affected by water and heat stress, spread of diseases</i></p> <p><i>Fish catch decreases as migratory path of pelagic fish changes and lagoonal fish catch decreases as corals are bleached</i></p>
Global climate change negotiations	No available funding or assistance to implement climate change mitigation and adaptation projects	<p><i>Epidemics due to water-borne and new vector-borne diseases</i></p> <p><i>Coastal infrastructure damaged due to land loss</i></p>

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
GHG emissions	<p>Power sector reform Diversify renewable energy base & enhance energy efficiency and conservation</p>	<p>Stabilisation or decrease in GHGs emissions</p>
Impacts on the climate system	<p>Implement national climate change adaptation strategy and action plans</p>	<p>More than 35% electricity generated from renewable sources</p>
Impacts of climate change on the various sectors	<p>Develop and enforce climate change legislative framework</p>	<p>Increased resilience to climate change</p> <p><i>Beach erosion and inundation of coastal areas controlled or on the decline</i></p> <p><i>Inland and coastal biodiversity protected</i></p>
Coordination at national level	<p>Assess sectoral vulnerability and socio-economic impacts of climate change</p>	<p><i>Water stress decreases due to integrated water resources management (reduce unaccounted for water, improve water storage and collection system, promote rainwater harvesting, reuse treated wastewater)</i></p> <p><i>Disease and drought-resistant crop varieties</i></p>
Global climate change negotiations	<p>Regularly assess monitoring and reporting programme with enhanced coordination at international level</p> <p>Conclusive global negotiations and assistance to SIDS for adaptation and strengthening resilience</p>	<p><i>Improved fish catch as migratory path of pelagic fish is restored and lagoonal water quality improves</i></p> <p><i>Decrease in water-borne and vector-borne diseases Coastal infrastructure protected</i></p>

9.3.1 Policy Options for the Future

Climate change impacts are likely to pose considerable risks for Mauritius in the future and as shown in the Best Case Scenario, timely actions should be taken to reduce climate change impacts over time. It is therefore imperative that climate change be mainstreamed into core development policies, strategies and plans.

As highlighted in the Best Case Scenario, National Climate Change Adaptation and Mitigation Strategies and Action Plans as well as a climate change legislative framework should be developed, implemented, monitored and regularly reviewed. A comprehensive mitigation strategy could be based on increasing use of renewable energy, cleaner fuels, promoting energy efficiency and other measures to reduce GHG emissions. In parallel, the adaptation activities under the Africa Adaptation Programme require urgent implementation.

Introduction of long term planning mechanisms to manage climate change uncertainties

- Assessment of economic risks posed by climate change
- Climate risk assessments for vulnerable areas and ecosystem services assessments
- Construct inundation risk maps (sea level rise & flash flood)
- Carry out modelling exercises for informed decision-making
- Create a pool of local technical experts

Strengthen capacities and institutional frameworks to manage climate change risks and opportunities

- Establishment of an Adaptation Unit at the Ministry of Environment and Sustainable Development
- Develop comprehensive training courses and sensitisation campaigns on climate change adaptation for all target groups

- Creation of a knowledge platform to assist national and SIDS-adaptation practitioners

- Climate change awareness campaigns to mainstream adaptation into the public sector & increase public awareness.

Implementation of Climate-Resilient Policies and Measures in Priority Areas

- Revision of policies, strategies and plans to incorporate climate change considerations
- Formulation of a National Adaptation Strategy for Mauritius
- Support for the implementation of a selection of pilot projects in coastal and agricultural sectors

Expand Financing Options to Meet National Adaptation Costs

- Identification and implementation of innovative financing options, instruments and mechanisms
- Development of a financing strategy which includes adaptation financing from the private sector, from international adaptation funds and revenues from innovative financing options such as Payments for Ecosystem Services
- Assessment of micro-financing opportunities for adaptation

Chapter Summary

CHALLENGES

- ▶ Between 2002 and 2009, a 40% increase in CO₂ emissions has been recorded in Mauritius.
- ▶ Electricity generation, industrial processes and the transport sector are the main contributors of GHG emissions. Land use changes, agricultural practices and waste management also generate GHGs.
- ▶ The impacts of climate change are already apparent in Mauritius with increasing temperatures, decreasing rainfall, rising sea levels and extreme weather events.
- ▶ Climate change impacts on the coastal zone, water resources, agriculture, fisheries, food security and human health and wellbeing.
- ▶ Implementation of the National Climate Change Action Plan has been fragmented and uncoordinated due to lack of technical, human and institutional capacity.

PROGRESS

- ▶ The institutional framework for climate change is in place with a National Climate Change Committee at Prime Minister's level and a Climate Change Division at the Ministry of Environment & Sustainable Development.
- ▶ A series of national and sectoral policies and programmes to mitigate and adapt to climate change have been initiated.

PROSPECTS

- ▶ Implement all activities under the Africa Adaptation Programme.
- ▶ Develop and implement National Climate Change Mitigation and Adaptation Strategies and Action Plans.
- ▶ Promulgate and enforce Climate Change legislation.
- ▶ Reduce GHG emissions by promoting renewable energy use.
- ▶ Undertake regular assessment and monitoring of climate change programmes.
- ▶ Assess the economic risks posed by climate change.
- ▶ Undertake climate change risk assessment for vulnerable areas and ecosystems and construct inundation risk maps.
- ▶ Capacity building to assess present and future impacts of climate change for informed decision-making.
- ▶ Explore financing options to meet national adaptation costs.
- ▶ Assistance to SIDS for adaptation and strengthening resilience.

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Offshore Islets

Mainland Mauritius is surrounded by 49 offshore islets that vary in size from 0.012 ha to 253 ha. While some are far out at sea and difficult to access (e.g. Round Island), others are found inside the lagoon and are easily accessible to the casual visitor (e.g. Ile d'Ambre). Some islets are ecologically sensitive and are of international reputation for their natural biodiversity. In some cases, they harbour the last refuge of endemic species which are endangered. The flora and fauna of some of these islets are characterised by rich, diverse and high endemism and are susceptible to decline and extinction. Figure 10.1 shows the offshore islets of Mauritius.

● 10.1 CHALLENGES

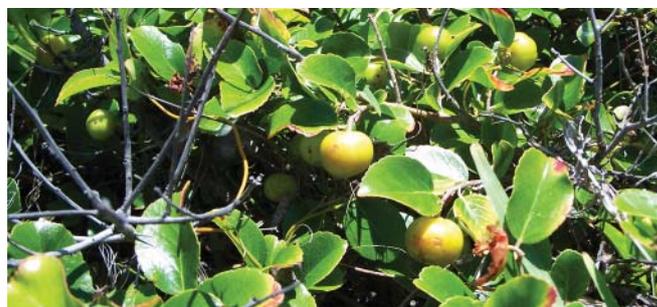
⊙ 10.1.1 Human Activities

The increase in human activities on some of the islets led to the introduction of weeds and animals such as: goats, deer, rats, cats, dogs, shrews, agamid lizards, wolf-snakes, exotic birds, house geckos, rabbits and hares causing destruction of natural habitat affecting the ecology of the offshore islets.

Furthermore, some islets such as Ilot Vacoas, Gunner's Quoin, Ilot Mariannes and Ile aux Aigrettes have public beaches, which put these islets at risk from illegal landing, introduction of invasive alien species and problems of littering, irresponsible camping, lighting of fires, bird poaching and defacing of historical buildings on islets. Those islets least touched by human activities have been Pigeon Rock and Serpent Island.

⊙ 10.1.2 Tourism and Leisure Activities

Islets have always been used for tourism and other leisure activities. For example, some islets such as Bernache Island, Gabriel Island, Ilot Mangénie and Ile aux Bénitiers have been venues for regular but unregulated tourist boat trips. Similarly, Ile aux Cerfs has a world golf course and is a prime tourist attraction for water sports. Moreover, given the increasing pressure on already scarce coastal land for hotel development, offshore islets are now offering a potential avenue for exploitation. For instance, Government has received proposals for the construction of a six-star hotel on Ile aux Bénitiers. In 2006, Cabinet agreed to lease Gabriel Island and Flat Island for ecotourism and recreational purposes for both tourists and residents. These future developments are likely to impact on the native biodiversity of these islets besides causing



Prune Malgache (*Flacourtia indica*) an invasive alien species of coastal areas and islets Courtesy: V.Tatayah

problems related to recreational activities. Impacts may also arise from increasing and uncontrolled day visits, especially if no investment is made in facility development and habitat restoration.

⊙ 10.1.3 Global Warming and Sea Level Rise

Some of the low-lying islets, such as Flammants, Ile aux Oiseaux, Bénitiers and the Mariannes group, are susceptible to sea level rise. These are already affected by cyclones, storm surges and beach erosion.

⊙ 10.1.4 Enforcement

Enforcement of existing legislation for islets' management is under the responsibility of several authorities: the National Parks and Conservation Service, the Forestry Service and the National Coast Guard. However, there is a general lack of coordination and capacity in the fulfilment of enforcement functions.

⊙ 10.1.5 State of Islets

A number of islets have been declared as Nature Reserves under the Forests and Reserves Act 1983 (Round Island, Ilot Gabriel, Flat Island, Gunner's Quoin, Ile aux Mariannes, Ile aux Aigrettes and Ile aux Serpents), while Ile D'Ambre and Ilot Bernache are under the control of the Forestry Service. Out of the 49 islets, 16 form part of the islets national park. These offshore islets have been demarcated as:

- Closed Reserves, which are strictly used for the purpose of conservation and protection of native biodiversity. Access is restricted to authorized personnel for the purposes of monitoring, enforcement and restoration of native habitat.
- Open Reserves, in which a wide array of activities are allowed: protection, conservation, research, eco-tourism, education and public awareness and recreation.

Out of the 33 remaining islets, 22 are leased for specific uses. Of the other 11 islets, one is privately owned, one is a declared public beach and nine are uncommitted. These have no biodiversity or wilderness value and therefore can be used for ecotourism, recreational and associated activities. Table 10.1 shows the status of some of the offshore islets.

Table 10.1: Status of some offshore islets

ISLET	AREA	POTENTIAL VALUE	PROPOSED MANAGEMENT REGIME	RESPONSIBLE BODY
Flat Island	253.5 ha	<ul style="list-style-type: none"> • Low impact research • Ecotourism • Beach based recreation 	Open Reserve	NATIONAL PARKS & CONSERVATION SERVICE
Rocher des Oiseaux	0.1 ha	<ul style="list-style-type: none"> • Conservation and Protection of Species 	Closed Reserve (Declared National Park in 2004)	
Ile aux Fous	0.3 ha	<ul style="list-style-type: none"> • Conservation and Protection of Species 	Closed Reserve (Declared National Park in 2004)	
Gabriel Island	42.2 ha	<ul style="list-style-type: none"> • Long term reserve of native and endemic plants and animals • Ecotourism and education 	Open Reserve	MINISTRY OF AGRO INDUSTRY & FOOD SECURITY
Ile Mariannes	4.1 ha	<ul style="list-style-type: none"> • Conservation and Protection of Species 	Closed Reserve	
Ilot Fourneau	12.6 ha	<ul style="list-style-type: none"> • Low value for tourism site development, recreation or intermediate conservation • Agriculture to be discouraged 	No recommendation	MINISTRY OF HOUSING & LANDS
Ile aux Bénitiers	65.5 ha	<ul style="list-style-type: none"> • Recreation (attraction to day visitors) • Habitat restoration and ecosystem conservation 	No recommendation	

Note: Ile aux Bénitiers & Ilot Fourneau do not form part of the Islets National Park
Sources: Ministry of Housing and Lands (2001); Development of Management Plans for the Conservation & Management of Offshore Islets for the Republic of Mauritius: Phase II, NPC (2008)

◎ 10.2 PROGRESS

○ 10.2.1 Policies and Strategies

Government has commissioned various studies to consider the potential for ecological restoration on the islets. The first study on islets, undertaken in 1994, was entitled “Mauritius Offshore Island Survey Report and Management Plan”. It recommended the eradication of invasive alien animals and plants on those islets having high conservation potential.

- Islets National Park Task Force

The Islets National Park Task Force was set up in 2001 and it highlighted that “many of the islets are biologically very important and have great conservation potential due to their unique native flora and fauna”. It recommended the creation of the Islets National Park consisting of 16 islets and a marine area up to 1 km around them.

- Islets National Park Strategic Plan

In 2004, an Islets National Park Strategic Plan was formulated under three main themes, namely: development of a management strategy, promotion of conservation through public awareness campaigns and enforcement of laws to prevent further habitat degradation. This strategic plan was prepared for the following sixteen islets: Flat Island, Gabriel Island, Pigeon Rock, Gunner’s Quoin, Serpent Island, Ile d’Ambre, Round Island, Ile aux Mariannes, Rocher

des Oiseaux, Ile aux Fous, Ile aux Flammants, Ile aux Aigrettes, Ile aux Fouquets, Ilot Vacoas, Ile de la Passe and Ile aux Oiseaux.

Between 2004 and 2010, islet-specific biodiversity and conservation management plans have been prepared for the following islets: Flat Island, Gabriel island, Pigeon Rock, Gunner’s Quoin, Serpent Island, Ile d’Ambre, Round Island, Ile aux Mariannes, Rocher des Oiseaux, Ile aux Fous, Ile aux Flammants and Ile aux Aigrettes. Though not part of the Islets’ National Park, management plans have also been developed for two other islets, namely Ilot Fourneau and Ile aux Bénitiers because of their potential for recreation and tourism development. The detailed management plans for the islets and associated lagoons aim at restoring, conserving and sustaining the natural biodiversity of these islets and include provision for ecotourism.

Steps have been taken to regulate human activities on the islets. In these, nesting grounds and sensitive habitats are protected through zoning, fencing and signposting the area or by providing pathways that lead away from these areas. Box 10.1 shows important features of the Round Island Management Plan.



Ile aux Serpents

Courtesy: National Parks and Conservation Service

BOX 10.1: ROUND ISLAND MANAGEMENT PLAN

Round Island is a 163 ha islet about 20 km from the northern coast of Mauritius. It is a basaltic volcanic cone with steep slopes and over half of the island is covered in bare rock. Round Island vegetation suffered from the introduction of rabbits and goats in the 19th century and soil erosion increased with the resulting destruction of ground-cover vegetation. Rabbits and goats have now been removed and activities are underway to restore the island's vegetation. Round Island contains the last remnants of the palm-rich forest that once covered much of northern Mauritius. However, many of its native plants are endangered and invasive weed species are widespread. Round Island also has the most important population of native reptiles remaining in Mauritius, presumably because rats and exotic reptiles never became established on the islet. The conservation and restoration of Round Island is carried out jointly by the National Parks and Conservation Service and the Mauritian Wildlife Foundation.

The main components of the Round Island Management Plan are to:

- ▶ Continuously improve effective precautions against introduction of alien animals and plants.
- ▶ Attain effective control or eradication of all weeds.
- ▶ Secure the Round Island populations of the ten species of threatened native plants.
- ▶ Intensify the restoration process in areas with suitable soils.
- ▶ Re-establish hardwood species formerly recorded on the island.
- ▶ Continue the assessment of the population biology and ecology of the Round Island Keel-scale Boa, Gunther's Gecko, Durrell's Night Gecko and Telfair Skinks in order to gather relevant information for planned translocations.
- ▶ Establish wild populations of threatened geckos, skinks and snakes, which are now found only on Round Island, on other rat-free islands.
- ▶ Continue the search for the Round Island Burrowing Boa to confirm its survival or extinction.
- ▶ Survey the invertebrate fauna of the island.
- ▶ Establish viable populations of carefully selected endangered plant species from Mauritius.
- ▶ Secure seabirds populations and consider use of the island as a refuge for selected endemic land birds.
- ▶ Increase understanding of soil erosion on the island and implement soil conservation measures.
- ▶ Continue monitoring and research programme on Round Island.
- ▶ Introduce and manage tortoise grazers to benefit the native grassland community and help control invasive species.

~ Study on Environmentally Sensitive Areas

Islets have been classified as Environmentally Sensitive Areas (ESAs) following the study undertaken in 2009 to identify, demarcate and classify ESAs. The study recommended that for remote islets that are uncommitted state land or national park, some form of co-management may be ideal. Degraded offshore islets can be actively restored and the ESA Study has proposed the following classification for islets protection:

BOX 10.2: LONG TERM OUTCOMES NEEDED FOR PROTECTION AND RESTORATION OF ISLETS

CATEGORY 1

- ▶ Offshore islets are protected intact and, where needed, restored to health and resiliency

CATEGORY 2

- ▶ Offshore islets are protected in a viable and healthy state, with restoration considered on a case-by-case basis and any mitigation for adverse impacts on offshore islets provided on-site

CATEGORY 3

- ▶ Offshore islets are protected, with an emphasis on conserving a viable number of Category 3 sites and any loss is compensated

~ Integrated Coastal Zone Management Study¹⁵¹

The Integrated Coastal Zone Management (ICZM) Framework for the Republic of Mauritius has recommended policy, institutional and legislative proposals for the conservation, restoration and development of islets, while taking into account the islets pressure zones. The ICZM Framework supports the implementation of islets management plans, which adopt a holistic terrestrial and marine management approach. The implementation of the recommendations will enable a more sustainable management of the islets and their ecosystems.

◎ 10.2.2 Legislation

In Mauritius, conservation, management and protection of islets have legislative support. The Forests and Reserves Act 1983 and the Wildlife and National Parks Act 1993 provide the legal instruments for the conservation and management of the offshore islets to protect them from human damage. These have to be adequately enforced and implemented.

◎ 10.2.3 Projects and Programmes for Islets Restoration and Conservation

BOX 10.3: ILE AUX AIGRETTES

- ▶ Ile aux Aigrettes is a 26 ha islet located inside the coastal lagoon of Mahebourg and is managed by the Mauritian Wildlife Foundation. The islet contains the remnant of the coastal ebony forest that used to surround Mauritius. The Mauritian Wildlife Foundation has been restoring the native vegetation over the past two decades. The islet has been weeded and all the cleared areas have been replanted with native plants, produced from the on-site nursery. Invasive animals such as rats, shrews, wolf-snakes, agamid lizards and Achatina snails have been eradicated or are now controlled. In parallel with habitat restoration and predator control, endemic birds and reptiles have been re-introduced. The islet is now a breeding ground and home to a good population of green ornate day geckos, Pink Pigeons, Mauritius Fodies, Mauritius Olive White Eyes, Telfair Skinks and Aldabra Tortoises.

Ile aux Aigrettes is an ecotourism site, where nature conservation runs in parallel to responsible tourism. Special attention is given to carrying capacity, group size and support to conservation works. In 2009, a special project entitled: 'Learning with Nature on Ile aux Aigrettes' was initiated to raise awareness on nature conservation. Ile aux Aigrettes is the best restored island in the Mascarenes.

¹⁵¹ For more information, refer to Chapter 6: Coastal and Marine Resources

○ Rare Pride campaign

(Mauritian Wildlife Foundation/RARE Pride UK)

The RARE¹⁵² Pride campaign in Mauritius was initiated by the Mauritian Wildlife Foundation together with Rare Pride UK, the National Parks and Conservation Service and the Forestry Service. The campaign focuses on the conservation of endemic reptiles, particularly geckos, some of which are Critically Endangered and are only found on the south east islets of Mauritius. The campaign also aims at sensitising locals to control littering and lighting of barbecues as well as in safeguarding their natural heritage.

○ Translocation of Reptiles Between Islets

In 2006, the National Parks and Conservation Service in collaboration with Durrell Wildlife Conservation Trust and the Mauritian Wildlife Foundation started a programme of translocation of reptiles between rodent free islets around Mauritius. Between 2006 and 2009, 250 Telfair Skinks were translocated to Ile aux Aigrettes and Gunner's Quoin. Bojer's Skinks from Ilot Vacoas were reintroduced on Ile aux Fouquets and Orange-tailed skinks from Flat Island were introduced on Gunner's Quoin. The second phase of the project has already started and will end in 2011. It aims at translocating:

- Gunther's gecko onto Ile aux Aigrettes,
- Bojer's skink on Ile aux Fouquets and Ile de la Passe,
- *Nactus* gecko from Ilot Vacoas and Round Island onto Ile aux Mariannes,
- Captive breeding of *Nactus* gecko at Durrell Wildlife Conservation Trust.

Translocated reptiles are closely monitored and their impacts on resident animal species are also assessed. Populations have been found to be healthy and juveniles have also been observed. Box 10.4 outlines the translocation of the Orange-tailed skink on Gunner's Quoin.

BOX 10.4: TRANSLOCATION OF THE ORANGE-TAILED SKINKS ON GUNNER'S QUOIN

The Orange-tailed skink *Gongylomorphus fontenayi* sp. was discovered in 1995 and although it was likely to have occurred throughout lowland Mauritius it has only ever been known from Flat Island. Plans to develop Flat Island for tourism threatened the survival of the species and it was agreed that approximately 80 skinks should be translocated to the relatively secure nature reserve island, Gunner's Quoin. In 2008, 159 individuals were released on Gunner's Quoin. The translocation represented the removal of approximately 2% of the lower population estimate from within prime forest habitat.



Orange tailed skink
Courtesy: V.Tatayah

¹⁵² RARE is an international conservation organisation that has worked in over 40 countries to equip people with the tools and motivation they need to care for their own natural resources. Rare's Pride Campaign aims to establish grassroots support for environmental protection, by training local conservationists to increase awareness, influence attitudes and to enable positive change.

● 10.3 PROSPECTS

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Increasing pressure from human, tourism and leisure activities	Implement the Islets National Park Strategic Plan and islet-specific management plans	Conservation of biodiversity on protected offshore islets achieved
Sea level rise	Develop management plans and extend restoration programmes to other islets	
Lack of information on marine ecosystems of islets	Build capacity to enhance management of islets	Better management of offshore islets
Lack of coordination and capacity for enforcement	Use islets as a global laboratory of good practice in ecological research, eco-education, conservation and ecotourism	
Lack of coordination and capacity for enforcement	Promote ecotourism on islets taking into consideration their carrying capacity	Sustainable use of offshore islets achieved

◎ 10.3.1 Policy Options for the Future

In the Best Case Scenario, the importance of offshore islets is fully recognised. While various islet-specific management plans have been developed under the Islets National Park Strategic Plan, it is imperative to allocate resources for the implementation of these plans for the protection and conservation of these islets. Conversely, some islets are free to be used for non-conservation objectives. However, as a matter of national policy, these islets should also be subject to control and regulation to ensure their sustainable management. There is a need to develop management plans for these islets to explore their potential for any future development.

Capacity building is a key component in ensuring the conservation and management of islets. In this context, a number of skills will be required by field officers and rotating staff for the management of offshore islets. These include: data logging, photography, boat operation, horticulture and planting, pest management and logistic coordination, correct observation of conservation guidelines and regulations and enforcement of laws and regulations.

Ecotourism on islets should be promoted in a transparent manner and developed in consultation with the local communities, as well as taking into consideration local recreational demands and the carrying capacity of the islets.

Islets can be used as global laboratories of good practice in ecological research, eco-education, conservation and ecotourism. In this connection, opportunities should be explored for sharing experience with other countries in and outside the region and encouraging greater involvement of NGOs and community based organisations for islets management. For example a twinning arrangement could be made with other islands.

Chapter Summary

CHALLENGES

- ▶ Islets are at risk from introduction of invasive alien species and problems of littering, illegal landing, irresponsible camping, lighting of fires, bird poaching and defacing of historical buildings.
- ▶ Leasing of islets for future tourism development is likely to impact on native biodiversity besides causing problems related to recreational activities. Impacts may also arise from increasing and uncontrolled day visits, especially if no investment is made in facility development and habitat restoration.
- ▶ Low-lying islets are vulnerable to sea level rise.
- ▶ Enforcement of existing legislation for islets management and protection is fragmented.

PROGRESS

- ▶ Studies commissioned by Government indicate that many islets are biologically very important and have great conservation potential due to their native flora and fauna.
- ▶ An Islets National Park Strategic Plan has been prepared and 21 islet-specific management plans have been approved by Government for implementation.
- ▶ In Mauritius, conservation, management and protection of islets have legislative support.
- ▶ Islets have been classified as Environmentally Sensitive Areas and strategies have been developed for their protection.
- ▶ The Integrated Coastal Zone Management Framework has recommended policy, institutional and legislative proposals for the conservation, restoration and development of islets.
- ▶ Projects and programmes for islet conservation include restoration of native flora and fauna and eradication of invasive alien species.

PROSPECTS

- ▶ Implement the Islets National Park Strategic Plan and islet-specific management plans.
- ▶ Develop management plans and extend restoration programmes to other islets.
- ▶ Build capacity to enhance management of islets.
- ▶ Use islets as a global laboratory of good practice in ecological research, eco-education, conservation and ecotourism.
- ▶ Promote ecotourism on islets taking into consideration their carrying capacity.

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Tourism and Environment

Tourism is an important component of the Mauritian economy. It is the third largest sector by contribution to the national income after manufacturing and agriculture. Its contribution to GDP has increased from 3% in 1995 to 7.9% in 2009. The World Economic Forum Travel and Tourism Competitiveness Report for 2009 lists Mauritius as the highest-ranked country in Sub-Saharan Africa. Mauritius is also ranked 3rd of all countries worldwide for its affinity for travel and tourism. The rapid development of the tourism industry has brought along extensive coastal development and major environmental challenges, namely pressure on the coastal and marine ecosystems and on basic resources such as land, water and energy supply.

● 11.1 CHALLENGES

In 2006, Government announced a target of attracting two million tourists by 2015¹⁵³ as its new vision for the tourism industry. Figure 11.1 shows tourist arrivals from 1990 to 2009 and the projected two million to 2015. In order to attain this number by 2015, a minimum annual growth rate¹⁵⁴ of at least 10% will have to be achieved (Mauritius Sector Strategy Plan on Tourism 2009 - 2015). This means that

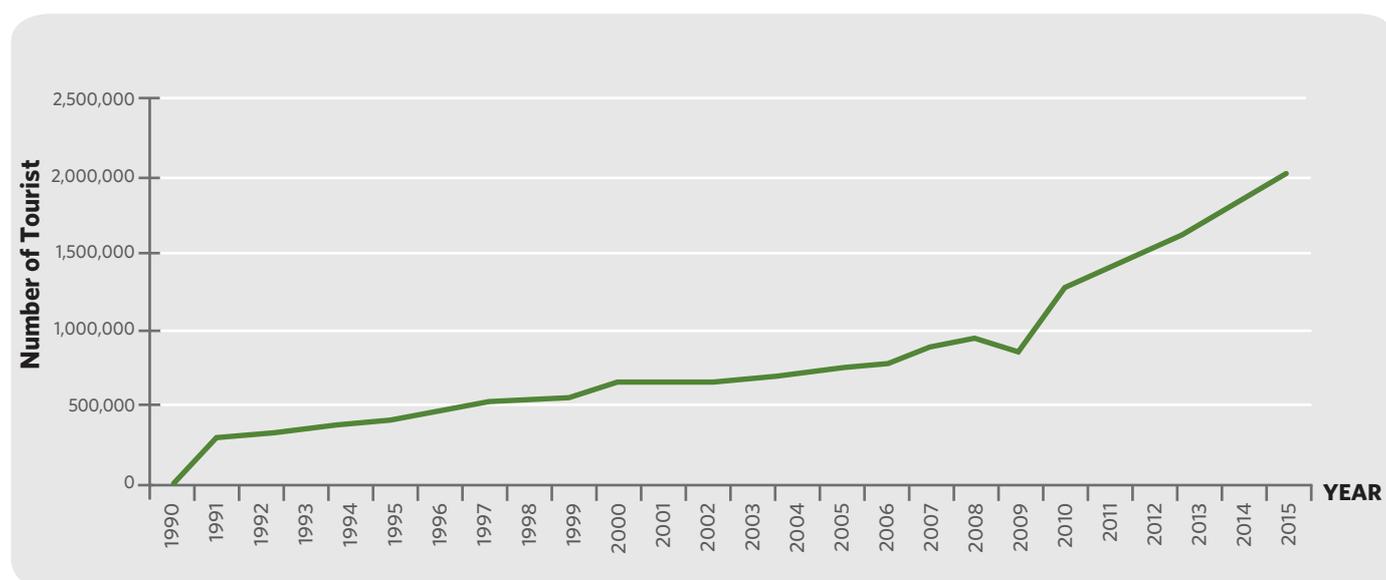
Mauritius needs to increase the quality of the tourism product, which will also entail increasing demand in terms of infrastructure, services and facilities for tourists, coastal land for hotel development, water, sanitation, energy and waste disposal, amongst others.

◎ 11.1.1 Increasing Demand for Coastal Land

The tourism sector is characterised by the development of large, high quality hotels, which have been sited almost exclusively in the coastal zone of Mauritius. Increasingly, over the last 30 years, the coastal zone has experienced very rapid development and growing ecological pressure. In 2000, it was estimated that out of the 323 km of coastline around 13% was occupied by 71 hotels and public beaches occupied around 9%. However, in 2010, there were 112 hotels in operation. Table 11.1 shows the main tourism indicators from 1990 to 2010.

As a small island, there is a scarcity of beach frontage sites for hotel development. It is estimated that there are no more than some 20-30 future coastal hotel sites that can be made available. According to the Mauritius Sector Strategy Plan

Figure 11.1: Tourist arrivals (1990 - 2009) and projected two million till 2015



Source: CSO – Digest of International Travel and Tourism, 2009

¹⁵³ Source: Budget Speech 2006 - 2007

¹⁵⁴ A growth rate of 10% means an increase in market share as the world average growth rate was anticipated at only 4.1% a growth rate likely to be reduced in the light of the international financial crisis and its aftermath.

on Tourism (2009-2015), some 5,000 rooms are expected to be constructed over the next ten years. On the basis of the current tourism pattern, this suggests that an additional 225,000 tourists can be accommodated and will require construction of some 30 hotels assuming an average size of 250 rooms per hotel and an average stay of 10 days. The main challenge faced by the Mauritian tourist industry is to avoid over-built and inappropriate construction on the coastal margin.

The increase in the number of hotels, Integrated Resort Scheme (IRS) / Real Estate Scheme (RES) and bungalows along the coast have also led to land clearing and loss of biodiversity, including loss of mangroves and wetlands. In coastal villages like Flic en Flac and Grand Baie, wetlands have been backfilled to provide additional land for construction of hotels and bungalows. Extensive coastal development is therefore degrading the coastal zone and weakening its protective function. The pressure on the coastal zone is set to increase with development of new hotel/villas. As at end of May 2010, there were 35 hotel projects that had already been approved by the Ministry of Tourism and Leisure. In addition to that, 14 IRS projects and 42 RES projects are also in pipeline (Board of Investment).

11.1.2 Rising Demand for Water

Tourism growth will result in increased water demand, which may pose a challenge to the water sector in terms of the additional capacity required, given the current water scarcity problem. The daily throughput of treated water in the distribution network presently averages 540,000 m³ per day. The demand for water per tourist/per hotel/room/day averages 1 m³. With the target of 2 million tourists by 2015, assuming the actual number of tourists is at around 55,000 at a peak period and the resident population of 1.2 million, on this basis an additional volume of 25,000 m³ per day would be required. Furthermore, given decreasing rainfall, hotels are now resorting to desalination¹⁵⁵ and rainwater harvesting to meet water needs.

¹⁵⁵ Four hotels have so far installed desalination plants.

Table 11.1: Main tourism indicators (1990 - 2010)

YEAR	TOURISTS ARRIVALS	No. OF HOTELS	No. OF ROOMS
1990	291,550	75	4,603
1999	578,085	92	8,255
2000	656,453	95	8,657
2001	660,318	95	9,024
2002	681,648	95	9,623
2003	702,018	97	9,647
2004	718,861	103	10,640
2005	761,063	99	10,497
2006	788,276	98	10,666
2007	906,971	97	10,857
2008	930,456	102	11,488
2009	871,356	102	11,456
2010	934,824	112	12,075

Source: CSO - Digest of International Travel and Tourism, 2009 & Ministry of Tourism and Leisure

11.1.3 Energy Supply

The Central Electricity Board (CEB) projects that the overall demand for electricity will be around 490 MW by 2015, of which 43 MW¹⁵⁶ will be required for the tourism sector. However, the CEB recognises that accommodating 2 million tourists will have an additional spill over effect on the other sectors and sub-sectors and accordingly may influence the national electricity demand.

11.1.4 Disposal of Wastewater

Results of analyses show that, wastewater treatment plants¹⁵⁷ in large hotels have been properly designed and are well operated and maintained. Physicochemical parameters are within the prescribed norms for irrigation and are not impacting negatively on the environment. However, other small hotels, bungalows and commercial premises linked to the tourism industry are not connected to the national sewerage network and their impacts on the environment have not been studied.

11.1.5 Beach Erosion

Sea level rise and extreme weather events like cyclones and storm surges, are aggravating beach erosion and are detrimental to tourism-related infrastructure. Man-made structures¹⁵⁸ (e.g. sea walls, groins, gabions), which were initially constructed to minimise erosion, also have downstream effects that change beach dynamics and trigger more continuous erosive effects. The natural long-shore and offshore sand transport linked to tidal currents is often interrupted by coastal structures. These structures act as a barrier to sand transport in the lagoon and on the beach, causing an accretion on one side and depletion on the other side of the structure.

11.1.6 Deterioration of Coral Reefs and Lagoon Ecosystem

Land clearing, reclamation and construction activities related to urbanisation as well as marine pollution in the coastal zone have caused an increase in sedimentation within the lagoon, leading to degradation of the fringing coral reefs and the marine ecosystems. Furthermore,

tourism activities such as diving, snorkelling, reef walking, sport fishing, undersea walk, dolphin watching and water sports also impact on the lagoonal ecosystem. The widening of natural passes or the blasting of fringing reefs to create new passes for dive boats and pleasure crafts has changed the wave energy in specific locations, thus initiating long-term changes in beach dynamics.

11.1.7 The Challenges of Enforcement

As per the Environment Protection Act, a number of tourism-related activities¹⁵⁹ require Environmental Impact Assessment (EIA) license. It has been observed that even though hotel developers comply with prescribed EIA conditions, some tend to deviate from their scope of work, which affect beach, lagoon and ecosystem dynamics through:

- Illegal constructions on the beach with prescribed setback distances not being respected
- Construction of artificial islets (headlands) and beaches, breakwaters, etc.
- Breaking of coral reefs for the creation of passes for leisure boats
- Removal of rocks from the sea
- Backfilling of the sea and wetlands
- Operating without EIA licence for example in cases of jetty renovation among others



Illegal construction on beach and in the lagoon

¹⁵⁶ Assumption: The peak power and energy relationship in the hotel sector is assumed to be similar to the national peak power and energy relationship. The demand for electricity in the hotel sector has been used as proxy to prepare the forecast demand for electricity in the tourism sector.

¹⁵⁷ Hotels with more than 75 rooms are required to have wastewater treatment plants.

¹⁵⁸ Numerous groins and sea walls have been privately built in front of beachfront hotels and private villas to protect the beaches from erosion. Seawalls tend to actually increase erosion due to increased scouring at the base and groins cause sediment to be deposited on one side and eroded on the other.

¹⁵⁹ Construction of bathing areas, breakwaters, groins, jetties, revêtements, seawalls, marinas, golf courses, hotels or Integrated Resort Schemes as well as activities such as modification of existing coastline, lagoon dredging, land clearing and development.

● 11.2 PROGRESS

◎ 11.2.1 Institutional and Legal Setup

A number of bodies including the Ministry of Tourism and Leisure, AHRIM (Association des Hôteliers et Restaurateurs de l'Île Maurice), Ministry of Environment and Sustainable Development, Board of Investment, Tourism Authority, Beach Authority and Local Authorities are responsible for policy formulation and management of the tourism sector.

○ Tourism Fund

A Tourism Fund was established under the Ministry of Tourism and Leisure to improve tourism products. The Fund is empowered to finance tourism-related projects, tourist sites and attractions. Finances of the Fund are used for the:

- Development and maintenance of tourism-related projects, including but not limited to ecotourism and cultural tourism.
- Protection and rehabilitation of scenic landscapes, lagoon, rivers and islets.
- Cleaning and maintaining of the environment in any area of importance to the tourism industry.

○ Environmental Impact Assessment

The Ministry of Environment and Sustainable Development regulates many undertakings associated with tourism development through the Environmental Impact Assessment (EIA) licensing mechanism for the following: construction of bathing areas, breakwaters, groins, jetties, revêtements, seawalls, marinas, golf courses, hotels or Integrated Resort Schemes as well as activities such as modification of existing coastline, lagoon dredging, land clearing and development. The EIA encourages promoters to take into consideration environmental issues at the stage of conception and planning and provides for mitigating measures. Conformity to the coastal guidelines of the Planning Policy Guidance is also ensured. Non-compliance to an EIA licence condition amounts to an offence punishable by fines and imprisonment under the Environment Protection Act 2002, as amended in 2008.

Promoters of new hotel projects are encouraged to use renewable energy and energy-saving devices and adopt eco-friendly practices such as recycling of wastes, composting of organic wastes, recycling of treated wastewater and rainwater harvesting.

○ Tourism Authority Act (2006)

The Tourism Authority Act (2006) has been promulgated to promote sustainable development of the tourism industry. It fosters and encourages the conduct of activities in the tourism industry in a responsible manner.

◎ 11.2.2 Policies and Strategies

○ Tourism Sector Strategy Plan 2009-2015

To address international and country-specific challenges, a Tourism Sector Strategy Plan 2009-2015 was formulated to achieve sustainable tourism development and to offer a high level of tourism product. The strategy recommended among others, the creation of a High Level National Tourism Council comprising high level decision makers with the authority to drive through necessary change. A 50-point action plan was also put forward for the National Tourism Council to pursue with all relevant stakeholders.

○ Hotel Development Strategy

The development of the hotel sector is now being governed by the Hotel Development Strategy, which is being enforced by the Ministry of Tourism and Leisure. Emphasis is more than ever being laid on investment, quality of development, maintaining the tropical cachet, adherence to the Planning Policy Guidance, use of local materials, type of development, preservation of the environment, architectural design, eco-friendly and energy saving practices, preservation of natural integrity, safety and security and community inclusion.

○ Planning Policy Guidance

Planning Policy Guidance has been developed on various aspects of development design. It includes design guidance on a range of key land uses, including: hotel, ecotourism, golf and marina development. Design factors include building height, plot coverage and minimum room size and promoters are urged to minimise the harmful visual effects by combining judicious land use principles with environment friendly development. Provision is also made for respecting the appropriate setback distances from the high watermark for beach protection and sustainable management.

○ Long Term Energy Strategy 2009 - 2025

The Long Term Energy Strategy 2009-2025 has set a well defined plan for the tourism sector and outlines the following actions for ensuring sustainable energy use in the sector as shown in Box 11.1.

BOX 11.1 : ENERGY STRATEGY FOR THE HOTEL SECTOR

- ▶ Retrofitting of existing hotel with energy efficient technologies
- ▶ Use of solar water systems in hotels
- ▶ Use of low-energy lighting/appliances/air-conditioning and other devices throughout the hotel industry
- ▶ Introduction of low-energy airport transfer of passengers policies
- ▶ Provision of facilities to allow tourists offset the carbon impact of their flights by investing in sustainable energy schemes in Mauritius

○ 11.2.3 Projects and Programmes for Sustainable Tourism

Sustainable tourism now forms an integral part of the national strategies, policies and action plans of concerned stakeholders.

○ Energy Management in Small and Medium Hotels and Restaurants and Green Lending Scheme

AHRIM and Enterprise Mauritius have been assisting small and medium hotels and restaurants in the following projects:

- Producing green energy for own and/or sale on the grid.
- Projects to reduce energy consumption.
- Projects that enable protection of natural resource and their sustainable use.
- Consultancy services for a complete energy diagnosis (premises and infrastructure setup).

○ Management of Tourism Activities

Tourism activities have contributed to the degradation of coral reefs through sea-based activities. However, the impacts have not been left unattended. As at 2010, the following developments have taken place for the protection of the lagoon and its ecosystems:

- 60 Permanent Mooring Buoys have been placed at dive sites to avoid damages to coral reefs through anchoring of boats and 70 Moorings have been installed in the region of Flat Island, Palisade Bay, Trou D'eau Douce and Mon Choisy.
- Speed limit zones have been declared at Trou D'eau Douce, Le Morne, Flic en Flac and Bel Ombre.

○ Tourism Environment Charter

In its quest to promote quality tourism, AHRIM launched a Tourism Environment Charter in 2002. The charter is a statement of commitment to environmental protection and sustainable development. It is a voluntary corporate responsibility to achieve sound environmental practices.

BOX 11.2: OBJECTIVES OF THE TOURISM ENVIRONMENT CHARTER

- ▶ To make the protection of the environment an integral part of the day-to-day management of hotels and the other operations of the tourism industry.
- ▶ To show the commitment of hoteliers and the other stakeholders of the tourism industry to bring about sustainable tourism development.
- ▶ To create better awareness among the population of the actions initiated in the tourism industry to minimise the effects on the environment caused by the operations of hotels and the other tourism related activities.
- ▶ To encourage hotels and other stakeholders in the tourism sector to work towards attaining the appropriate environmental certification standards.

● 11.3 PROSPECTS

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Target of 2 million tourists by 2015	Develop an ecotourism strategy	Mauritius acquires a “Green Destination” Status by 2020
Pressure on coastal and marine ecosystems	Determine the carrying capacity of the country for setting future targets for tourism industry	
Pressure on basic resources such as land, energy and water	Build capacity on green certification, environmental sustainability and reporting	Conservation, rehabilitation and enhancement of the natural environment
Lack of strict compliance to EIA licence and planning guidelines	Adopt eco-friendly practices, ecolabelling schemes and carbon offset programmes in the tourism sector	
	Monitor the cumulative impacts of tourism development	Zero carbon footprint holidays by 2030
	Strict enforcement of EIA licence and planning guidelines	

11.3.1 Policy Options for the Future

National tourism potential is closely linked to preserving natural resources in a sustainable condition. A best case scenario would be to ensure that tourism also serves to enhance the quality of the environment, rather than leading to its degradation. It is imperative to monitor the impacts of tourism and determine the carrying capacity of the island in order to achieve sustainable development.

Hotel Development and Planning

The Planning Policy Guidance for Coastal Development, including setback, height and plot ratio regulations need to be strictly adhered to. The low-density and low-rise hotel development policy should be maintained and negative visual impacts avoided. Architectural design should reflect distinctive Mauritian characteristics. These policy guidelines reflect the overall strategy of delivering a quality tourism product. Furthermore, strict enforcement of EIA licence and planning guidelines should be undertaken.

Protection of the Coastal Zone

Protection of the coastal resources that make Mauritius appealing needs to be a high priority within Government policy development and planning. Though there are some conservation efforts in place in the form of the marine parks and coral reef protection, management needs an island-wide approach, whereby all lagoon habitats are protected and their ecosystem functions sustained. The efforts are more relevant now because tourism is set to become an even more important part of the Mauritian economy with the target of two million tourists by 2015. To attain this number, a minimum annual rate of at least 10% will have to be achieved (Mauritius Sector Strategy Plan on Tourism 2009 - 2015). Therefore, protection of marine resources is probably the most important area for long-term sustainability.

Capacity Building

There is a need to establish Environment Management Systems, audits and verification in hotels and IRS. Industry operators should therefore be trained on green certification, environmental sustainability and reporting for the adoption of eco-labelling schemes.

Reducing Carbon Footprint

The target of welcoming 2 million tourists calls for a more than two-fold increase in the number of flights daily. In the long-term, the strategic objective will be to offer zero-carbon-footprint holidays, thereby mitigating the risk of losing market share to other countries for environmental reasons. The tourism industry should also be encouraged to adopt Carbon-offset programmes by paying for carbon emissions through investments in forest restoration.

Energy Efficiency in Hotels

Due consideration needs to be given to eco-friendly and energy-saving practices by hotel promoters. In the design of new hotel projects, provision should be made for the adoption of energy saving devices, renewable energy supply and eco-friendly practices.

Regulation on Dolphin and Whale Watching

In order to achieve a balance between sustainable use of wildlife in tourism, conservation of species and the ecological system, the regulations on dolphin and whale watching need to be finalised to regulate the activity.

Ecotourism

There is a need to develop an ecotourism strategy to promote inland tourism and ease pressure on the coastal zone.

Chapter Summary

CHALLENGES

- ▶ To meet the target of 2 million tourists by 2015, pressure on the coastal zone will increase with development of new hotel/villas.
- ▶ Tourism growth will result in increased water and electricity demand.
- ▶ Most small hotels and bungalows are not connected to the national sewerage network and their impacts on the environment have not been studied.
- ▶ Sea level rise and extreme weather events are aggravating beach erosion and are detrimental to tourism-related infrastructure.
- ▶ Tourist activities impact on lagoon ecosystems.
- ▶ It has been observed that some hotel developers do not comply with prescribed EIA conditions.

PROGRESS

- ▶ Tourism-related development is controlled through the EIA mechanism.
- ▶ To address international and country-specific challenges, a Tourism Sector Strategy Plan 2009-2015 was formulated to recommend the ways and means towards sustainable tourism development.
- ▶ The Hotel Development Strategy focuses on: quality of development, maintaining the tropical cachet, adherence to the Planning Policy Guidance (PPG), use of local materials, preservation of the environment, architectural design, eco-friendly and energy saving practices and preservation of natural integrity amongst others.
- ▶ Planning Policy Guidance includes design guidance for hotel, ecotourism, golf and marina developments to ensure environment-friendly and aesthetic development.
- ▶ The Long Term Energy Strategy 2009-2025 has set a well defined plan for the tourism sector, which aims at promoting energy efficient technology, using renewable energy and carbon offsetting.
- ▶ Sustainable tourism now forms an integral part of the national strategies, policies and action plans
- ▶ Actions have been taken to control recreational activities in the lagoon.
- ▶ To promote quality tourism, a Tourism Environment Charter has been published.

PROSPECTS

- ▶ Determine the carrying capacity of the country for setting future targets for the tourism industry.
- ▶ Monitor the cumulative impacts of tourism development
- ▶ Strengthen monitoring of coastal hotel projects to ensure strict compliance with EIA licence, PER approval and planning guidelines
- ▶ Develop an ecotourism strategy
- ▶ Protect coastal resources and regulate dolphin and whale watching activities
- ▶ Establish Environment Management Systems, audits and verification in hotels and IRS
- ▶ Adopt eco-friendly practices and eco-labelling schemes
- ▶ Encourage the tourism industry to adopt Carbon-offset programmes by paying for carbon emissions through investments in forest restoration.

References

- Budget Speech 2006 - 2007
- Central Statistics Office, 2009, "Digest of International Travel and Tourism"
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Chemicals and Hazardous Waste | Section 1: Chemicals

Chemicals have become an integral part of the agricultural, industrial and service sectors and of daily activity. Fertilizers and pesticides, for example, have increased agricultural productivity, while other chemicals have led to improvements in industrial development, domestic hygiene, disease control and environmental protection. If codes of practice¹⁶⁰ are followed, chemicals can be used widely, effectively, and safely.

Common usage of many chemicals however has given rise to adverse health and environmental impacts. Moreover, experience shows that where restrictions have been devised to reduce negative impacts, best practices have not always been followed. The increase in chemical usage over recent decades has contributed to many health and environmental risks for example through land and water pollution from industrial and agricultural chemicals, through air pollution from the use of fossil fuels and through the depletion of the atmospheric ozone layer from the use of Chlorofluorocarbons¹⁶¹.

This chapter is principally concerned with dangerous chemicals and extremely dangerous chemicals which are defined by the Dangerous Chemicals Control Act¹⁶² 2004. The Act defines a “chemical substance” as “any chemical element, product or preparation and its compounds in the natural or manufactured state”.

● 12.1 CHALLENGES

The possible drivers that have caused an increase in the use of chemicals are agricultural activities, industrial activities and the increasing number of school and other laboratories using dangerous chemicals. Table 12.1 shows an indicative list of some chemicals used in different sectors.

Table 12.1: An indicative list of chemicals used in different sectors

INDUSTRY	TYPES OF CHEMICAL USED
Textile	Dyes, Solvents, Softeners, Reducing agents, Detergents, Sizing Agents, Sodium Chloride, Glacial Acetic Acid, Oxalic Acid, Sodium Hypochlorite, Sodium Sulphide, Sodium Hydroxide, Hydrogen Peroxide, Sodium Hydro Sulphite, Dichloromethane, Tetrachloroethylene
Paint	Solvents, Titanium Dioxide, Talc, Thinner, Lacquer, Zinc Oxide, Formic Acid, Ammonia, Boric Acid, Pigments, Resins, Polymers, Thickeners, Dibutyl Phthalate, Silicon oils
Metal	Zinc, Cyanides, Sodium Hydroxide, Degreasing Agents, Cutting Oils, Inhibitors, Zinc Chloride, Deoxidant, Hydrochloric Acid, Ammonium Chloride
Manufacture of Detergent	Sodium Hydroxide, Perfumes/fragrances, Softeners, Javel Water, Sodium Hypochlorite, Acetic Acid, Hydrochloric Acid, Sodium Carbonate, LABSA (Linear Alkyl Benzene Sulphonic Acid, Surfactants, Dispersants, Biocides, Glycerine, Citric Acid)

¹⁶⁰ Safety and health in the use of chemicals at work, International Labour Organisation

¹⁶¹ CFCs are used in aerosol spray cans, refrigeration gases, solvent cleaners and blowing foam plastics used in food packaging

¹⁶² The Act can be accessed at <http://muelex.gov.mu>. ‘Dangerous chemicals’ are specified in the First Schedule of the Act, while ‘Extremely dangerous chemicals’ are specified in the Second Schedule

Table 12.1: An indicative list of chemicals used in different sectors

INDUSTRY	TYPES OF CHEMICAL USED
Sugar	Sulphur, Calcium Carbonate, Sodium Hydroxide, Flocculants
Hotel	Pesticides, Detergents, Sodium Hydroxide, Sodium Hypochlorite, Butane, Cleaning Agents
Manufacture of gas	Carbon Dioxide, Acetylene, Dry Ice (Solid Carbon Dioxide), Soda Ash, Nitrogen, Calcium Carbide, Nitrous Oxide, Caustic Soda, Acetone, Mono Ethano Amine (MEA), Potassium Permanganate, Hydrochloric Acid, Copper Carbonate, Argon, Helium
Food industry	Detergents, Sodium Hydroxide, Citric Acid
Educational sector	Sulphuric acid, Hydrochloric Acid, Sodium Hydroxide, Silver Nitrate, Sulphur Dioxide, Aluminium Nitrate, Ammonium Nitrate, Ammonium Chromate, Barium Hydroxide, Bromine, Calcium Oxide, Cobalt, Cupric Chloride, Copper Sulphate, Ferric Chloride, Formaldehyde, Hydrogen Disulphide, Iodine, Naphthalene, Oxalic Acid, Potassium Dichromate, Potassium Permanganate, Sodium Nitrate, Toluene

© 12.1.1 Absence of a Chemical Profile

Import of chemicals is subject to permits¹⁶³ as a means of controlling their use and reducing risks to people and the environment. Table 12.2 shows the number of permits issued for the import of chemicals in 2008 and 2009, but these give no indication on the volume of and risks associated with these chemicals. The number of permits for agricultural chemicals is by far greater than for industrial and consumer chemicals. The use of chemical fertilizers and pesticides from 1998 to 2009 is shown in Figure 12.1.

Figure 12.2 shows that the imports in 2009 of insecticides, herbicides and rodenticides were higher than the levels in 2005, with some annual variation, but the imports of fungicides decreased over the same period. These groups of chemicals are either dangerous or extremely dangerous chemicals (depending on specific products) as per the Dangerous Chemicals Control Act 2004.

Table 12.2: Import permits issued for chemicals for 2008 and 2009.

YEAR	IMPORT PERMIT ¹⁶⁴ FOR AGRICULTURAL CHEMICALS	IMPORT PERMIT FOR CONSUMER CHEMICALS ¹⁶⁵	IMPORT PERMIT FOR INDUSTRIAL CHEMICALS
2008	691	356	332
2009	637	407	304

¹⁶³ Permits are issued after ensuring that the storage sites for the chemicals are adequate to prevent environmental contamination and health hazards. The proposed storage sites are inspected by a multi-disciplinary committee, which makes recommendations to the Dangerous Chemicals Control Board (See Box 12.5) on the adequacy of the site.

¹⁶⁴ A Permit is issued under section 11 of the Dangerous Chemicals Control Act 2004 (DCCA) to import or export pesticides and extremely dangerous chemicals. A licence to trade in dangerous chemicals is issued under Section 10 of the DCCA. About 200 licences to trade in dangerous chemicals have been issued as at present.

¹⁶⁵ Consumer chemicals are those formulated for household use on the adequacy of the site.

Figure 12.1: Imports of fertilizers and pesticides (1998 - 2009)

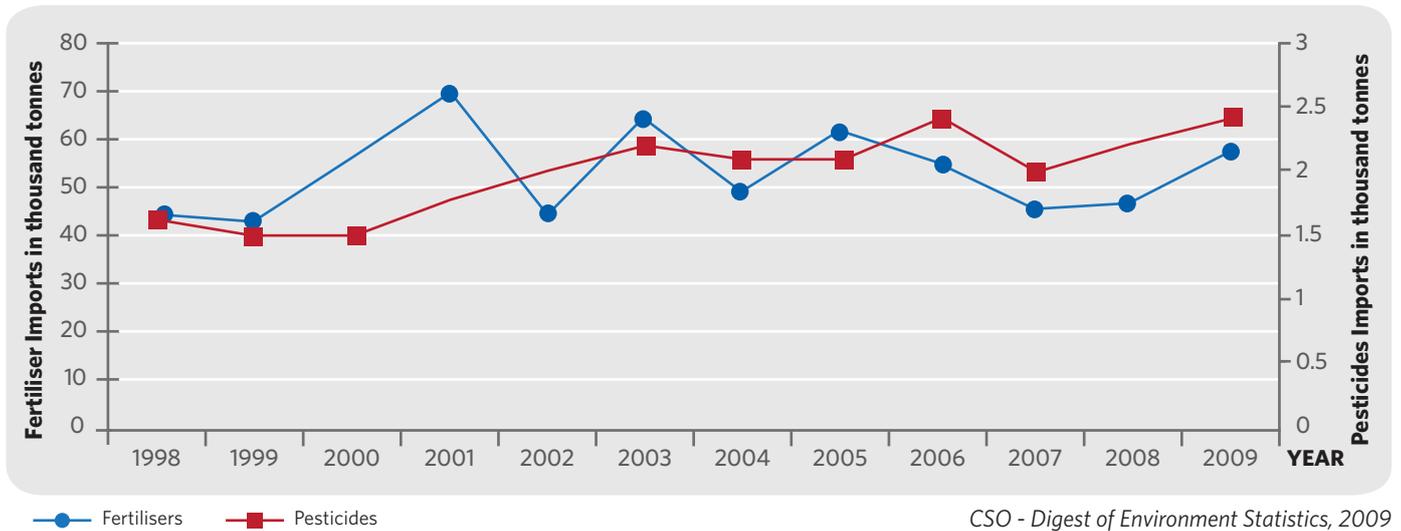
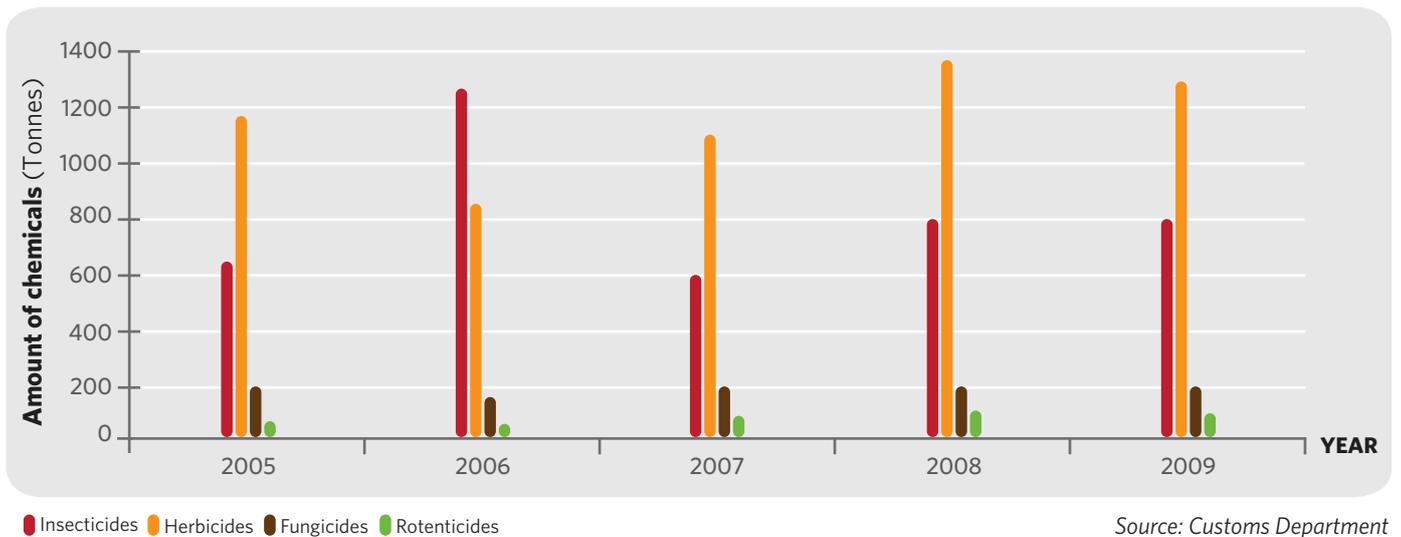


Figure 12.2: Import of selected chemicals (2005 - 2009)



Detailed data on types and amount of chemicals imported over the years is lacking as there is no systematic record of permits and licences issued. There is a need to establish a system for the proper recording and a database of chemicals used in different sectors and the traceability of these chemicals.

© 12.1.2 Stockpiles of Chemicals

○ Dichloro-Diphenyl Trichloroethane (DDT)

A stock of about 100 tonnes of DDT, which dates back to the early 1980s is being stored at Powder Mill, Pamplemousses. DDT was previously also stored at Fort George and Mahebourg. Analyses have confirmed that these sites are contaminated with DDT.

DDT is used solely for malaria vector control that is for spraying of building in cases of indigenous and introduced malaria. The port and air port areas are sprayed twice yearly and the amount used is about 800 - 1,000 kg, of which 260 - 400 kg are used in the port area. In the latter case, the runoffs of DDT into the sea may constitute a potential threat to the marine environment. However, no study has been undertaken to evaluate the actual effects of DDT.

Out of the 100 tonnes of DDT stockpile, 92 tonnes are obsolete. The challenge is now to ensure that the obsolete DDT is disposed of in an environmentally sound manner. The remaining viable stock of DDT¹⁶⁶ represents 8 years supply at current rates of use.

BOX 12.1: PERSISTENT ORGANIC POLLUTANTS (POPs)

Persistent Organic Pollutants (POPs) are chemicals that possess a particular combination of physical and chemical properties such that they remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel. POPs have been recognized as causing adverse effects on humans and the ecosystem and these can be placed in 3 categories:

- ▶ **Pesticides:** aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, chlordecone, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, lindane, pentachlorobenzene.
- ▶ **Industrial chemicals:** hexachlorobenzene, polychlorinated biphenyls (PCBs), hexabromobiphenyl, hexabromodiphenyl ether and heptabromodiphenyl ether, pentachlorobenzene, perfluorooctane sulphonic acid, its salts and perfluorooctane sulphonyl fluoride, tetrabromodiphenyl ether and pentabromodiphenyl ether.
- ▶ **By-products:** hexachlorobenzene, dioxins, furans, PCBs, alpha hexachlorocyclohexane, beta hexachlorocyclohexane and pentachlorobenzene

The Dangerous Chemicals Control Act 2004 is a comprehensive legal framework for the management of dangerous chemicals and includes most of the POPs.

○ Management of other Unused or Obsolete Chemicals

Apart from DDT, a national inventory undertaken from March to July 2004, showed the presence of small quantities of three other POPs pesticides (Aldrin, Dieldrin and Mirex), which have been properly packed and soundly kept in their respective stores, until their safe disposal is finalised. The inventory also revealed the presence of eight non-POPs banned pesticides amounting to 586 kg. These are: Azinphos-Methyl, Dimethoate, Endosulphan, Methamidophos, Methomyl, Monocrotophos, Omethoate and Paraquat (Ministry of Environment and NDU, 2005).

There have been specific cases (Box 12.2) whereby, factories under receivership or upon closure were left with stockpiles of unused chemicals, which became difficult to manage for various reasons, namely:

- The factory was the sole user of the particular product.
- Potential users of the chemicals were not easily identified.
- Procedures for export of chemicals for reuse and/or disposal is cumbersome.

BOX 12.2: MANAGEMENT OF UNUSED ISOPROPYL CHLOROFORMATE IN 2006

- ▶ A company under receivership was found to possess two tonnes of unused Isopropyl Chloroformate, a dangerous chemical of explosive nature, which was stacked on its premises. Possibilities were being explored to export the chemical either for re-use or treatment. However, bids obtained for treatment of the chemical were very costly. After negotiation, the supplier agreed to take back the stock for reuse and necessary arrangements were made for shipping the chemical in compliance with the International Maritime Dangerous Goods Code for the smooth transboundary movement of the chemical.

¹⁶⁶ Mauritius registered an exemption with the Stockholm Convention Secretariat for the continued use of DDT in 2004. This exemption, which is annually renewable, is valid for an annual amount of 1,500 kg until other alternatives are found.

© 12.1.3 Impacts of Chemical Use on Human Health

A survey undertaken by the Ministry of Health and Quality of Life from January to May 2009 indicated that on average 43% of cases related to poisoning are caused by chemicals and pesticides. Despite continuous sensitisation of farmers on the safe use of pesticides and other agricultural chemicals, there are many reported cases where the misuse of chemicals was associated with health problems. Box 12.3 shows some of these selected cases.

BOX 12.3: HEALTH IMPACTS OF CHEMICALS

CASE	IMPACTS	RESPONSE
▶ Intoxication by pesticide Methamidophos	In April and June 2001, 30 school children were intoxicated by the extremely dangerous pesticide Methamidophos (commonly known as "Taron").	Prohibition Notices were served to planters and land owners to cease the application of pesticides. Planters were also sensitised on the proper handling, selection and application of pesticides.
▶ Intoxication by agricultural chemicals	In September 2001, a teacher and seven school children were intoxicated with the extremely dangerous agricultural chemicals "Velpar" (Hexazinone) and "Atrazine" (6-chloro-N-ethyl-N'-isopropyl-1, 3, 5-triazine-2, 4-diamine).	The pesticide Methamidophos has been banned since 2004.
▶ Intoxication by alcohol / vinasse odour	In October 2003 and March 2004, 54 students were affected after their school premises were invaded by a strong alcohol / vinasse odour from an alcohol production unit. Some were admitted to the hospital for observation, while others suffered from eyes and throat irritation and nausea due to the discomforting odour.	During this incident, notices were served on the company to ensure compliance to the EIA conditions and the company was requested to undertake an audit of its factory.
▶ Intoxication from acetylene gas from a factory	In September 2004, 24 primary school children and four teachers suffered from headache, vomiting, eyes and throat irritation. The source of these health problems were suspected to be acetylene gas from a factory involved in production of gases for laboratories and hospitals.	The company was requested to install a gas detection and an alarm system.
▶ Chlorine spill	In September 2009, inhabitants of a village in the South of Mauritius were thought to be affected by a chlorine spill, which was associated with a closed factory involved in manufacturing of Javel water (sodium hypochlorite). The company had several cylinders containing residual chlorine on its premises. Chlorine is corrosive and causes irritation of the eyes, skin and lungs.	Following an Enforcement Notice, the company took necessary measures to stop the leakage of chlorine in the environment and neutralised it with caustic soda.

© 12.1.4 Impacts of DDT on the Environment

Investigations undertaken in 2005 and 2009 near DDT stores at Pamplémousses, Fort George and Mahebourg, showed varying levels of DDT in soil ranging from 0.19 to 762 parts per million (Ministry of Environment and NDU, 2005). The soils at Mahebourg and Fort George are in fact heavily contaminated and need remediation. Moreover, dust samples within the ex-storage rooms at Fort George were also found to be heavily contaminated with DDT and require proper decontamination.

© 12.1.5 Pesticide Residue Analyses

Analyses of pesticide residues in fruits and vegetables are carried out routinely. Results show that 70% - 90% of the tested samples had no detectable levels of pesticide residues as shown in Table 12.3.



DDT storage at Pamplémousses

Table 12.3: Analyses of pesticide residues in fruits and vegetables

DESCRIPTION	YEAR									
	2000	2001	2002	2003	2004	2005	2006 ⁺	2007	2008	2009
No. of Samples of vegetables & fruits analysed	297	396	259	234	466	228	15	146	272	107
% Samples with No Detectable Level (NDL) of pesticide residues	85.8	89.9	90.3	85	85.8	81.6	100	80.1	76.1	70.1
% Samples with pesticide residues below Codex MRL ¹⁶⁷	12.8	8.6	8.1	12	13.3	17.1	0	19.2	20.2	24.3
% Samples with pesticide residues exceeding Codex MRL	1.4	1.5	1.6	3	0.9	1.3	0	0.7	3.7	5.6

⁺ In 2006, there was a breakdown of equipment. In 2007, new equipment were purchased and installed at the Food Technology Laboratory.

¹⁶⁷ Codex Alimentarius (Food and Agricultural Organisation / World Health Organisation) MRL: Codex Maximum Residue Limits - When Codex MRL is being exceeded it indicates that the farmer has not followed Good Agricultural Practices in the utilisation of the pesticides i.e. the recommended rate of application, the frequency of application or the pre-harvest interval were not observed.

● 12.2 PROGRESS

◎ 12.2.1 Institutional and Legislative Framework

○ Dangerous Chemicals Control Act 2004

The promulgation of the Dangerous Chemicals Control Act (DCCA) in 2004 has been an important step in rationalizing chemical management schemes in Mauritius. It repealed the Pesticide Control Act of 1972, which was very limited in scope and was not adequate for chemical control.

The scope of the DCCA is much broader and its objective is to prevent damage to health and environment caused by dangerous chemicals (industrial and agricultural). The Act also provides for better protection of workers and the public. New regulations under the DCCA, the Dangerous Chemicals Control (Amendment) Regulations 2010, which is still at draft stage, will prohibit the import of Ozone Depleting Substances, some highly toxic pesticides and newly identified POPs.

The Act also makes provision for the Dangerous Chemicals Control Board, the main functions of which are to, among others, regulate the registration, import, storage, sale and export of chemicals as shown in Box 12.4.

BOX 12.4: FUNCTIONS OF THE DANGEROUS CHEMICALS CONTROL BOARD

The functions of the Board are to:

- ▶ Disseminate information relating to dangerous chemicals.
- ▶ Ensure coordination amongst the law enforcement agencies, Government departments and other institutions for the effective control of dangerous chemicals.
- ▶ Develop policies and administrative measures on matters relating to dangerous chemicals.
- ▶ Consider applications for grant of licences, permits and authorisation under the Act.
- ▶ Register and classify dangerous chemicals.

The following laws are related to chemicals:

- Inflammable Liquids and Substances Act 1954
- Explosives Act 1959
- Chemical Fertilizers Control Act 1980
- Pharmacy Act 1983
- Merchant Shipping Act 1986
- Consumer Protection Act 1991
- Environment Protection Act 2002
- Chemical Weapons Convention Act 2003
- Dangerous Chemical Control Act 2004
- Occupational Safety and Health Act 2005
- Food Act - The Food Regulations 1999 specifies the pesticide residue limits

○ Occupational Safety and Health Act 2005

Under the Occupational Safety and Health Act 2005, every employer has the duty to ensure the safety and health of his employees. This includes the obligations to provide information, training, instruction and supervision for the safe use, handling, storage or transport of substances. Importers and suppliers of chemicals must provide technical information that will ensure the safe use of every chemical including proper labels and Material Safety Data Sheets¹⁶⁸.

Regular health surveillance is mandatory where exposure to a substance may lead to an occupational disease listed in the Act, an employee is exposed to any chemical listed in the Act and when advised by a medical practitioner. Every employer must keep health surveillance records for each employee and non-compliance is an offence. The Occupational Safety and Health Inspectorate of the Ministry of Labour, Industrial Relations and Employment enforces the Occupational Safety and Health Act 2005 through regular inspections at places of work.

¹⁶⁸ A Material Safety Data Sheet (MSDS) contains data regarding the properties of a particular substance. MSDS are widely used for cataloguing information on chemicals and include instructions for the safe use and potential hazards associated with these chemicals.

○ Chemicals System of Classification

Mauritius is one of the 65 countries having incorporated 'The Globally Harmonized System (GHS) of Classification and Labelling of Chemicals' within the Dangerous Chemicals Control Act¹⁶⁹. The latter ensures that information on physical hazards and toxicity from chemicals are available in order to enhance protection of human health and environment during the handling, transport and use of chemicals. It is an important and innovative tool that can be used as a basis for establishing comprehensive national chemical information systems.

Box 12.5: GLOBALLY HARMONISED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS)

- ▶ The GHS is a system of standardized graphic elements and phrases that communicate information about chemical hazards. The goals of this system are to facilitate international trade in chemicals and to avoid confusion that results from differences in national and regional systems using similar terms differently. The GHS applies to product labels, Material Safety Data Sheets and with other chemical hazard communication tools.

GHS PICTOGRAMS AND HAZARD CLASSES IN THE DCCA



OXIDIZERS



EXPLOSIVE



IRRITANT / HARMFUL



FLAMMABLE



HEALTH HAZARD



ENVIRONMENT HAZARD



DANGER / TOXIC



CORROSIVES



GAS UNDER PRESSURE

¹⁶⁹ The Dangerous Chemicals Control Act 2004 provides for the labelling rules for chemicals; the hazard symbol, precautionary pictograms and statements to be put on labels and hazard communication for comprehensive information on chemicals in the workplace. All these information are requested from an importer prior to issuing an import permit by the Dangerous Chemicals Control Board. Monitoring by authorised officers and approved enforcing agencies has shown that in general, there is compliance with the Act. Labelling requirements for consumer chemicals are under preparation.

© 12.2.2 Projects Under Implementation

Mauritius is party to several chemicals-related conventions and protocols as shown in Box 12.6.

Box 12.6: CHEMICALS-RELATED CONVENTIONS

- ▶ The Stockholm Convention is a global treaty to protect human health and the environment from Persistent Organic Pollutants (POPs).
- ▶ The objective of the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in international trade is to promote shared responsibility and cooperative effort among Parties for certain hazardous chemicals (banned or severely restricted industrial chemical and pesticides) in order to protect human health and the environment by facilitating information exchange about their characteristics. Under this convention, identified chemicals should not be exported unless prior consent has been provided by the Government of the importing country. Exporting countries will also be legally bound to inform importing countries about exports of chemicals banned or severely restricted in the exporting country.
- ▶ Vienna Convention on the protection of the ozone layer and Montreal Protocol on Substances that Deplete the Ozone layer.

Under these conventions, a number of projects are being implemented and are as follows:

○ Project on Persistent Organic Pollutants (POPs)

Mauritius prepared its National Implementation Plan for the management of POPs in 2005, which describes how the country will meet its obligations under the Stockholm Convention to manage and phase out POPs sources in an environmentally sound manner. A four year project was launched in 2008, to implement the first two priorities from the National Implementation Plan namely:

- Disposal of obsolete POPs chemicals¹⁷⁰ and decontamination of POPs-affected areas
- Development of alternative strategies for malaria vector management with reduced or no reliance on DDT

○ Phasing out of Ozone Depleting Substances (ODS)

Mauritius is a signatory to the Vienna Convention on the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer (1987). Under the Montreal protocol, projects were implemented to eliminate use of potent ozone depleting substances (CFCs) in the refrigeration and aerosol sectors. CFCs have been phased out in 2005, five years ahead of the provisions of the Montreal Protocol. With the phasing out of CFCs, it has become apparent that there has been a steady increase in the use of another ozone depleting chemical: HCFC-22 (Hydrochlorofluoro carbon) in the refrigeration and air conditioning servicing sectors. The recent adjustment of the Montreal Protocol for the early phase out of HCFC has meant that Mauritius must now address the issue¹⁷¹.

¹⁷⁰ These obsolete chemicals include: Dichloro-Diphenyl Trichloroethane (DDT), Polychlorinated Biphenyls (PCBs), Aldrin, Mirex and Dieldrin

¹⁷¹ More information in HCFC phase out is given in Chapter 2: Air (Section 2.2.8)

● 12.3 PROSPECTS

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
No chemical profile for Mauritius	Implement the SAICM Programme	<i>Systematic record of types and amounts of chemicals used</i>
No monitoring to assess impacts of chemicals on the environment	Establish the national chemical profile	<i>Adverse health and environmental impacts controlled</i>
Long term health effects of cumulative releases of chemicals not given due consideration	Conduct environmental traceability of chemicals	<i>Judicious use of chemicals</i>
Some chemicals-related conventions are not systematically implemented	Undertake occupational health risk assessments and medical surveillance	<i>Better policies in place for management of chemicals</i>
No strategy to minimise use of chemicals	Train personnel and reinforce staff	<i>Active implementation of chemical-related conventions</i>
	Organise awareness and sensitisation programmes for all stakeholders	
	Priority setting and action plan on sound management of chemicals	

© 12.3.1 Policy Options for the Future

A wide array of chemicals is being used in Mauritius, yet there is no chemical profile and no system for accounting the fate and impacts of these on humans and the environment. The promulgation of the Dangerous Chemicals Control Act and the setting up of the Dangerous Chemicals Control Board have been important achievements in chemicals management. However, management of obsolete chemicals still remains problematic due to lack of facilities for treatment and disposal. Therefore, much remains to be done to prevent adverse impacts of chemicals on ecosystems and human health.

In the Best Case Scenario for chemicals management, Government recognises the gaps in this sector and decides to speed up and support the implementation of the Strategic Approach to International Chemicals Management (SAICM)¹⁷² programme at national level. As such, Government:

- i. Develops a National Chemical Profile.
- ii. Carries out a Chemicals Management Capacity Assessment.
- iii. Undertakes a National Priority Setting on chemicals.
- iv. Assesses sources of and emissions related to mercury¹⁷³.

Complementary to the above, attention is also given to:

- Training of personnel and reinforcement of staff.
- Devising action plans on sound management of chemicals.
- Awareness and sensitisation programmes for all stakeholders, such as importers, end users and workers exposed to chemicals.
- Undertaking occupational health risk assessments and medical surveillance. Risk assessment serves as a tool to organise, structure and compile scientific information in order to help identify existing hazardous situations or problems, anticipate potential problems, establish priorities and provide a basis for regulatory controls and/or corrective actions.
- Environmental traceability of chemicals - Studies are undertaken to evaluate the effects of chemicals on air, water and soil and relate it to economic losses that may be incurred by contaminating these environmental media.

The successful implementation of SAICM sets the base for sound chemicals management in Mauritius.

¹⁷² SAICM is a policy framework to promote chemical safety around the world. It addresses the sound management of chemicals at all stages of their life cycle. SAICM was adopted in February 2006 at the International Conference on Chemicals Management to meet the growing concern of the harmful effects of chemicals on human health and the environment. It sets the stage for national and global reforms pertaining to the production and use of synthetic chemicals, including the possibilities to ban, phase-out or restrict production and use of chemicals of highest concern. SAICM also deals with the sound management of waste from consumer products containing chemical components such as polymers (plastics), additives, adhesives, dyes or toxic metals. Governments of developing countries and countries with economies in transition are eligible for support through the Quick Start Programme Trust Fund for project between \$50,000 and \$250,000, which are of a maximum duration of 24 months (<http://www.saicm.org>).

¹⁷³ Mercury is a chemical of global concern due to its long-range atmospheric transport, its persistence in the environment once anthropogenically introduced, its ability to bio-accumulate in ecosystems and its significant negative effects on human health and environment. It has been globally agreed that there is a need to enhance international action by elaborating a legally binding instrument on mercury, which could include both binding and voluntary approaches to reduce risks to human health and environment. The United Nations Environment Programme has constituted an Intergovernmental Negotiating Committee to prepare a global legally binding instrument on mercury by 2013 (<http://www.unep.org/hazardoussubstances/Mercury/>).

Chemicals and Hazardous Waste | Section 2: Hazardous Waste

The increasing use of complex chemicals in various sectors (as described in Section 1) results in the production of equally, if not more, complex hazardous waste¹⁷⁴. As in many places in the world, the management of hazardous waste has not been an easy field based on the wide range of characteristics and complexity displayed by the waste generated.

● 12.4 CHALLENGES

◎ 12.4.1 Lack of Data on Hazardous Waste

Updated information on the amount of hazardous waste generated is lacking. The latest available figures date back to 2003 and might be completely outdated. These are shown in Table 12.4.

Table 12.4: Types and quantities of hazardous waste generated in 2003

SECTOR	TYPE OF WASTE	WASTE AMOUNT (Tonnes/year)		
		MINIMUM	AVERAGE	MAXIMUM
Agriculture	Pesticides	70 (Obsolete)		
	Laboratory Waste	0.1	0.3	0.5
	Herbicides Packaging	0.5	1	1.5
Chemicals and Detergents	Sludge from Wastewater Treatment Plants	5	8	12
Port Activities	Oil sludge, lubricating oil and slops	1,000	2,000	5,000
Paint Industry	Sludge from Wastewater Treatment Plants	2	10	12
Electronic Industry	Electronic scrap, flux	0.1	0.2	0.3
Laboratories	Laboratory waste, Contaminated water	1	3	6
Pharmaceutical Industry	Contaminated packaging, Laboratory waste Cleaning Water	10	20	25
Dry Cleaning Industry	Waste from dry cleaning	7	12	15
Metal Surface Industry	Hydrochloric Acid (HCl) containing Iron Rinse water containing HCl and Iron	3,500	4,500	5,000
		(420 tonnes sludge)		
Chemicals	Import, distribution of raw base chemicals	15 (obsolete)		
		0.1	0.2	0.3
Leather Industry	Wastewater from tanning operation Chromium liquids	300	400	1,000
		(0.5 tonnes sludge)		
Textile Industry	Obsolete Dye Chemicals	0.5	1	3
Photographic Industry	Photo chemicals	100	120	150
Oil Industry	Lubrication oil (excluding ships)	2,000	2,900	4,800
Landfill	Asbestos waste	50	200	3,000
Hazardous waste included in household waste	Various	500	2,400	3,600
TOTAL		4,400	8,500	22,600

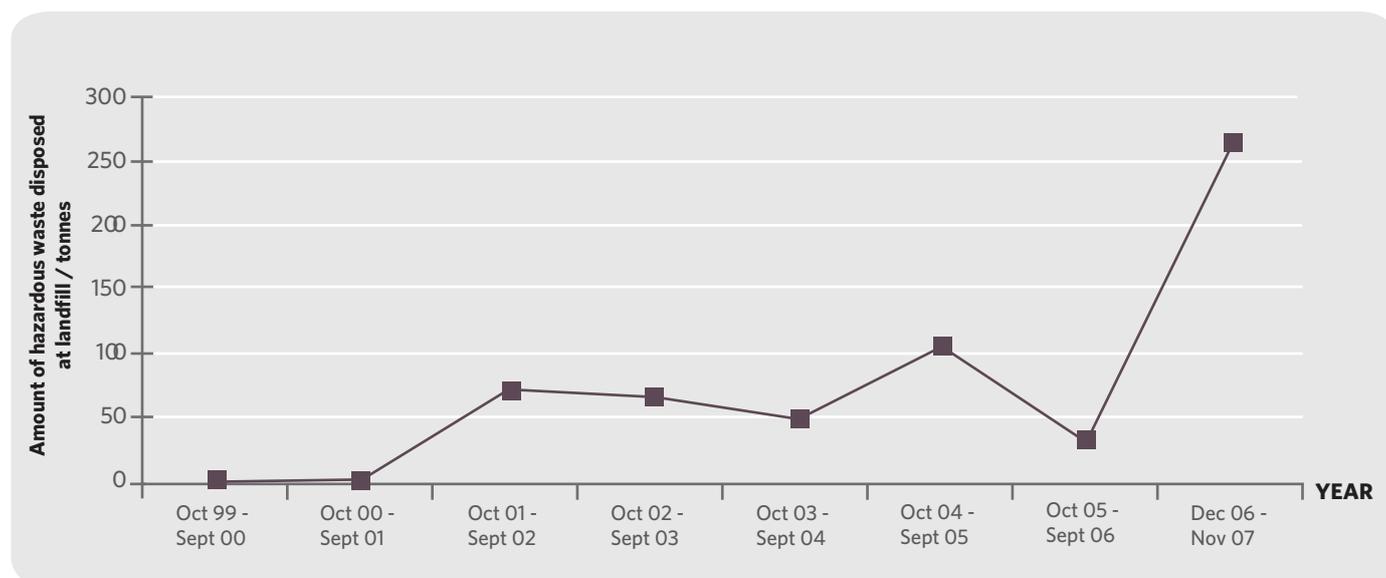
Source: *Environmental Solid Waste Management Project (Carl Bro Report), 2004*

¹⁷⁴ The Environment Protection (Standards for hazardous wastes) Regulations 2001 defines hazardous waste as:

- Those listed in the first schedule in respect of the corresponding waste stream (such as: batteries and accumulators, electronic industry, pharmaceuticals, soap/detergent manufacturing, paint industry, health care waste)
- Having as constituents substances specified in the second schedule (e.g. antimony, arsenic, cadmium, lead, mercury, radioactive materials, cyanides) and
- Displaying any of the hazardous properties specified in the third schedule (such as: carcinogenic, corrosive, eco-toxic, explosive, flammable, infectious).

The amount of hazardous waste disposed at the Mare Chicose landfill from 1999 shows a lot of variations, as shown in the Figure 12.3. However, these figures do not reflect the amount of hazardous waste generated on the island as all hazardous waste is not landfilled¹⁷⁵.

Figure 12.3: Amount of hazardous waste landfilled (1999 - 2007)



Source: Ministry of Local Government & Outer Islands

© 12.4.2 Management of Medical Waste

Medical waste is segregated from other waste in all health care facilities. Six hospitals¹⁷⁶ operate incinerators, which cater for medical waste generated from all Government health care facilities. Based on information gathered from previous surveys, it is estimated that about 1,200 tonnes of medical waste are incinerated annually resulting in the production of about 90 tonnes of incinerator ash. Ash from medical waste incinerators is known to be toxic¹⁷⁷ and is being disposed at Mare Chicose landfill. Most of the hospital incinerators are located between 15 to 100 m from residential areas giving rise to complaints from inhabitants against nuisances such as odour from the medical waste as well as noise and smoke emissions from incinerators.

The temperatures at which medical waste is incinerated are very often not known especially for old incinerators. Thus, the formation and release of dioxins¹⁷⁸ and furans cannot be assumed to be zero. Moreover, the incinerators are not equipped with pollution control equipment to check the atmospheric releases. The simultaneous breakdown of most of the hospital incinerators caused a major problem in health care waste management in 2010. The waste had to be transported and disposed at the Mare Chicose landfill. The management of health care waste requires immediate attention, as the present incinerators are old and inadequately equipped for efficient pollution control.

¹⁷⁵ When the Mare Chicose landfill was opened in 1997, open dumps were still in operation. These dumps were closed in phases until 2001 and all the waste were channelled to the landfill. This explains the low waste input in the hazardous waste cell from 1999 to 2001.

¹⁷⁶ Flacq, SSRN, Jeetoo, Victoria, Poudre d'Or and Brown Sequard hospitals

¹⁷⁷ Medical waste incinerator ash contains heavy metals which are harmful to the environment. They are classified as hazardous waste both by the national hazardous waste legislation and the EU Directive on hazardous waste (91/689/EEC).

¹⁷⁸ Medical waste typically contains a variety of plastic materials such as polyvinyl chloride (PVC). Combustion of PVC, especially at low temperatures, causes the release of substances like dioxins and furans (temperatures higher than 850°C may minimize their formation). Dioxins and furans form part of a group of chemicals known as Persistent Organic Pollutants (See Box 12.1).

◎ 12.4.3 E-Waste

E-waste¹⁷⁹ is a growing component of the solid waste stream around the world, as people are upgrading their computers, mobile phones, televisions more than ever before. E-waste, in general contains more than 1,000 different substances including both hazardous and non-hazardous ones. Mobile phones for example, contain toxic heavy metals and hazardous chemicals like brominated flame retardants¹⁸⁰. When released in the environment, they may contaminate soil and water resources. A study undertaken by the Ministry of Local Government and Outer Islands and the University of Technology (Mauritius) in 2009 has shown that e-waste represents about 0.4 % of the general solid waste that are disposed.

E-WASTE

- *It is estimated that about 6,500 tonnes of e-waste were generated in 2008, out of which about 1,600 tonnes were disposed in the landfill.*
- *It is projected that the amount of e-waste generated may reach up to 7,500 tonnes in 2011, that is an increase of 15 % over 3 years.*
- *The amount of e-waste produced per inhabitant in Mauritius was estimated to be 5.5 kg in 2008 (as compared to e-waste generated in EU which is about 14 – 15 kg per capita).*
- *This is projected to increase to 6.2 kg/capita in 2011.* (Source: <http://mrc.org> (Presentation on E-waste Characterisation))



Presently, there is no comprehensive policy for the management of e-waste. Apart from those which are disposed in the hazardous waste cell of the landfill, the remaining e-waste is either being stored by the waste generators or is disposed with municipal waste. The Ministry of Local Government and Outer Islands however recognises that disposal of e-waste at the landfill is not a recommended practice despite the necessary measures taken to prevent pollution such as encapsulation (covered with concrete). It is to be noted that e-waste recycling can only be feasible if there is adequate volume of such waste and if these have some economic value.

◎ 12.4.4 Liquid Hazardous Waste

Disposal of liquid hazardous waste is an issue of concern, as it is increasing in volume year by year and there is neither a strategy for its management nor disposal facilities. Where possible, low cost techniques such as: neutralisation of concentrated acids, are used to manage liquid hazardous waste. In other cases, the waste is stored under strict conditions to prevent health and environmental hazards. However, management of liquid hazardous waste requires special expertise and facilities, which is presently lacking in Mauritius.

◎ 12.4.5 Inadequate Enforcement of the Hazardous Waste Regulations

The Environment Protection (Standards for Hazardous Wastes) Regulations 2001 was promulgated to regulate amongst other matters the safe handling, pre-treatment, labelling, storage, transport and disposal of hazardous wastes, as well as the requirement to carry out an inventory of hazardous wastes. However, there is an important lack of capacity, in terms of expertise, human resources and infrastructural facilities to ensure a proper enforcement of this legislation.

¹⁷⁹ E-Waste or Waste Electrical and Electronic Equipment (WEEE) is the term used to describe old, end-of-life or discarded electrical appliances.

¹⁸⁰ Brominated flame retardants are a group of chemicals added to many products, including computers, TVs and household textiles, in order to reduce fire risk.

◎ 12.4.6 No Segregation of Hazardous Waste at Household Level

Hazardous waste generated at household level like expired drugs, compact fluorescent lamps and used batteries are all disposed together with other non-hazardous waste. Though these hazardous wastes are generated in small quantities (less than 1% of the total municipal solid waste) as compared to the non-hazardous components, they represent a potential risk of groundwater contamination when disposed at Mare Chicose landfill.

● 12.5 PROGRESS

◎ 12.5.1 Legislative Framework

○ Review of the Hazardous Waste Regulations

The Ministry of Local Government and Outer Islands is responsible for enforcing the Environment Protection (Standards for Hazardous Wastes) Regulations 2001 and implementation of the Basel Convention¹⁸¹ on the Control of Transboundary Movements of Hazardous Waste. Currently, the regulations are being amended in light of experience acquired and constraints encountered in the enforcement of these regulations. A model legislation on management of hazardous waste has been developed under the Convention and the new local regulations will be in line with it.

○ Industrial Waste Audit Regulations 2008

Another major initiative taken to keep track of pollutant release in the environment is the promulgation of the Environment Protection (Industrial Waste Audit) Regulations 2008. These regulations aim at keeping an account of the waste generated from an industrial activity and includes keeping record of the origin, composition, quantity and disposal routes of waste produced. There are about 800 industrial units which are classified as generators of hazardous waste. It is now being envisaged to create a database to manage all the data collected from industries.

¹⁸¹ The Basel Convention on the Control of Transboundary Movements of Hazardous Waste is the most comprehensive global environmental agreement on hazardous and other waste and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other waste (<http://www.basel.int/>). Mauritius is also party to the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa.

¹⁸² <http://missionverte.com/>

◎ 12.5.2 Projects Initiated

○ Hazardous Waste Cell at the Sanitary Landfill

The Mare Chicose sanitary landfill is equipped with a new hazardous waste cell, which is operational since December 2009. This cell, of a capacity of 2,000 m³, is double lined with synthetic liner and concrete to ensure maximum environmental protection. The cell has so far received waste like expired chemicals from school laboratories, expired pharmaceutical products and e-waste. Hazardous waste are encapsulated (covered with concrete) to curtail any risk of environmental contamination.



Hazardous waste cell at Mare Chicose landfill

○ Recycling of Used Batteries and Mobile Phones

In November 2009, Mauritius Telecom in collaboration with the NGO, Mission Verte¹⁸² and BEM Enterprises Limited launched a project to collect and recycle used batteries and used mobile phones. Separate containers have been placed at 15 locations across the island for the collection of these wastes. The collection points have been increased from 535 to 640. The project is being extended to include the public sector in Mauritius as well as Rodrigues island. The collected mobile phones are channelled to a sorting facility where they are dismantled into four main components

namely: plastics, cables, batteries and metals. While plastics and metals are recycled locally, the batteries and electronic components are sent to France and Germany for recycling. As at 31st December 2010, more than 2.5 tonnes of batteries and 400 discarded mobile phones have been collected. It is now planned to further sensitise the population to increase the collection rate of these hazardous waste.

○ **Interim Hazardous Waste Storage Facility**

Government has initiated action for the setting up of an interim hazardous waste storage facility. The project aims at providing a safe storage area for hazardous waste. A pre-treatment area will be included to render certain hazardous waste inert and suitable for disposal in a cost effective manner. The unit will be equipped with a laboratory to carry out preliminary tests to facilitate classification and pre-treatment of certain waste. The interim hazardous waste storage facility is expected to be ready by 2012.

○ **Management of School Laboratory Waste and Medical Waste**

School¹⁸³ laboratory waste, comprising mostly obsolete chemicals, has for a long time been an issue of concern. An agreement has been reached whereby waste from school laboratories will be exported to Reunion Island and subsequently to France for proper treatment and/or disposal. Under this agreement, special containers have been placed in secondary schools for the collection of the laboratory waste. A first exercise of this kind, which consisted of sorting, packaging, labelling and export of some 5.3 tonnes of school chemicals was conducted in 2010. This has resulted in the clearing of old stocks, which represented potential fire and environmental hazards on school premises.

The preparation of a National Health Care Management Plan has also been initiated.

○ **Management of E-waste**

The Ministry of Local Government and Outer Islands has carried out a survey on e-waste from the Government

sector and is now looking into the collection, transportation, dismantling and export of such waste for recycling. Based on this preliminary exercise, a comprehensive study will be undertaken on the mechanism for sound management of e-waste.

◎ **12.5.3 Action Plan on Asbestos**

Asbestos surveys and inspections carried out during the last decade in Mauritius have revealed its presence in various sectors such as: educational and health care institutions, factories, residential buildings, public and private commercial buildings, water and wastewater infrastructures in the form of panels, lagging and pipes. The degradation of asbestos with time may constitute an environmental hazard as well as a health hazard as exposure to asbestos fibres for long duration may eventually give rise to lung diseases.

To prevent health and environmental problems, a National Action Plan on Asbestos was developed in 2002. Import of all types of asbestos has been banned and a protocol on precautions and measures to protect workers at work from asbestos has also been prepared. Renovation or refurbishment works in Government building where asbestos is present need the approval of a number of authorities before works begin. Medical surveillance of workers involved with asbestos is also undertaken. Regarding the disposal aspects, all asbestos waste is properly contained, transported and disposed in the hazardous waste cell at the sanitary landfill.

◎ **12.5.4 Waste Oil**

The Environment Protection (Collection, Storage, Treatment, Use and Disposal of Waste Oil) Regulations 2006 control the management of waste oil. Presently, waste oil from inland sources and ships is being collected, treated and mixed with other fuels for use in boilers. 1,092,740 litres of waste oil was treated in 2010.

¹⁸³ There are presently 70 secondary schools doing science subjects in Mauritius. These laboratories use various chemicals as listed in Table 12.1, which result in various types of complex chemical waste.

● 12.6 PROSPECTS

TOWARDS MAURICE ÎLE DURABLE (BEST CASE SCENARIO)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
No inventory of hazardous waste since 2003	Amend and enforce the Hazardous Waste Regulations	<i>Database on hazardous waste established</i>
Poor management of hazardous waste	Formulate and implement a hazardous waste management strategy	<i>Improved management of hazardous waste</i>
No segregation of hazardous waste at household level	Hazardous waste storage facility set up by 2012	<i>Environmental impacts mitigated</i>
No facility for treatment /disposal of liquid hazardous waste	Increase human resources for better management of hazardous waste	
Inadequate enforcement of the hazardous waste regulations		

© 12.6.1 Policy Options for the Future

Hazardous waste management in Mauritius is constrained due to limited options for their treatment locally, their small quantities and data gaps in this field. While the formulation of the hazardous waste regulations has been a major step in this sector, its enforcement has been hampered owing to capacity constraints. While short-term solutions are being sought for some waste types (e.g. chemical waste from school laboratories) there is a need to focus on other hazardous waste.

In the Best Case Scenario for hazardous waste management, Government is fully aware of the gaps in this sector and decides to take a holistic approach for its management. Actions are initiated to formulate a hazardous waste management strategy, based on the inventory carried out. This strategy is implemented with special focus on the management of medical waste, liquid hazardous waste, segregation of hazardous waste at household level and setting up of the interim hazardous waste storage facility. The new hazardous waste regulation is also promulgated and strictly enforced.

The enforcement capacity of the Solid Waste Unit of the Ministry of Local Government and Outer Islands is enhanced by increasing human resources and providing appropriate training in hazardous waste management. In addition, besides controlling disposal of hazardous waste, strategies and best practices are adopted to minimize their generation.

Hazardous waste poses a greater risk to the environment and human health and thus requires a stricter control regime. It is therefore imperative that hazardous waste management is undertaken in a collaborative effort by all concerned parties to minimise risks.

Chapter Summary ~ Section 1: Chemicals**CHALLENGES**

- ▶ A wide array of chemicals is used in Mauritius, yet, there is no chemical profile and no system for accounting the fate and impacts of these chemicals on humans and environment.
- ▶ The management of obsolete chemicals remains problematic due to lack of facilities for treatment or disposal.
- ▶ The misuse of chemicals is still being associated with health problems.
- ▶ DDT stocks have contaminated storage sites.

PROGRESS

- ▶ The Dangerous Chemicals Control Act was enacted in 2004 to provide for the prevention of damage to health and the environment caused by dangerous chemicals and for better protection for the workers and the public.
- ▶ Mauritius is party to all three chemical related conventions/protocols: Stockholm Convention, Rotterdam Convention and Montreal Protocol. A number of initiatives/projects are being implemented under these conventions, namely a project on Persistent Organic Pollutants and phasing out of Ozone Depleting Substances.
- ▶ Mauritius is one of the few countries which has incorporated the Globally Harmonized System of Classification and Labelling of Chemicals to ensure that information on physical hazards and toxicity from chemicals are available for better protection of human health and environment during handling, transport and use of these chemicals.

PROSPECTS

- ▶ Implement the Strategic Approach to International Chemical Management (SAICM) programme, which will allow for:
 - Development of a national chemical profile
 - Carrying out of a chemicals management capacity assessment
 - A national priority setting on chemicals management
 - Assessing sources of and emissions related to mercury
- ▶ Undertake occupational health risk assessment and medical surveillance
- ▶ Train and reinforce staff involved in chemical management
- ▶ Sensitise all stakeholders such as importers, end users and workers exposed to chemicals.
- ▶ Undertake studies to evaluate the impacts of chemicals on the environment.

Chapter Summary ~ Section 2: Hazardous Waste

CHALLENGES

- ▶ No inventory of hazardous waste since 2003.
- ▶ Poor management of medical waste.
- ▶ No facility for treatment or disposal of liquid hazardous waste.
- ▶ Inadequate enforcement of the Hazardous Waste Regulations.

PROGRESS

- ▶ Hazardous Waste Regulations already in place and its review is under progress to be in line with the Basel convention on the Control of Transboundary Movements of Hazardous Waste.
- ▶ Better tracking of industrial hazardous waste through the Industrial Waste Audit Regulations.
- ▶ Construction of hazardous waste cell at Mare Chicose sanitary landfill.
- ▶ Setting up of an interim storage facility for hazardous waste initiated and expected by 2012.
- ▶ Project initiated for collection of used mobile phones and batteries as well as collection and export of laboratory waste from schools.
- ▶ National Action Plan on Asbestos developed and implemented.
- ▶ Regulation on waste oil promulgated; collection and treatment is ongoing.

PROSPECTS

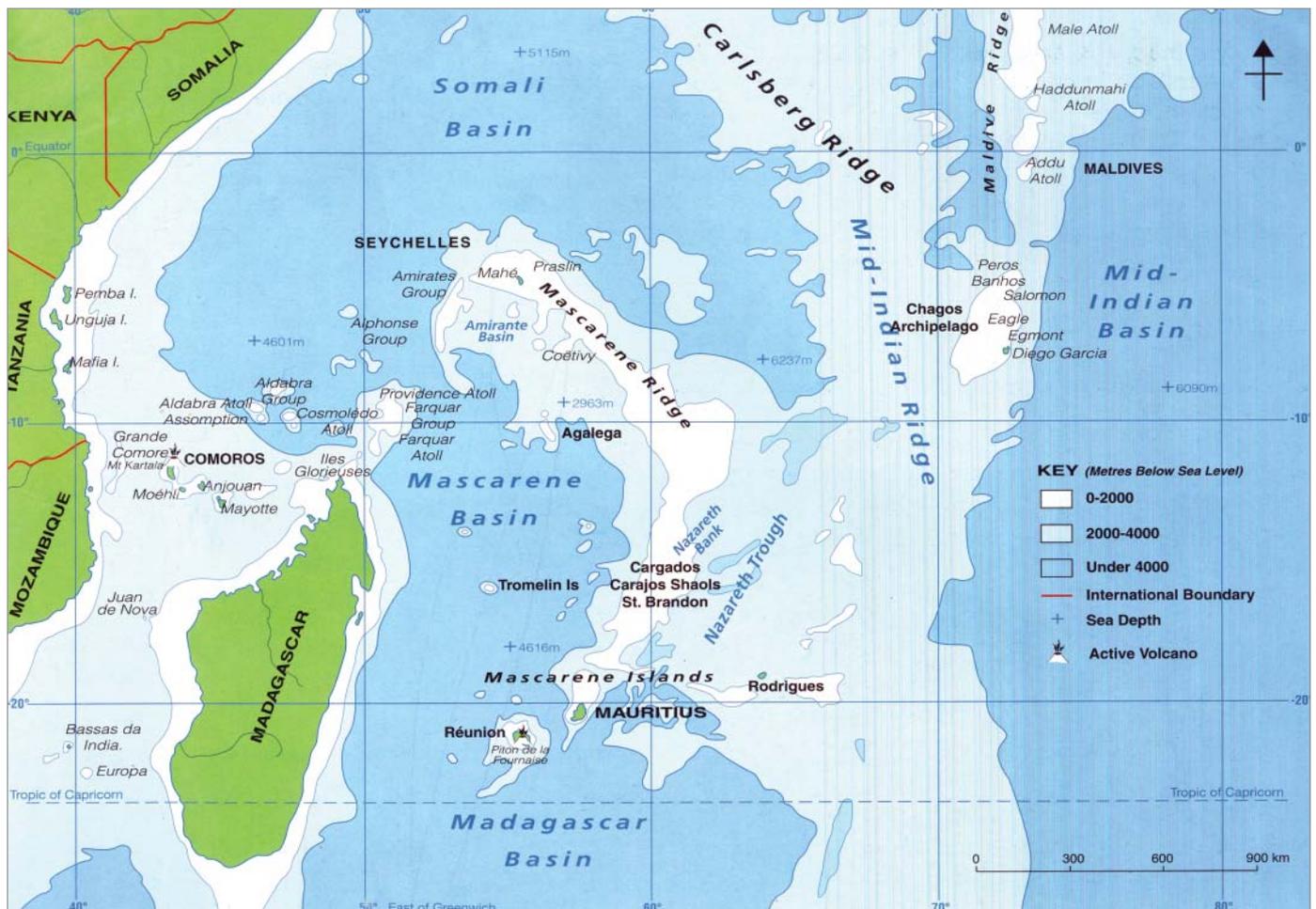
- ▶ Amend and enforce the Hazardous Waste Regulations.
- ▶ Formulate and implement a comprehensive hazardous waste management strategy.
- ▶ Enhance capacity for better management of hazardous waste.

References

- **Ministry of Environment, 2004**, Report of Survey on Medical Waste Incinerators in Hospitals and Clinics in Mauritius”
- **Ministry of Environment and NDU, 2005**, “Enabling Activities for the Stockholm Convention on Persistent Organic Pollutants, Mauritius National Implementation Plan”
- **Joint World Health Organization (WHO)/ Convention Task Force on The Health Aspects of Air Pollution, 2003**, “Health Risks of Persistent Organic Pollutants from Long-Range Transboundary Air Pollution” (http://www.euro.who.int/data/assets/pdf_file/0009/78660/e78963.pdf)
- <http://www.unep.org/hazardoussubstances/Mercury/>
- <http://www.saicm.org>
- <http://mrc.org>

Outer Islands

The outer islands of Rodrigues, Agalega, St. Brandon and the Chagos Archipelago¹⁸⁴ are an integral part of the Republic of Mauritius under the jurisdiction of the State of Mauritius. The following chapter deals with Rodrigues Island while Chapter 14 covers the islands of Agalega and St. Brandon.



Source: Resource Atlas for Mauritius and Rodrigues, 2010

¹⁸⁴ The Chagos Archipelago, located about 2,000 km to the North East of Mauritius, consists of a group of 55 islands, the largest of which is known as Diego Garcia. The total area of the islands is about 41 km² and these are now uninhabited, except for the Island of Diego Garcia, which is a US military base. The Great Chagos Bank hosts the world's biggest living coral structure and is the habitat for more than 220 coral and 1,000 reef fish species (<http://news.bbc.co.uk/2/hi/8599125.stm>). The deep oceanic waters around the Chagos Islands include an exceptional diversity of undersea geological features (such as 6,000 m deep trenches, oceanic ridges, and sea mounts). These areas almost certainly harbour many undiscovered and specially adapted species although the deep-water habitats surrounding the islands have not been explored or mapped in any detail (<http://protectchagos.org/about-chagos/species/>).

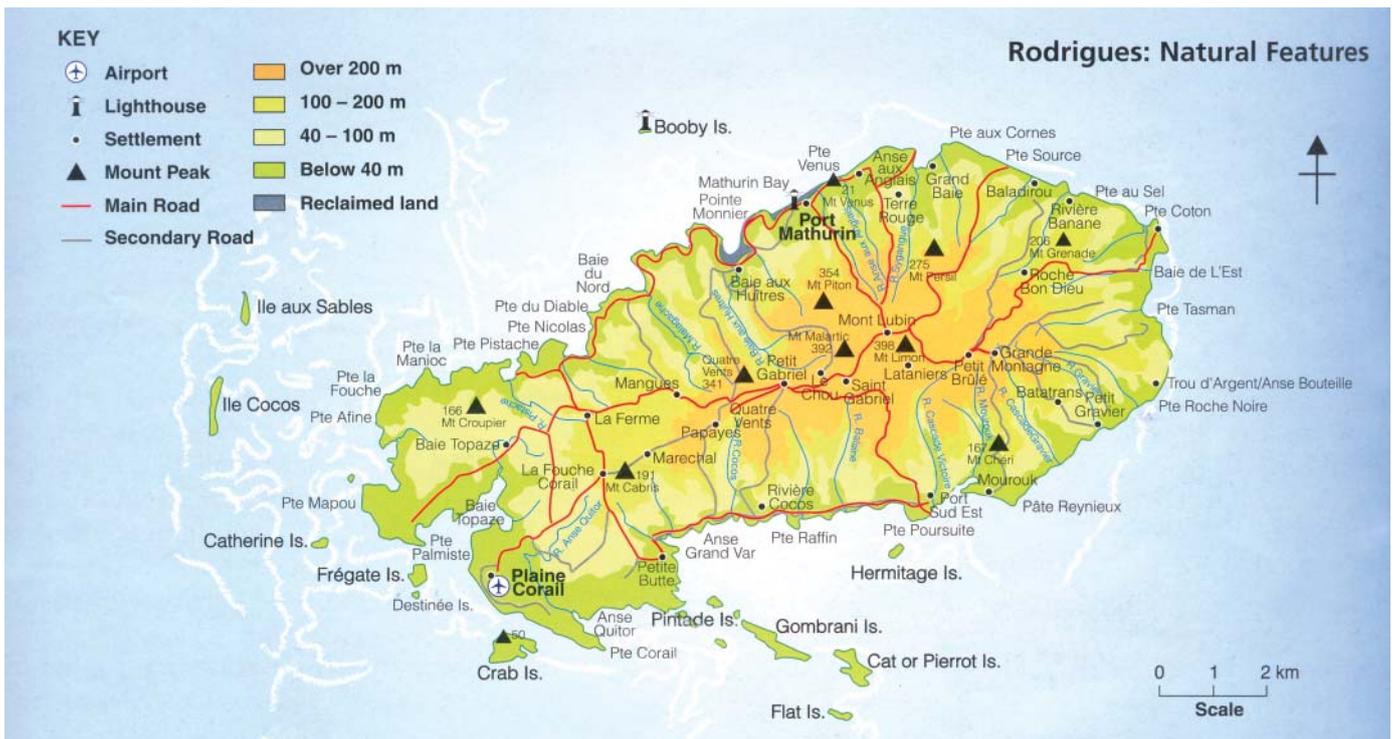
Tromelin Island is found about 500 km to the North West of Mauritius in the Indian Ocean. It has a coastline of 3.7 km and an area of 1 km² together with an Exclusive Economic Zone (EEZ) of 200 nautical miles. The island is uninhabited but serves as a site for sea turtle and bird sanctuary and harbours an important meteorological station for forecasting cyclones (<http://www.nationmaster.com/country/te-tromelin-island/geo-geography>). There is no economic activity on the island.

Tromelin has been a disputed territory claimed both by France and Mauritius. Since 2008, Mauritius and France have been pursuing discussions on the co-management of Tromelin pending the resolution of the sovereignty issue. In June 2010, the Governments of Mauritius and France signed a Framework Agreement on the co-management of the island with three implementing agreements relating to fisheries, archaeological research and the protection of the environment including in its territorial sea and Exclusive Economic Zone. The preparation of a management scheme pertaining to the environment and a plan to combat the dumping of pollutants are being prepared (<http://www.gov.mu/portal/site/Mainhomepage/menuitem>).

Rodrigues

The rocky volcanic island of Rodrigues is about 650 km to the Northeast of Mauritius. The island is 8 km wide by 18.3 km long with an area of 108 km². Rodrigues island is dominated by a steep central ridge which crosses the island almost throughout from the East to the South-West, over a distance of about 10 km, tapering off in the West into a calcareous coral plain. Numerous steep-sided river valleys have been eroded into this ridge. The island is surrounded by a large fringing reef forming a lagoon 50 m to 8 km wide. It is the largest reef-enclosed lagoon of the Indian Ocean. Rodrigues gained independence in union with Mauritius in 1968 and has now Regional Autonomy with the Rodrigues Regional Assembly and a Ministry of Rodrigues within the Mauritian Government¹⁸⁵.

Figure 13.1: Map of Rodrigues



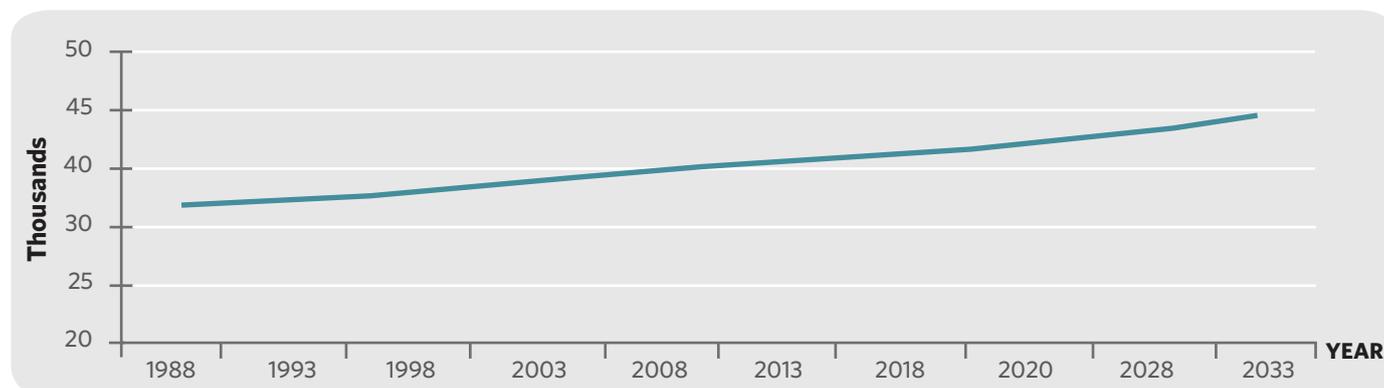
Source: Resource Atlas for Mauritius and Rodrigues, 2010

¹⁸⁵ The roles of and linkages between the Rodrigues Regional Assembly and the Mauritian Ministry of Fisheries and Rodrigues together with its accompanying legislative framework are presently under review.

Population and Economic Status

Figure 13.2 shows population growth and projections in Rodrigues Island, where population is expected to reach around 43,000 by 2030.

Figure 13.2: Population growth (1988 - 2008) and projected growth (2010 - 2033) for Rodrigues



Source: CSO - Digest of Demographic Statistics, 2008

Rodrigues has in the past decades experienced growth in the core economic sectors: agriculture, fisheries and tourism but also, housing and small scale industrial sectors. This has helped boost up the island's economy but at the same time, these developments have impacted on Rodrigues' environment. The major sectors of development in Rodrigues are as follows:

Box 13.1: DEVELOPMENT IN THE KEY ECONOMIC SECTORS OF RODRIGUES

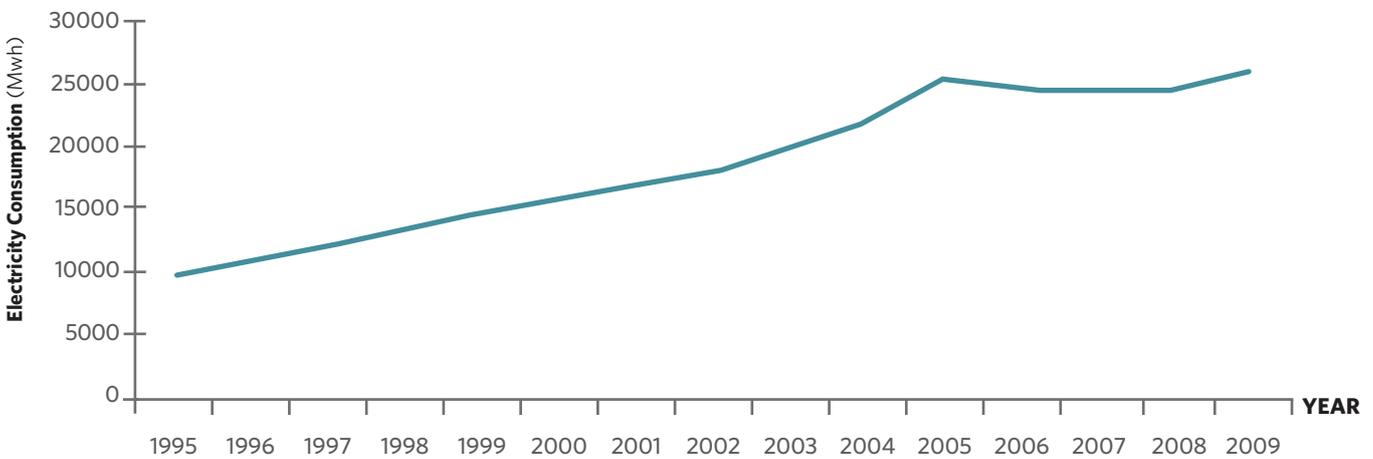
INFRASTRUCTURE	<ul style="list-style-type: none"> ▶ Construction of roads ▶ Dredging of the port for the establishment of a fishing port ▶ Extension of runway ▶ Installation of desalination plants for the treatment of brackish water for the production of bottled water; rehabilitation of dams and water distribution network; construction of reservoir
TOURISM	<ul style="list-style-type: none"> ▶ Promotion of Rodrigues as a tourist destination ▶ Extension of runway in Rodrigues airport to attract tourists from regional countries but also to position Rodrigues as a transit destination ▶ Daily flights on the Rodrigues-Mauritius route ▶ Construction of new hotels
AGRICULTURE	<ul style="list-style-type: none"> ▶ Boosting crop production and animal rearing to ensure food security ▶ Construction of additional farms ▶ Construction of a modern slaughterhouse ▶ Increase in milk production and setting up of cheese and pasteurization unit ▶ Promotion of honey production
FISHERIES	<ul style="list-style-type: none"> ▶ Promotion of offshore fishing ▶ Dredging works to enable easy navigation of boats ▶ Deepening and enlargement of pass
INDUSTRIAL AND SMALL AND MEDIUM ENTERPRISE DEVELOPMENT	<ul style="list-style-type: none"> ▶ Enhance Small and Medium Enterprise development

⦿ **Production and Consumption Trends**

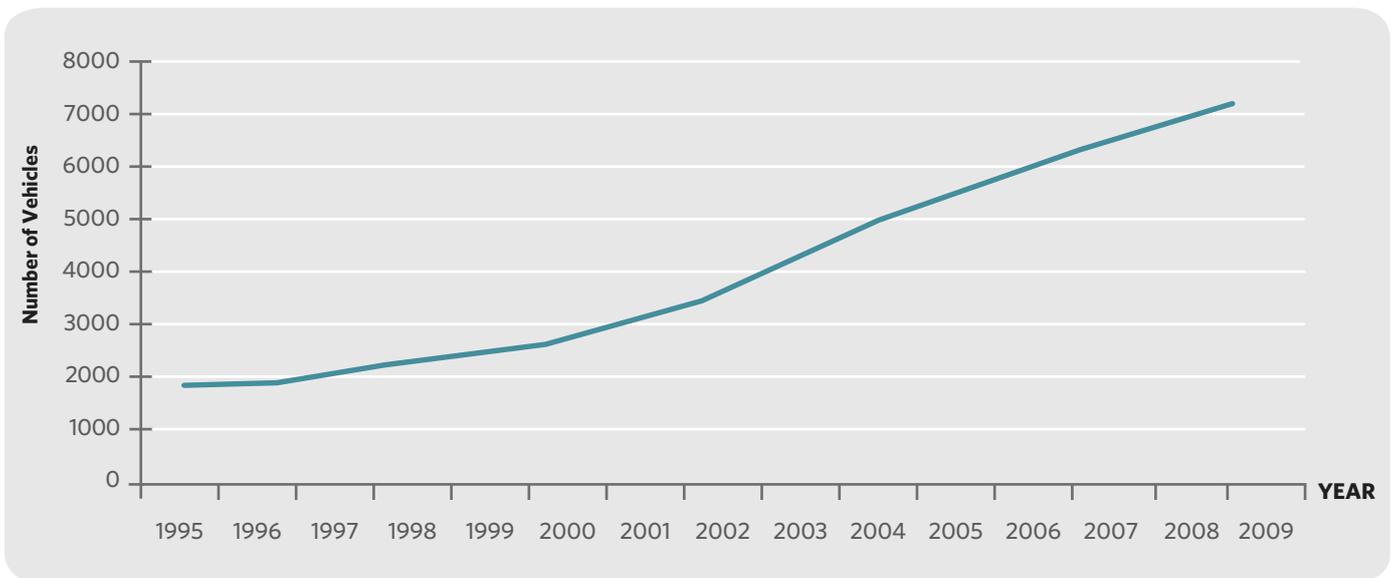
Figure 13.3 shows the production and consumption trends in electricity consumption, number of vehicles, food crop production and construction sector in Rodrigues. The trend in electricity consumption from 1995 to 2009 increased from 9,982 MWh to 26,113 MWh, while the number of motor vehicles has known a net increase from 2,000 in 1995 to 7,154 in 2009. Food crop production shows an overall decreasing trend. The number of permits issued for residential buildings has increased considerably from 112 in 1993 to 619 in 2006 though there has been a sharp decline from 2007 and 2009.

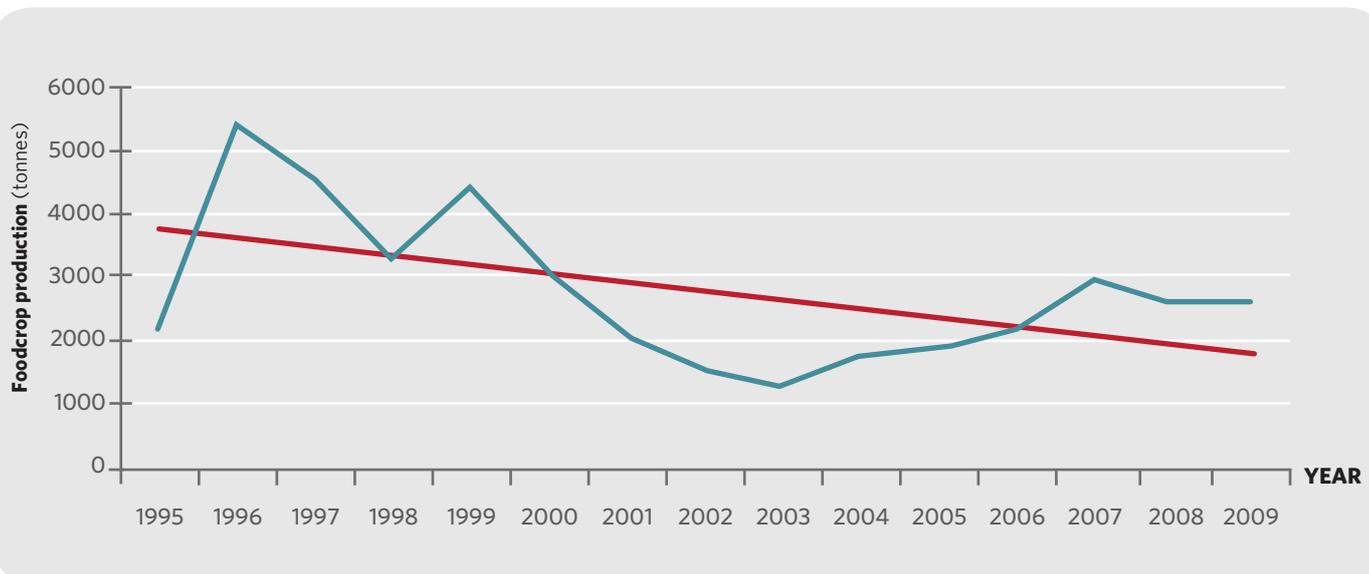
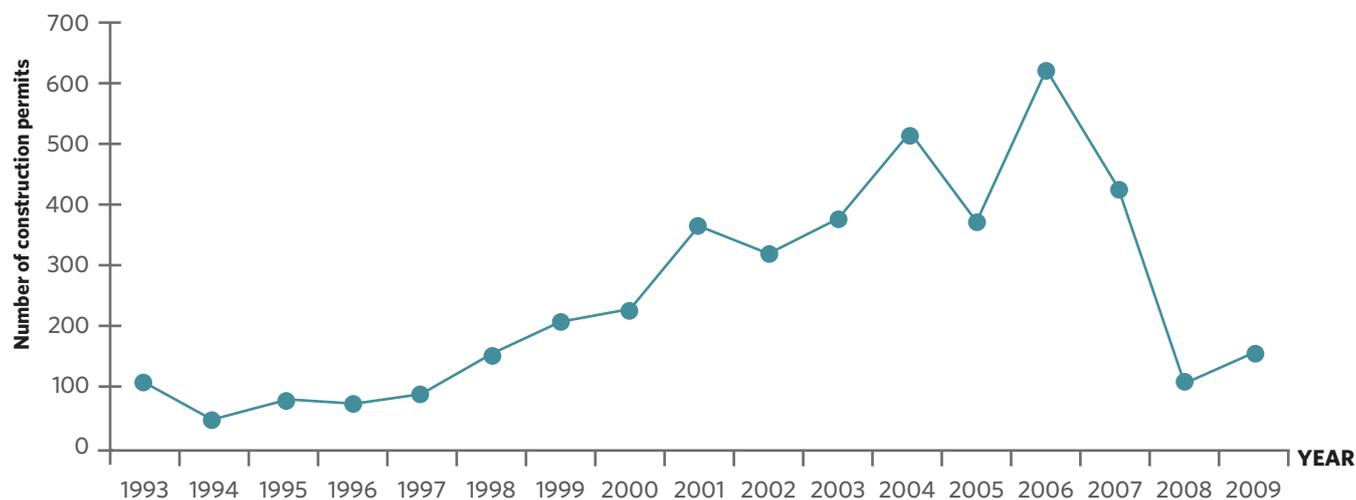
Figure 13.3: Production and consumption trends in Rodrigues

ELECTRICITY CONSUMPTION (1995 - 2009)



NUMBER OF REGISTERED MOTOR VEHICLES (1995 - 2009)



TREND IN FOOD CROP PRODUCTION (1995 - 2009)**NUMBER OF CONSTRUCTION PERMITS ISSUED (1993 - 2009)**

Source: CSO - Digest of Statistics for Rodrigues, 2009

In the short to medium terms, the three core economic sectors: agriculture, fisheries and tourism will remain highly dependent on the environment. Identifying the right policy mix will minimise the environmental impact of increased development, while ensuring the sustainable management of natural resources and the environment. A Sustainable Integrated Development Plan for Rodrigues was prepared in 2009 as a strategic response to sustainable development.

○ **Environmental Management Framework in Rodrigues**

The main environmental legislation, the Environment Protection Act, also applies to the island of Rodrigues. Under this Act, a Rodrigues Environment Committee and an Environment Unit responsible for the overall management and protection of the environment have been established. The Rodrigues Regional Assembly is also empowered to make regulations applicable to the island in matters relating to the protection and management of the environment. Some environmental management responsibilities such as processing of Environment Impact Assessment and Preliminary Environmental Report as well as establishment of environmental standards lie with the Ministry of Environment and Sustainable Development in Mauritius.

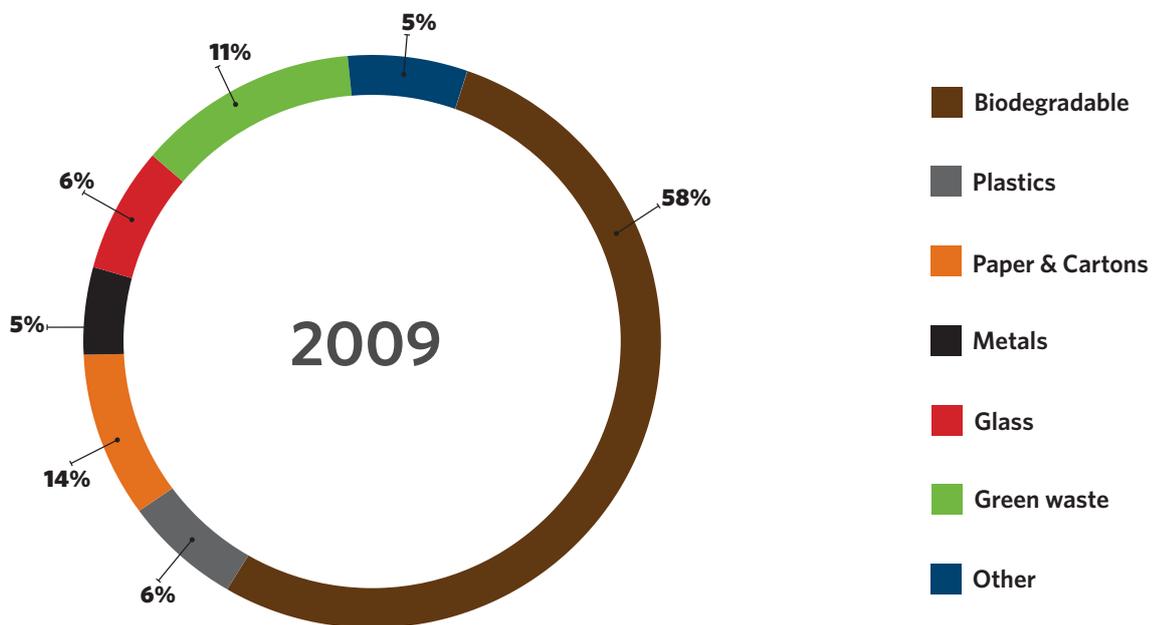
● **13.1 CHALLENGES**

◎ **13.1.1 Solid Waste Management**

○ **Waste Generation**

The per capita waste generation in Rodrigues is about 0.65 kg/day compared to nearly 1 kg/head/day in Mauritius. This figure is on the rise in view of increasing population, expanding tourist industry and new consumption patterns. Based on the 0.65 kg per capita waste generation, the annual amount of waste generated on the island of Rodrigues is around 8,900 tonnes. Waste characterization exercise has shown that nearly 70% of waste is organic and therefore biodegradable. The detailed waste composition is shown in Figure 13.4

Figure 13.4: Waste Composition in Rodrigues¹⁸⁶ (2009)



Source: Rodrigues Regional Assembly

¹⁸⁶ Biodegradable waste include waste from households and the fishing sector

○ Waste Management

All waste (excluding hazardous waste) is dumped at the Roche Bon Dieu dumping site, which is nearing saturation. The dumping site is associated with a number of environmental problems like odour, smokes from accidental fires and risk of pollution of the lagoon. Furthermore, plastic bags also constitute a nuisance as these get blown away by wind and get trapped on the surrounding vegetation. Though waste collection services are provided to 90% of the island, some parts are still inaccessible.



Dump site at Roche Bon Dieu

○ 13.1.2 Land and Agriculture

Rodrigues is about 10,800 ha in size, of which only 1,000 ha (about 9%) is privately owned while the rest is managed by the State. The private lands are primarily located in Port Mathurin, La Ferme and Saint Gabriel-Mont Lubin and are in relatively small plots of two and three hectares. State land is leased to private individuals for development projects, be it for residential, agricultural or commercial purposes. A number of challenges are faced in this sector and are as follows:

○ Soil Erosion

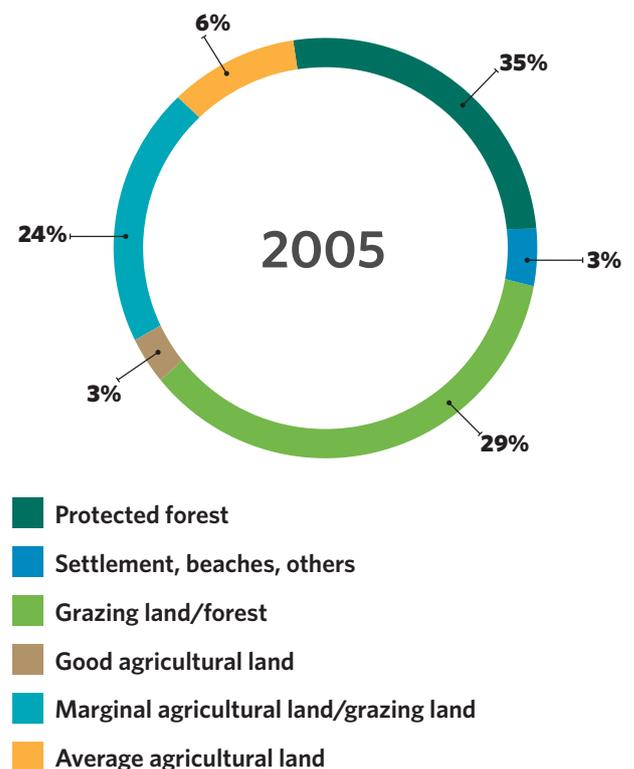
Soil erosion is a typical problem in Rodrigues caused by bad agricultural and grazing practices, past deforestation, poor building practices¹⁸⁷, steep topography and high intensity of rainfall thereby leading to land degradation. Deforestation has been occurring over a long period of time, the most important cause being land tenure. Grazing land has increased, as previously restrictive grazing

regulations have been relaxed. This has damaged agricultural terraces and exacerbated soil erosion problems. Access to pastures is open and hence there is no control on grazing activities.

○ Demand for Land

Land requirements for housing and industry are small. However, scattered development is resulting in the loss of agricultural land and reducing the aesthetic appeal of the countryside (Sustainable Integrated Development Plan for Rodrigues, 2009). Figure 13.5 shows land use in 2005.

Figure 13.5: Land use in Rodrigues (2005)



Source: Rodrigues ICZM Strategy, 2008

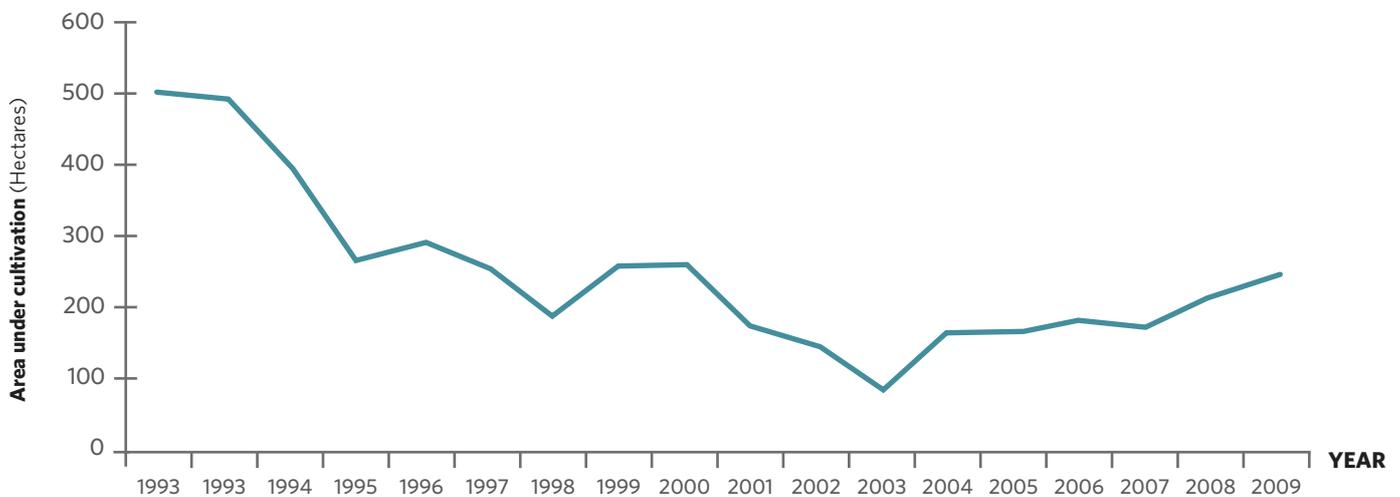
Over the last three years, some 2,773 new residential leases have been finalized. The housing stock evolved from 7,810 units in 1990 to 11,172 in 2008. The projections for the establishment of new housing units up to year 2020 are estimated to be about 13,640.

¹⁸⁷ Human settlement in Rodrigues is dispersed. Rodriguans tend to build their houses in the agricultural land leased to them so as to look after their crops and cattle (Rodrigues Regional Assembly, 2009).

○ Decreasing Agricultural Activity

Agricultural land use has declined dramatically over recent years as a result of a complex relationship between market prices and outlets available to the farmer (often controlled), low achievable yields compared with costs of inputs, lack of available credit, unavailability of water for irrigation and exogenous factors such as weather (Sustainable Integrated Development Plan for Rodrigues, 2009). Effective land under food crop cultivation has decreased from 994 ha in 1992 to about 488 ha in 2009 as shown in the Figure 13.6.

Figure 13.6: Area of land under cultivation in Rodrigues (1992 - 2009)



Source: CSO - Digest of Statistics on Rodrigues, 2009

○ Environmentally Sensitive Areas (ESAs)

Nearly 80% of the land area in Rodrigues is considered as environmentally sensitive with about four-fifths of this area attributable to moderate and steep slopes. There are no significant freshwater marshlands, lakes or reservoirs on the island that have been classified as ESA (Ministry of Environment and Sustainable Development, 2010).

○ Siltation of Lagoons

Silt transported by rivers is ultimately deposited in dams, used for drinking water, and the lagoon where it impacts upon the ecosystem, particularly coral reefs. Up to one meter of soil (mainly silt) is reported to have accumulated in certain areas of the lagoon close to river estuaries.

● 13.1.3 Water Resources

○ Water Scarcity and Water Supply

Water scarcity has been recognised as the number one problem of Rodrigues deserving immediate attention and resource mobilisation. The 2009 Sustainable Integrated Development Plan for Rodrigues reviewed water and sanitation services as part of a comprehensive examination of the prospects for sustainable development. The report concluded that “the whole system is archaic, inefficient, costly, unsustainable and severely inhibiting development of the isle”. Whilst piped supply is provided to all people, water is provided to most customers only twice a month for two hours as a result of inadequate public storage, supply systems and rainfall variability. This has wide-ranging economic and social impact, restricting domestic life,

agricultural and industrial development and inward investment. The island lacks a public sewerage system and mainly relies on the use of septic tanks for sewage disposal.

○ **Water Demand**

In 2009, water demand was estimated at 9,600 m³/day and it is estimated that this will increase to about 13,800 m³/day by 2020. On the other hand, current production is only about 6,000 m³/day. Low rainfall together with inadequate storage capacity reduces water availability, especially during the dry season (Rodrigues Commission for Water Resources, 2009).

● **13.1.4 Coastal and Marine Resources**

Rodrigues is outlined by 67 km of coast, consisting of 70% rocky coasts, 21 % of silt-clay coast and 9% of coral sand beaches, including two sand islets: Ile aux Sables and Ile aux Cocos. Despite the presence of a wide coral platform that encloses the 240 km² of lagoon, the latter is endangered by artisanal fishing, sedimentation and coastal erosion. Moreover, the legislative framework is inadequate for conservation of marine resources. These pressures are elaborated below:

○ **Bad Fishing Practices**

Artisanal fishers generally use seine, trap, line and harpoon (for octopus) as fishing methods. The majority of the fishermen work on foot thus destroying the delicate coral structures and the algal matting, which are both a habitat and primary food source for many marine animals (Sustainable Integrated Development Plan for Rodrigues, 2009). As a result, the ecosystem is affected in a potentially irreversible way due to these bad fishing practices. Moreover, outer reef fisheries are not highly exploited despite its good potential.

○ **Management of Fishing Reserves**

Presently, there are five fishing reserves in Rodrigues in which no net fishing is allowed. However, these are not being closely monitored by relevant institutions due to capacity limitation. The comprehensive laws and regulations

governing marine protected areas are vital for the sustainability of marine life and fisheries, but will only be effective if they have continued political support, are resistant to short term commercial and social pressures for relaxation of controls and are implemented by a regulatory body that operates with probity without fear or favour in this close knit cultural setting. Reports from independent observers suggest that the potential for rehabilitating the coastal and marine resources are being undermined by lax implementation of controls. Baseline studies have been completed in one of the protected areas and follow up will provide more evidence of the extent of the effectiveness of the scheme.

○ **Sand Extraction**

Sand mining activity started in December 1993 at Banc Catherine. Sand extraction is carried out at a rate of about 25, 000 tonnes per year. Although sand should not be extracted within 1 km of any islet, it is reported that sometimes this activity is carried out outside the demarcated area. No study has been carried out to assess the sand stock to ensure its sustainable exploitation.

○ **Beach Erosion and Climate Change**

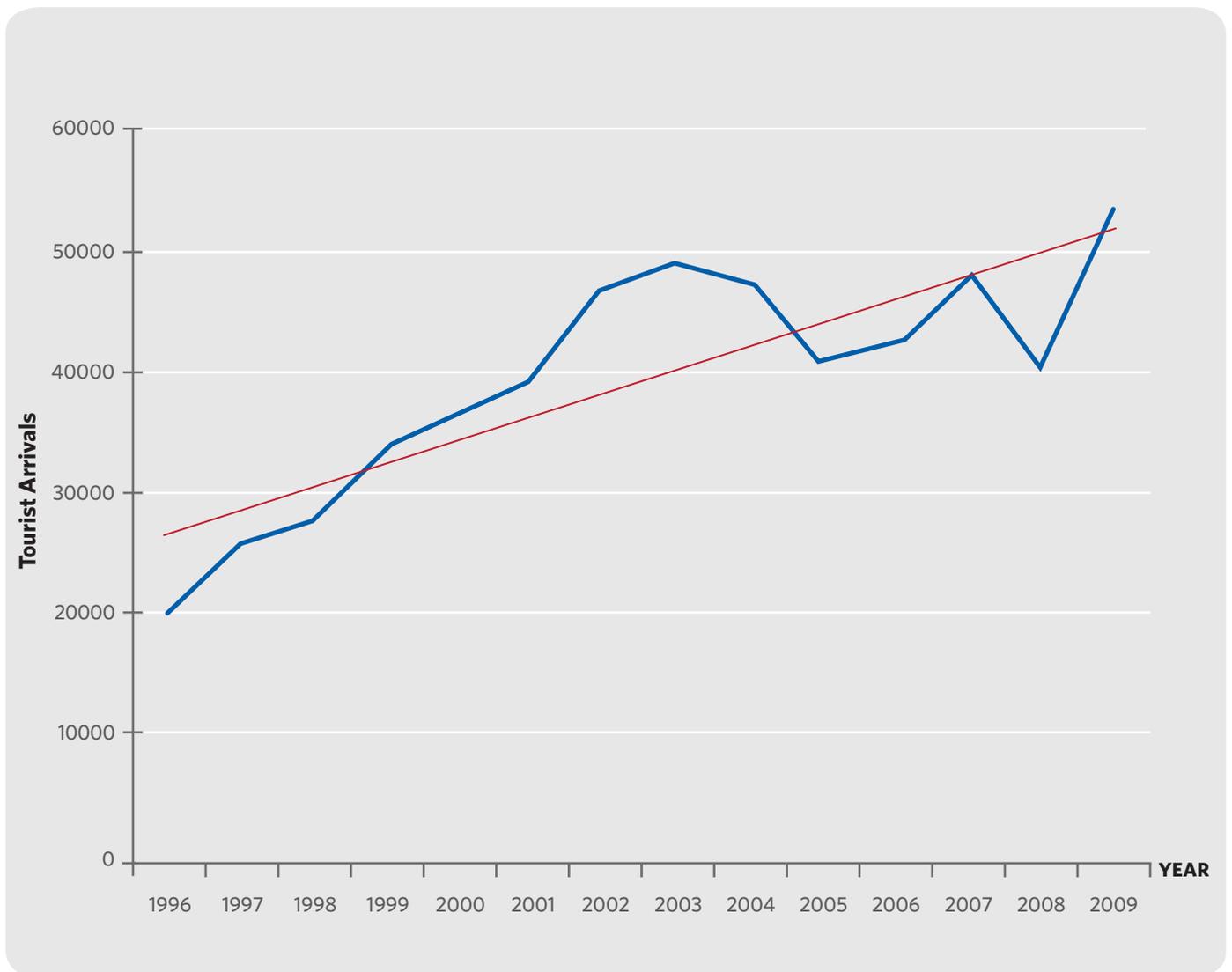
The beaches in Rodrigues are generally classified as highly vulnerable to erosion (Cazes-Duvat, 2003¹⁸⁸). The Northern beaches (e.g. Anse Aux Anglais, Baladirou) and Eastern beaches (e.g. Trou d'Argent, Anse Bouteille) are relatively stable as they are protected by cliffs, whilst those of the South East are highly susceptible to erosion (e.g. Gravier, Mourouk). Concerning the two sandy islets, Ile aux Cocos is considered to be vulnerable to erosion and Ile aux Sables is categorised as highly susceptible to erosion. Rodrigues is not spared from the threat and impacts of climate change. Meteorological data show a warming trend for Rodrigues, St. Brandon and Agalega with a temperature rise between 0.5-1.0 °C over the last 50 years.

¹⁸⁸ In the study, the beaches were classified on a scale of 1 (less vulnerable) to 4 (highly vulnerable) based on 7 parameters including: erosion status of the beaches, structure of the beach, erosion and accretion dynamics and resilience of the beach.

○ **Tourism Development**

Tourist¹⁸⁹ arrivals in Rodrigues have been increasing from 1996 to 2009 as shown in Figure 13.7. This will continue to increase especially with the reinforcement of marketing strategies¹⁹⁰ and extension of the runway at the Rodrigues airport to attract tourist from regional countries. Increase in tourist implies construction of more hotels, increase in demand for water, food and leisure activities in the lagoon. With fewer suitable sites available for tourism, remaining healthy sites become increasingly targeted by various user groups, further increasing pressure on the coastal and marine resources.

Figure 13.7: Trend in tourist arrivals in Rodrigues (1996 - 2009)



Source: CSO - Digest of Statistics on Rodrigues, 2009

¹⁸⁹ Mauritians visiting Rodrigues have been included as tourists

¹⁹⁰ The Rodrigues budget speech for 2010 provides for promoting the island as a tourist destination, extension of the runway, construction of two new hotels and launching of a new airline with daily Rodrigues-Mauritius flights.

○ Marine Biodiversity

Though Rodriguan waters are rich in biodiversity, the marine fauna and flora have not been intensively studied. The Study on Environmentally Sensitive Areas for Rodrigues has classified most of the lagoon ecosystem comprising of coral reefs, sea grass and algal beds as being environmentally sensitive. Table 13.1 gives details of the marine biodiversity.

Table 13.1: Marine biodiversity

SPECIES	NUMBER OF SPECIES
Coral	160
Macro-algae	139
Sea grass	2
Fish	494
Bivalve	109 known species / 15 newly identified species
Echinoderms	74

Source: Rodrigues Regional Assembly

BOX 13.2: STATE OF ENVIRONMENT IN THE PORT AREA

In accordance to the Ports Act 1998 and the Environment Protection Act 2002, the Port Authority is required to supervise enforcement of environmental requirements within the port limits including Port Mathurin and verify compliance with the provisions of the law.

Port Mathurin handles about 70,000 tonnes of cargo with about 40 calls annually and there are no major industrial activities with risk of severe pollution. However, there is some minor pollution such as:

- ▶ Noise and dust pollution
- ▶ Air pollution
- ▶ Water pollution from the existing water ways

Risks of accidental pollution by oil spills do exist. Two cases of oil spill occurred during unloading of crude oil. Basic response equipment is available within Port Mathurin and training and simulation exercises have been conducted. The Port also has facilities for the storage of waste oil from all over the island. Waste oil is temporarily stored prior to its shipment to Mauritius for recycling.

○ **State of Corals and Coral Reef**

Rodrigues has the most substantial and best-developed reefs in the Mascarenes and the living coral cover is generally high. 88 species of corals were recorded during a survey undertaken in 2008. The results from this survey indicate that the reef around Rodrigues is relatively healthy, apart from the two sites used by the local octopus fishers. At these sites, hard coral cover is extremely low (between 2-5%) due to a disturbed environment (The Status of the Coral Reefs in Rodrigues, 2008). Moreover, soil erosion and sedimentation are other factors affecting corals.

○ **Loss in Fish Stocks**

The different pressures on the coastal resources including over fishing have resulted in a decrease in fish stocks in the lagoon. As shown in Figure 13.8, octopus catch in the lagoon is also decreasing, while off lagoon fishing is still not a common practice.

● **13.2 PROGRESS**

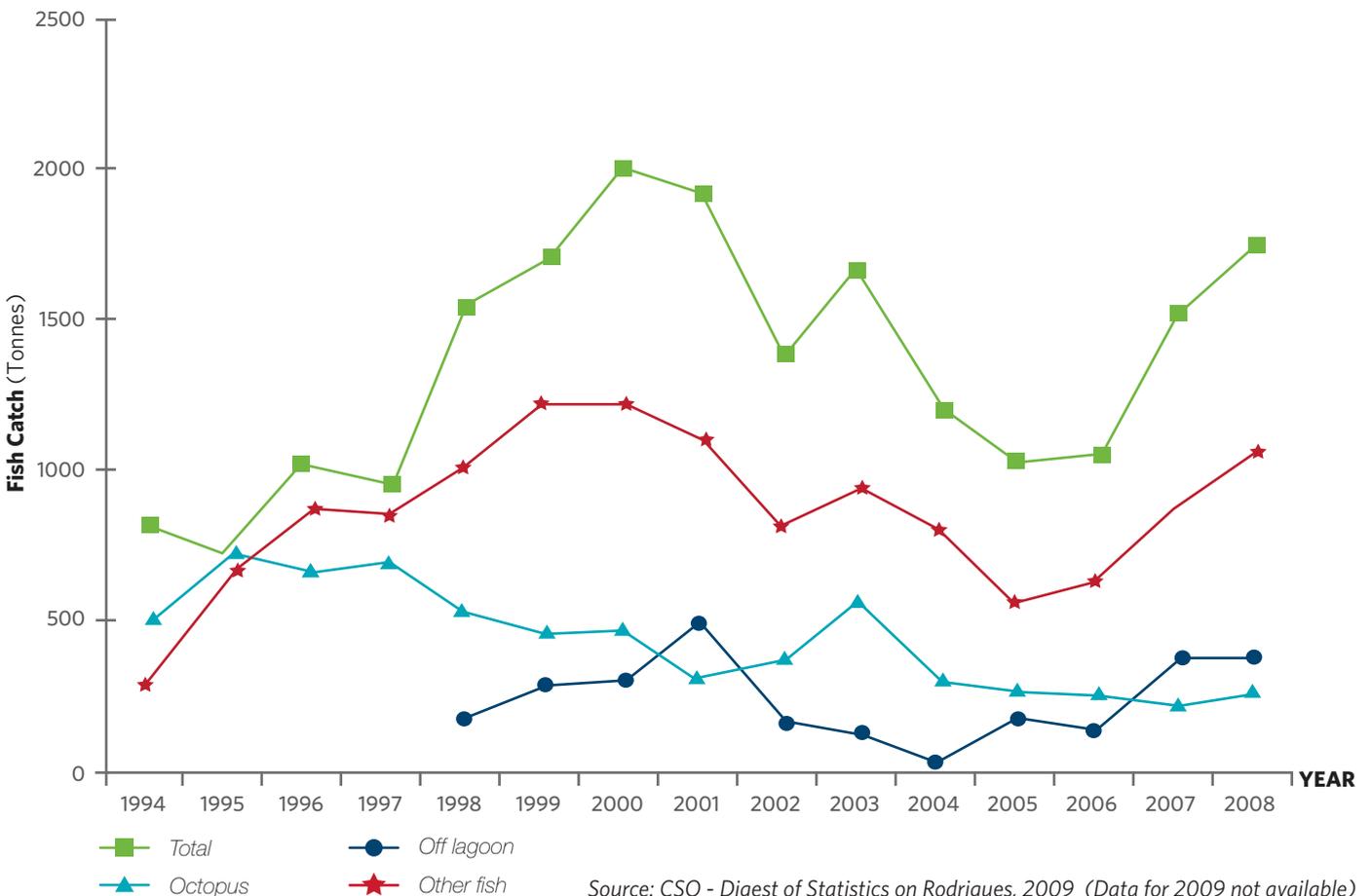
◎ **13.2.1 Solid Waste Management**

○ **Legal Framework**

The main environmental legislation, Environment Protection Act, also applies to the island of Rodrigues. Under this Act, the Rodrigues Regional Assembly is empowered to make regulations in matters relating to the protection and management of the environment. In this context, the following regulations have been promulgated regarding waste collection:

- Rodrigues Regional Assembly (Dumping and Waste Carriers) Regulations 2005
- Rodrigues Regional Assembly (Collection of Refuse) Regulations 2008

Figure 13.8: Fish catch in Rodrigues (1994 - 2008)





The first phase in the construction of the new sanitary landfill at Grenade

○ Improvement in Waste Management

Waste collection services have been extended to new localities, which are now accessible by track roads. A mobile team of workers has been set up to ensure cleanliness of public places. The dump site at Roche Bon Dieu was extended in 2008 and its management improved. An existing rock quarry site is being used as a disposal site for inert waste like construction debris, used tyres, woods and scrap metals at Montagne Baie du Nord. A new sanitary landfill is being set up at Grenade. The first phase has been completed with the construction of one cell of about 8,000 m³ capacity. With recycling initiatives and backyard composting activities, the lifespan on the cell can be increased. Also, new cells will be excavated as the need arises.

○ Recycling Initiatives

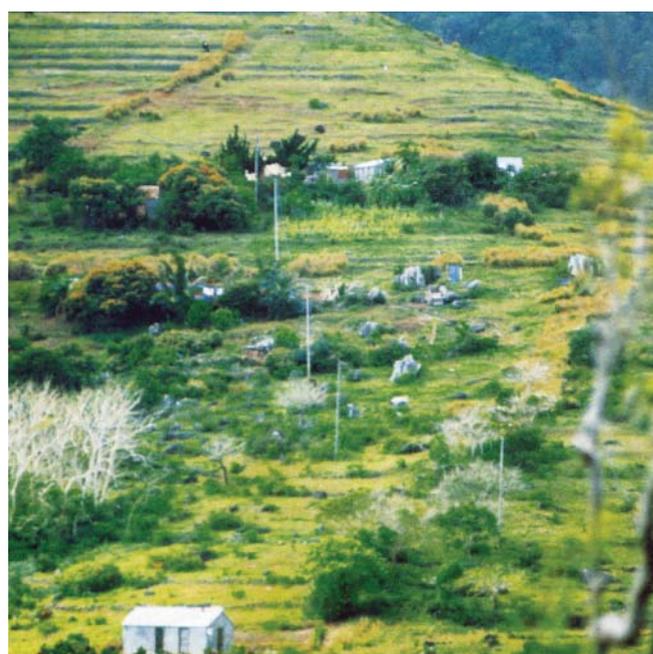
Scrap metals, used batteries, waste oil and plastic bottles are being collected by private individuals and shipped to Mauritius for recycling or for export. From January 2008 to December 2009, some 408 tonnes of scrap metals and from 2007 to February 2010, 89,000 litres of waste oil have been collected for export to Mauritius.

A project was initiated in January 2009 aiming at introducing waste segregation at household level. Two types of waste were targeted: plastic bottles and green waste. Collected plastic bottles are exported for recycling, while green waste is composted. Till now the project has been implemented in four villages: Pointe L'Herbe, Anse aux Anglais, Songes and Citron Donis. Composting projects were launched in the thirteen primary schools of Rodrigues.

◎ 13.2.2 Land and Agriculture

○ Control of soil erosion and delineation of pasture lands

Some 3,500 ha or one third of the island is under forest cover. Reforestation programme with endemic species is ongoing. This prevents soil erosion, serves as windbreaks and provides timber. Owing to the hilly nature of the island, terrace farming is being re-developed to prevent erosion and allow exploitation of the land for agricultural purposes. Grazing is being controlled through the fencing of pasture lands and to date, 1,000 ha have been fenced.



Terrace farming in Rodrigues

Source: Resource Atlas for Mauritius and Rodrigues, 2010



Board showing action being taken to control grazing and soil erosion

○ Policy Framework for Land Use Planning

With the adoption of the Sustainable Integrated Development Plan for Rodrigues in 2009, bold measures have been taken to manage land resources. A framework for land use planning has been prepared and translated in the Rodrigues Land Use Regulations. The two main components of land use planning include the local plan and the physical development strategy, which cover a period of 20 years. The Rodrigues Physical Development Strategy puts emphasis on clustering development, enhancing the natural character of the countryside and the coast, housing development schemes, recreation, transport and physical infrastructure.

◎ 13.2.3 Water Resources

Rodrigues has taken steps to remedy the challenges in the water sector by strengthening the institutional framework and by setting up an independent water company for improving the distribution system. Before 2009, about 60% of the water was obtained from boreholes and 40% from surface water sources and springs.

In February 2009, the Water Resources Unit commissioned three desalination plants treating low salinity brackish borehole water (Setting up and starting the Rodrigues

Water Company, 2009). A larger desalination plant of 500 m³/ day capacity treating sea water is also operational. Moreover, new large tourist facilities are required to provide their own desalination services. Currently, a new reservoir at Creve Coeur with a capacity of 1,000 m³ is in the pipeline. Furthermore, plans have been prepared for a sewerage system and treatment plant for Port Maturin with possibility for using the treated water for irrigation.

◎ 13.2.4 Coastal and Marine Resources

○ Policy and Legislation

Regulations have been enacted to promote sustainable exploitation of marine resources, namely to control octopus and sea cucumber catch and also to regulate sand mining under the Sand Mining Act 1991. Fisheries and Marine Resources (Marine Protected Area) Regulations for Rodrigues have also been developed and are being implemented. An Integrated Coastal Zone Management (ICZM) plan for the Republic of Mauritius including an ICZM Strategy for Rodrigues has been prepared in 2008. Action Area Plans have been developed for Cotton Bay and Anse aux Anglais regions. Four islet-specific management plans have also been prepared for better management of islets¹⁹¹.

○ Mangrove Propagation

In order to control soil sedimentation in the lagoon, mangroves have been planted in several bays and they are growing successfully except in rocky areas. The mangrove ecosystem is being established in areas such as Diamant, Baie Malgache, Mourouk, Grand Baie and Anse Pansia. The mangroves are also helping to establish a new ecosystem and plants and animals are starting to colonize the area. Sand accumulation is also observed at Baie Malgache, where previously only silt sediment was deposited.

○ Control of Sand Extraction

To avoid illegal sand mining and sale, control measures¹⁹² have been reinforced at sand landing station. A sand mining monitoring technical committee has been set up to oversee and control sand extraction.

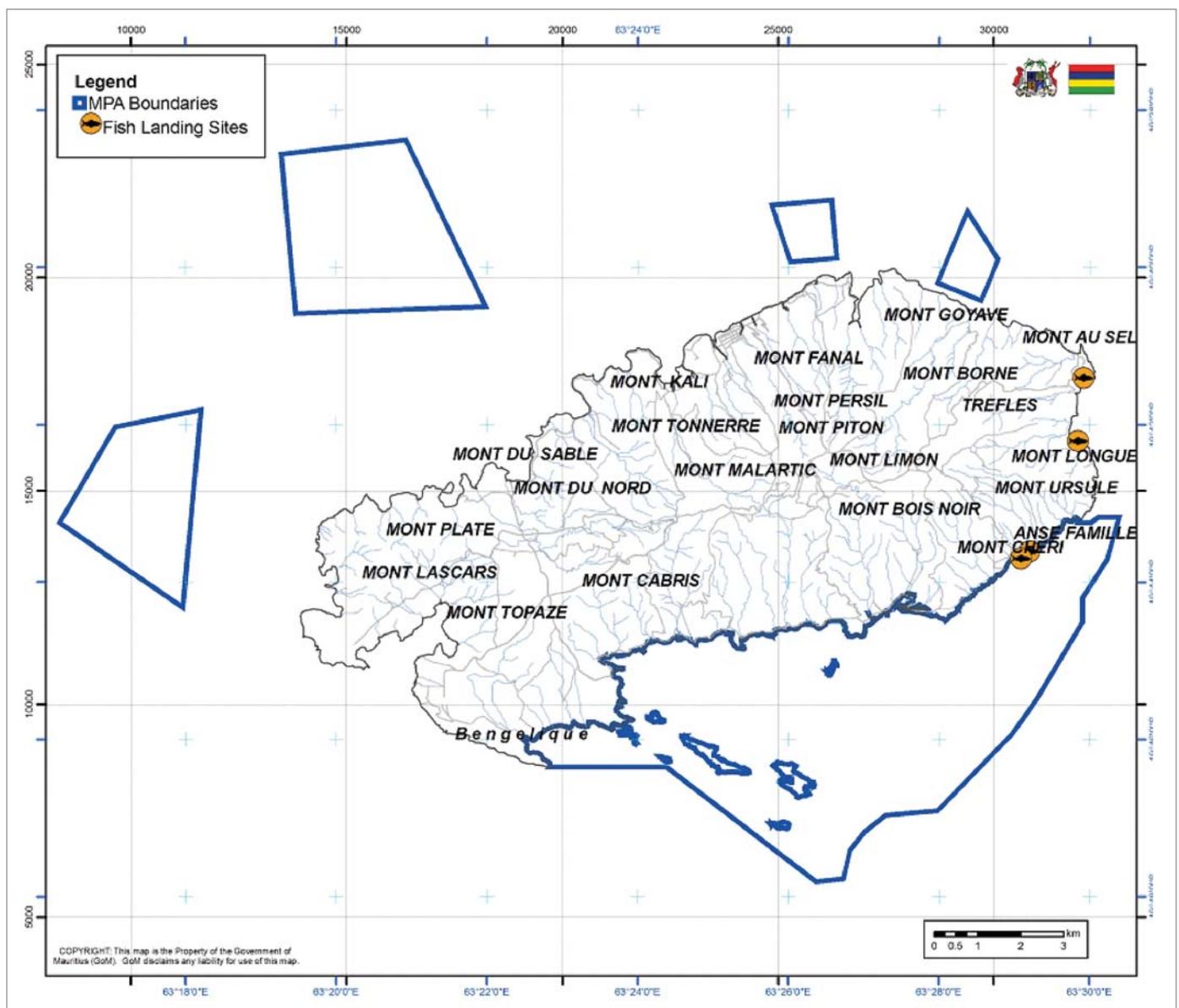
¹⁹¹ The responsibility for the management of Rodrigues islets still rests with Mauritius through the Nature Reserves Board.

¹⁹² A permit is required for dealing in coral sand

○ Setting up of Marine Protected Areas

In response to the decline in fish stocks, four marine reserves¹⁹³ in the northern lagoon were proclaimed (Rodrigues ICZM Strategy, 2008). The southern lagoon from Pointe Corail in the West to Pointe Roche Noire in the East has been declared as a marine park. The development of a management plan is under process. Figure 13.9 shows the location of the Marine Protected Areas.

Figure 13.9: Marine Protected Areas in Rodrigues



Source: Rodrigues ICZM Strategy, 2008

¹⁹³ Rivière Banane, Anse aux Anglais/Passé Cabri, Grand Bassin and Passé Demi

● 13.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO FOR RODRIGUES)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
<p>Environmental problems at dump site</p> <p>Inadequate waste collection</p> <p>No programme for hazardous waste management</p> <p>Low recycling levels</p>	<p>SOLID WASTE MANAGEMENT</p> <p>Creation of more cells at the new landfill</p> <p>Extend waste collection to all parts of the island</p> <p>Elaborate a waste management strategy</p> <p>Encourage recycling through fiscal incentives</p> <p>Composting of organic waste</p>	<p>Improved waste management</p>
<p>Inadequate data on land resources</p> <p>Soil erosion, land degradation and siltation of lagoons</p>	<p>LAND AND AGRICULTURE</p> <p>Set up a land management information system</p> <p>Control soil erosion through afforestation and terracing</p>	<p>Less siltation in the lagoon</p> <p>Better land use planning</p> <p>More control on lease and use of state land</p>
<p>Water scarcity and management</p>	<p>WATER RESOURCES</p> <p>Improve water and sanitation services</p>	<p>Improved quality of life due to availability of water</p>
<p>Overfishing in the lagoon</p> <p>Bad fishing practices and lack of capacity for monitoring of fishing reserves</p> <p>Illegal sand extraction from islets</p> <p>Inadequate legal framework for protection of marine resources</p>	<p>COASTAL AND MARINE RESOURCES</p> <p>Encourage offshore fishing</p> <p>Implement the ICZM Strategy and recommendations of the ESA study</p> <p>Encourage use of rock sand for construction</p> <p>Introduce regulations on protection of marine resources</p>	<p>Protection of marine biodiversity and increase in fish stock</p> <p>Healthy marine ecosystem established</p>

13.3.1 Policy Options for the Future

○ Solid Waste Management

If waste generation remains at the current rate of 0.65 kg/head/day, total waste generated will be slightly above 10,000 tonnes a year by 2030. This represents an increase of only about 1,000 tonnes compared to the 2008 level over a period of over 20 years. The newly set up landfill at Grenade can accommodate this increase in waste provided all the 8 cells are developed.

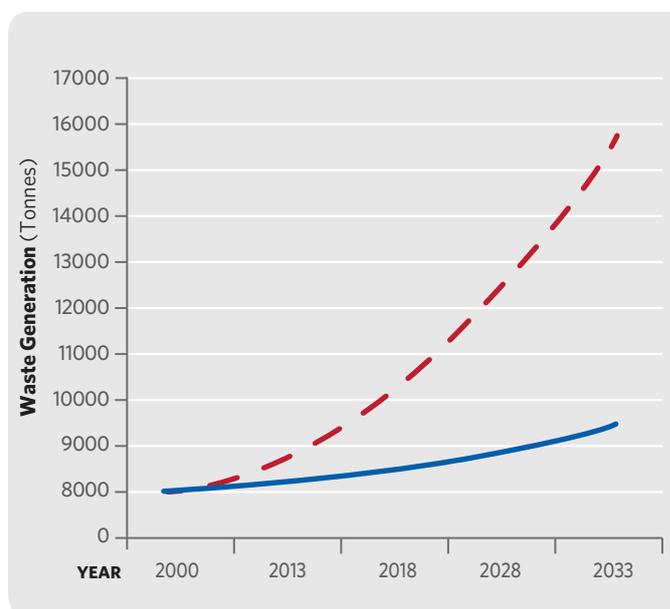
With an increase in tourist arrivals and changing consumption trends, current waste generation rate may be expected to increase. Assuming the per capita waste generation increases to 1 kg/day (i.e. the current Mauritian level) over the 20-year period, the total waste generated by 2030 would be nearly 16,000 tonnes a year, as shown in Figure 13.10. This would imply that both waste collection and waste disposal capacity would have to be increased.

However, if recycling initiatives are reinforced, this may lead to a decrease in the amount of waste requiring final disposal. Given that nearly 70% of the waste in Rodrigues is biodegradable, composting could be a viable option, with the double advantage of providing compost to boost up the declining agricultural sector and reducing the amount of waste to be disposed.

○ Land and Agriculture

In the Best Case Scenario for the land sector, the Rodrigues Regional Assembly fully realises the importance of the implementation of the Rodrigues Physical Development Strategy and the Rodrigues Local Plan for the sustainable use of land resources in Rodrigues. In this regard, the policy framework for land use planning is adopted and the Land Information System is set up. This helps in better land use planning and guides future leases of state land. The legislative framework is also scrutinised and a new legislation is put in place to ensure better planning and management of land.

Figure 13.10: Projected waste generation



— 0.65 Kg/head/day
 - - per capita waste generation increases to 1 kg/day

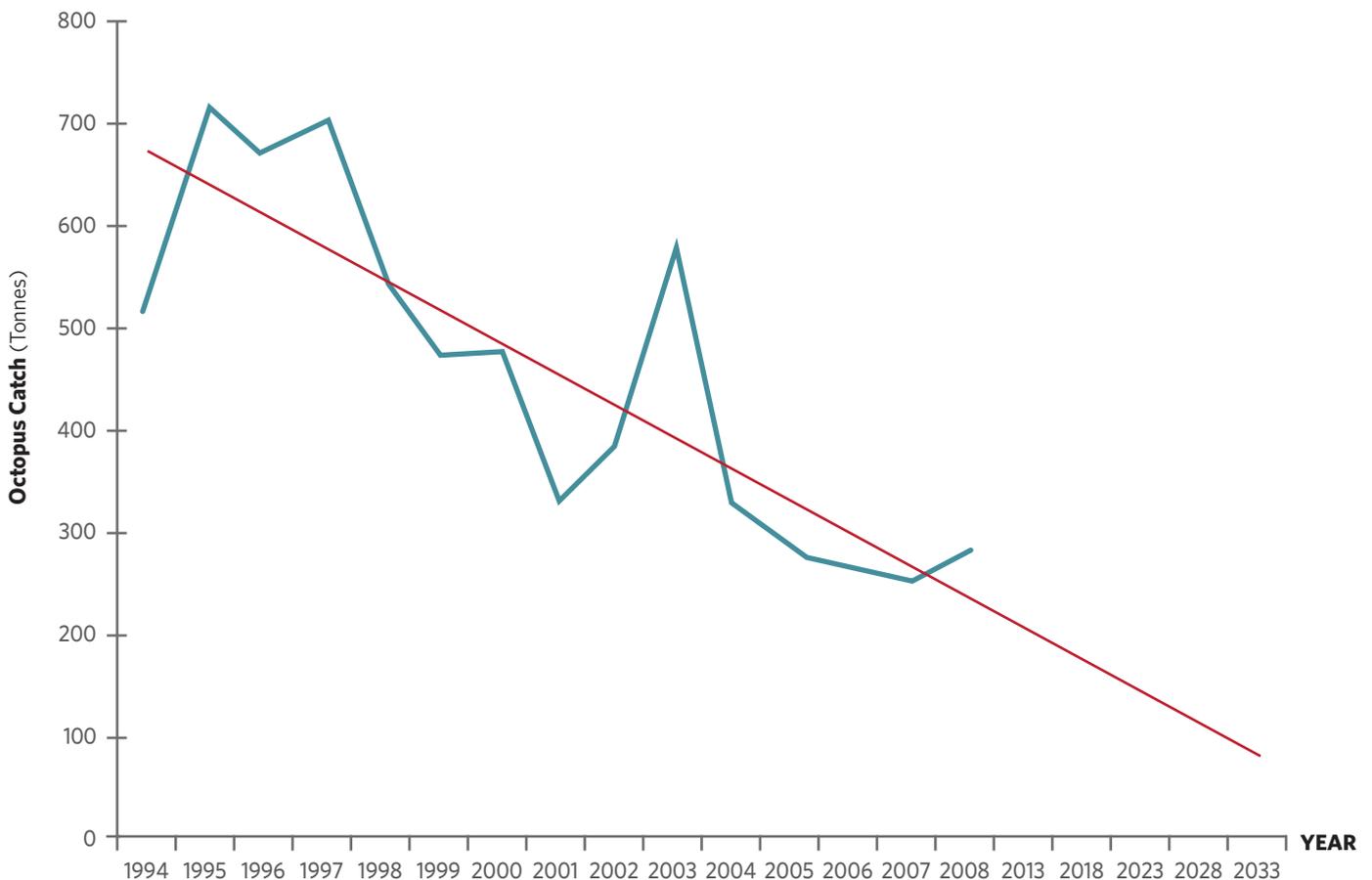
○ Water Resources Management

In the Best Case Scenario for water resource management, the Rodrigues Regional Assembly acknowledges improved water supplies as the most important precondition for economic development and the improvement of the quality of life on the island. Current commitments are aimed at increasing water hygiene and improved supply as well as community and domestic rainwater harvesting and storage. These plans can increase water provision by 5-10% but greater priority and commitment is needed to radically increase supply, improve efficiency of the distribution system and promote water use efficiency as a key element in securing greater economic and social development.

○ Coastal and Marine Resources

In the case of the coastal and marine resources, the need to implement the Integrated Coastal Zone Management Plan is given full attention. It is decided to introduce new legislation on the protection of marine resources, management of islets and to reinforce the control of sand extraction. As a complementary measure, serious thought is given to the gradual replacement of coral sand by rock sand or any other alternative. Appropriate policies are put in place to set the stage for the promotion of off-shore fishing. This reduces over-fishing in the lagoon and thus helps in restoring a healthy marine ecosystem. With bold measures taken to restore the marine habitat, the decline in octopus catch (Figure 13.11) is reversed and this sector contributes to the Rodriguan economy.

Figure 13.11: Decline in octopus catch (1994 - 2008) with projections till 2030



Source: CSO - Digest of Statistics on Rodrigues, 2009
(Data for 2009 not available)

Chapter Summary

~ Solid Waste Management

CHALLENGES

- ▶ Waste is generated at a rate of 0.65 kg/head/day and about 8,900 tonnes of waste is produced annually. Waste amounts are increasing with rising population, expanding tourist industry and new consumption trends.
- ▶ The Roche Bon Dieu dumping site is associated with environmental problems like odour, smokes from accidental fires and risk of lagoon pollution.
- ▶ About 10% of the island is not serviced by waste collection facilities.
- ▶ Recycling levels are very low and no scheme exists for the management of hazardous waste.

PROGRESS

- ▶ Legislation has been enacted to regulate waste collection.
- ▶ The Roche Bon Dieu dumpsite has been extended in 2008 and a new sanitary landfill is being set up at Grenade.
- ▶ Scrap metals, waste oil, plastic bottles and used batteries are being collected and sent to Mauritius for recycling or eventual export. Composting projects have been launched in all primary schools.

PROSPECTS

- ▶ Provide regular and efficient waste collection throughout the island.
- ▶ Elaborate and adopt a waste management strategy with emphasis on recycling and composting.
- ▶ Promote recycling through fiscal incentives.
- ▶ Consider composting as an option to reduce the amount of waste requiring final disposal.

~ Land and Agriculture

CHALLENGES

- ▶ Soil erosion is a serious problem in Rodrigues, caused by bad agricultural practices, past deforestation, poor building practices, steep topography and high intensity of rainfall.
- ▶ Heavy soil erosion results in siltation of lagoons and affects the marine ecosystem, especially corals.
- ▶ Soil erosion reduces agricultural productivity. Land under food crop cultivation has decreased from 994 ha in 1992 to 488 ha in 2009.

PROGRESS

- ▶ A physical development strategy and local plan for Rodrigues have been prepared to control land use on the island.
- ▶ Afforestation, terrace farming and fencing of pasture lands are some of the measures taken to curb soil erosion and control grazing.

PROSPECTS

- ▶ Adopt and implement the policy on land use planning and introduce legislation to regulate land use.
- ▶ Curb soil erosion through afforestation and terracing.
- ▶ Set up a Land Management Information System.

Chapter Summary

~ Water Resources

CHALLENGES

- ▶ Water scarcity, storage and distribution are the main problems in the water sector. This has wide-ranging socio-economic impacts thereby, restricting domestic life, agricultural and industrial development and inward investment.

PROGRESS

- ▶ An independent water company has been set up to improve the water distribution system.
- ▶ Four desalination plants have been commissioned in 2009 to increase potable water supply.
- ▶ A new reservoir of 1,000 m³ capacity is in the pipeline.

PROSPECTS

- ▶ Increase community rainwater storage, water hygiene and domestic rainwater harvesting.
- ▶ Increase supply, improve the efficiency of the distribution system and promote water use efficiency.

~ Coastal and Marine Resources

CHALLENGES

- ▶ The legislative framework is inadequate for the conservation of marine resources.
- ▶ Bad fishing practices (like trampling) are causing irreversible damage to the ecosystem.
- ▶ There is overfishing in the lagoon and fish stocks are decreasing.
- ▶ Outer reef fisheries are not being highly exploited despite its good potential.
- ▶ Sand extraction is being carried out at a rate of 25,000 tonnes per year. Illegal extraction is not uncommon, especially around the islets.
- ▶ Rodrigues is not spared from the threat and impacts of climate change and a general warming trend has been recorded.
- ▶ There is a lack of capacity for management of fishing reserves.
- ▶ The entire lagoon is considered as environmentally sensitive due to the widespread coral reef, sea grass and algal beds.
- ▶ Tourism expansion may put pressure on healthy coastal sites.

PROGRESS

- ▶ An Integrated Coastal Zone Management Strategy for Rodrigues has been prepared and some legislation enacted to control exploitation of marine resources.
- ▶ Mangroves have been propagated at several places to control soil sedimentation in the lagoon.
- ▶ Control measures have been strengthened to prevent illegal sand extraction.
- ▶ Four marine reserves and a marine park have been set up to protect marine resources.

PROSPECTS

- ▶ Encourage offshore fishing.
- ▶ Implement the Integrated Coastal Zone Management Strategy.
- ▶ Consider the replacement of coral sand by basalt sand or other alternatives.
- ▶ Introduce regulations for the protection of marine resources.

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Agalega and Saint Brandon

Agalega and the Cargados Carajos islands, commonly known as St. Brandon form an integral part of the territory of Mauritius. These two outer islands comprise a number of islets, some of which are inhabited.

Agalega

The atoll of Agalega is located about 1,000 km north of mainland Mauritius and consists of two narrow linear islands with a total area of 2,600 hectares: the North Island (12.5 km long and 1.5 km wide) and the South Island (7 km long and 4.5 km wide), which are linked at low tide by 1.3 km shallow bank, as shown in Figure 14.1. These two islands are surrounded by 100 km² of coral reef.

Access to Agalega by boat is limited and all the needs and requirements of its residents are shipped from Mauritius twice yearly. There is an air-plane strip for light aircrafts in the North Island. The airstrip is not licensed for commercial use and is used only for emergency and coast guard functions.

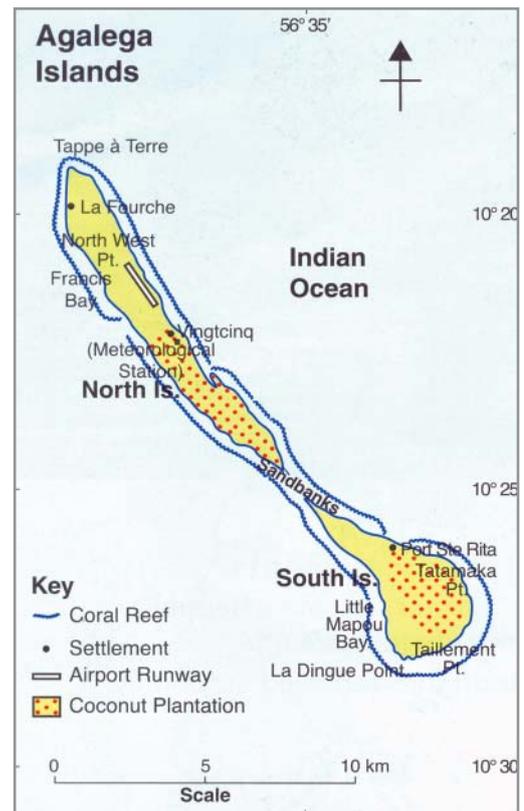
Agalega has three villages: two in the North Island, namely Vingt Cinq and La Fourche and Ste Rita in the South Island. Most infrastructures are situated in Vingt Cinq village. The population of Agalega is around 350.

To improve quality of life of Agaleans, a housing programme was initiated in 1996, which provided secure concrete dwellings resistant to cyclones. There are two pre-primary schools and two primary schools in Agalega. After successful completion of primary education and secondary education up to form three, students are sent to Mauritius for further studies. Measures are being taken to enhance the skills of workers in Agalega. In this context, some Agaleans have followed courses on rescue, fire fighting and safety. Some have received training for fishing off-lagoon at the Fishermen Training School, for pre-primary school and for bee-keeping. Health care is provided through two health centres. When required, doctors, specialists, and dentists from Mauritius visit

the island for brief periods of a few days using the twice yearly boat service. Patients can be airlifted from Agalega by the Dornier for emergency treatment. A meteorological station in the North Island of Agalega collects data on wind, sunshine, temperature and rainfall.

The economy of Agalega is mainly based on the exploitation of coconut¹⁹⁴ and its by-products. Agricultural diversification is a key challenge for Agalega in order to reduce its dependency on coconut and overcome its heavy dependency on mainland Mauritius. Artisanal fishery in Agalega is exploited at a subsistence level. Agalega was monetised in July 2002.

Figure 14.1: Agalega Islands



Source: Resource Atlas for Mauritius and Rodrigues, 2010

¹⁹⁴ Given that there is a good market for coconut oil, the target during the next five years is to increase oil production from the actual volume of 20,000 litres to a peak of 60,000 litres annually, which would earn a revenue of Rs. 1.2 millions.

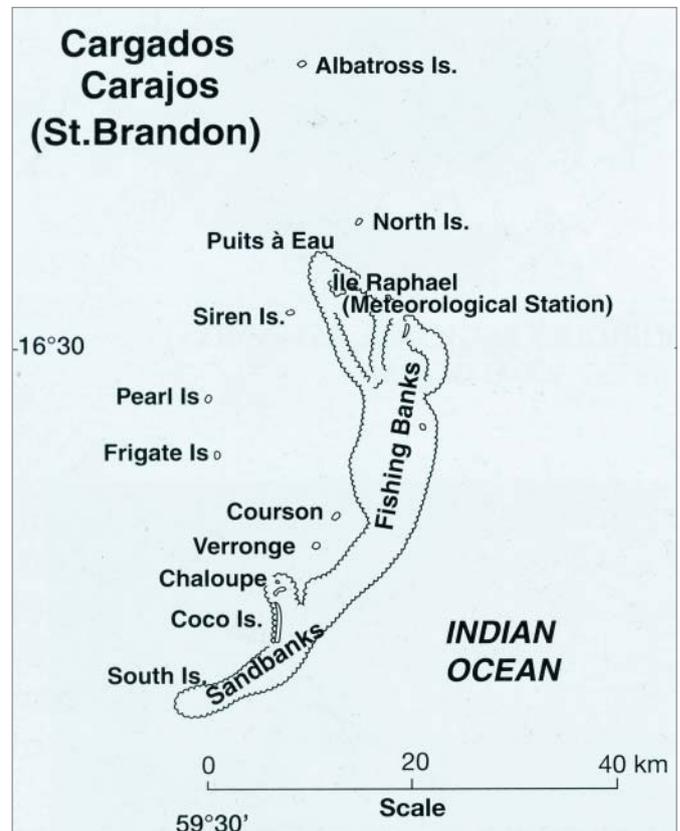
Saint Brandon

St. Brandon is a group of twenty eight islets, situated at approximately 450 km North East of Mauritius. A map of St. Brandon is shown in Figure 14.2. The total area of the islets is about 230 ha, which are spread over an area of 1,000 km². Some of these islets are mere sandy cays, which tend to change their shape and position after tidal waves or during cyclonic conditions. The lagoon is 190 km² with a coral reef of 100 km in length. Albatross Island is 6 m above mean sea level and is the largest and highest of the islands in the group, with an area of 1.01 km², followed by Ile Raphael, Avocaré, Cocos Island and Ile du Sud. The islands are covered with white granular sand from eroded coral.

Out of the 28 islets, 13 are leased to Raphael Fishing Co. Ltd. and the rest are under the control of the Outer Island Development Corporation as shown in Box 14.1. Access by boat is limited, without an effective jetty.

There is no permanent human settlement on St. Brandon. The population consists of fishers temporarily based on the island and staff of the National Coast Guard and the Meteorological Services. The main infrastructure on Ile Raphael comprise a privately owned commercial fishing station, a coast guard quarter, a meteorological station, a guest house, a chapel and a helicopter pad. No boat services exist for delivery of goods. Fishing for export to Mauritius is the main activity and there is no agricultural production in St. Brandon.

Figure 14.2: St. Brandon



Source: Resource Atlas for Mauritius and Rodrigues, 2010

BOX 14.1: STATUS OF ST. BRANDON ISLETS

LEASED TO RAPHAEL FISHING CO. LTD.

- ▶ Ile Boiséés/Ile du Sud
- ▶ Petit Fous
- ▶ L'Avocaire
- ▶ Aux Fous
- ▶ Du Gouvernement
- ▶ Petit Mapou
- ▶ Grand Mapou
- ▶ La Baleine
- ▶ Cocos Islands
- ▶ Ile Raphael
- ▶ Ile Verronge
- ▶ Ile aux Bois
- ▶ Baleine Rocks

UNDER THE CONTROL OF O IDC

- ▶ Albatross Island
- ▶ North Island
- ▶ Siren Island
- ▶ Pearl Island
- ▶ Frigate Island
- ▶ Sandy Cays
- ▶ Puits à Eau
- ▶ Tortues
- ▶ Paul
- ▶ Courson
- ▶ Capitaine
- ▶ Grand Dagonne
- ▶ Petit Dagonne
- ▶ Poulailier
- ▶ Longue

14.1 CHALLENGES

Isolation, climate change, fragile ecosystems and improvement in basic services to support economic development are the major challenges facing Agalega and St. Brandon. There is a general lack of environmental data on the Outer Islands as there is no systematic data collection and monitoring, due to the remoteness of the islands and lack of facilities for frequent visits there.

14.1.1 Climate Change and Sea Level Rise

Climate change and sea level rise are issues of major concern for Agalega and St. Brandon. Because of their small sizes and being low lying islands¹⁹⁵, they are vulnerable to sea level rise, which can affect the whole of the two islands. It is predicted that climate change will have serious impacts on Agalega and St. Brandon, resulting in flooding of the islands, salt water intrusion and damage to vital infrastructure. Other direct consequences of anticipated climate change and sea level rise will likely include: reduction in subsistence and commercial agricultural production of coconuts in Agalega, decreased security of water supplies and increased risk of diseases. Agalega might be in the same catastrophic situation as Tuvalu¹⁹⁶ in the Pacific Ocean.

The seas in the St. Brandon area are rough, making the islets prone to erosion such as Ile du Sud, which has suffered from massive natural coastal erosion during the last few years. Some islets have been completely washed out (Blue print on Saint Brandon, 2002). Climate change and sea level rise can accelerate this process of erosion.

14.1.2 Land Management

The absence of a land management plan for Agalega is a major issue of concern for the sustainable exploitation of land resources. The introduction of a land management plan to guide and assist landholders to actively manage their land and the associated resources for agricultural development for Agalega is important.

¹⁹⁵ The highest elevation for Agalega is 7 m at Colline D'Emmerez and that of St. Brandon is 6 m at Albatross Island.

¹⁹⁶ Tuvalu is a Small Island Developing State situated in the Pacific Ocean. People of Tuvalu are experiencing the impacts of climate change and sea level rise daily. Since the past few years, sea water is increasingly flooding the shores, crop cultivation is becoming more difficult due to high soil salinity, the frequency of floods is rising and groundwater is becoming undrinkable due to sea-water intrusion. The nation's smallest island has disappeared and to adapt to sea level rise, new houses are being built on 10-foot tall pillars. Local communities are being progressively more affected and main economic activities are disrupted. Tuvalu residents have been forced to evacuate parts of the country because of rising sea levels. As a result, the Tuvalu Government has been exploring the possibility of buying land in a nearby country in case the inhabitants became climate change refugees.

¹⁹⁷ The population in Agalega relies on bottled and boiled water for drinking. About 1,000 bottles of water are sent from Mauritius every 6 months. Ground water is used for washing purposes.

¹⁹⁸ Sewage and grey water (wastewater generated from domestic activities such as laundry, dishwashing, and bathing) are disposed into septic tanks and absorption pit. In view of high water table, there is an evident risk of groundwater contamination.

14.1.3 Decreasing Fish Catch

Fishing in Agalega is practised at artisanal level only for subsistence, as compared to St. Brandon, which has two major fishing grounds. The Food and Agriculture Organisation and the Albion Fisheries Research Centre have estimated the sustainable fish yield for St. Brandon at 680 tonnes per year (Blue Print on Saint Brandon, 2002). However, since 1995, a decreasing trend in fish catch has been reported as shown in Figure 14.3. Furthermore, the fish catch in St. Brandon area from 1995 to 2003 was well above the sustainable yield of 680 tonnes of fish per year. If management measures are not strictly implemented, it is estimated that fish catch will decrease to 100 tonnes by 2030. The major challenge for St. Brandon is to ensure protection and management of fisheries resources within sustainable limits.

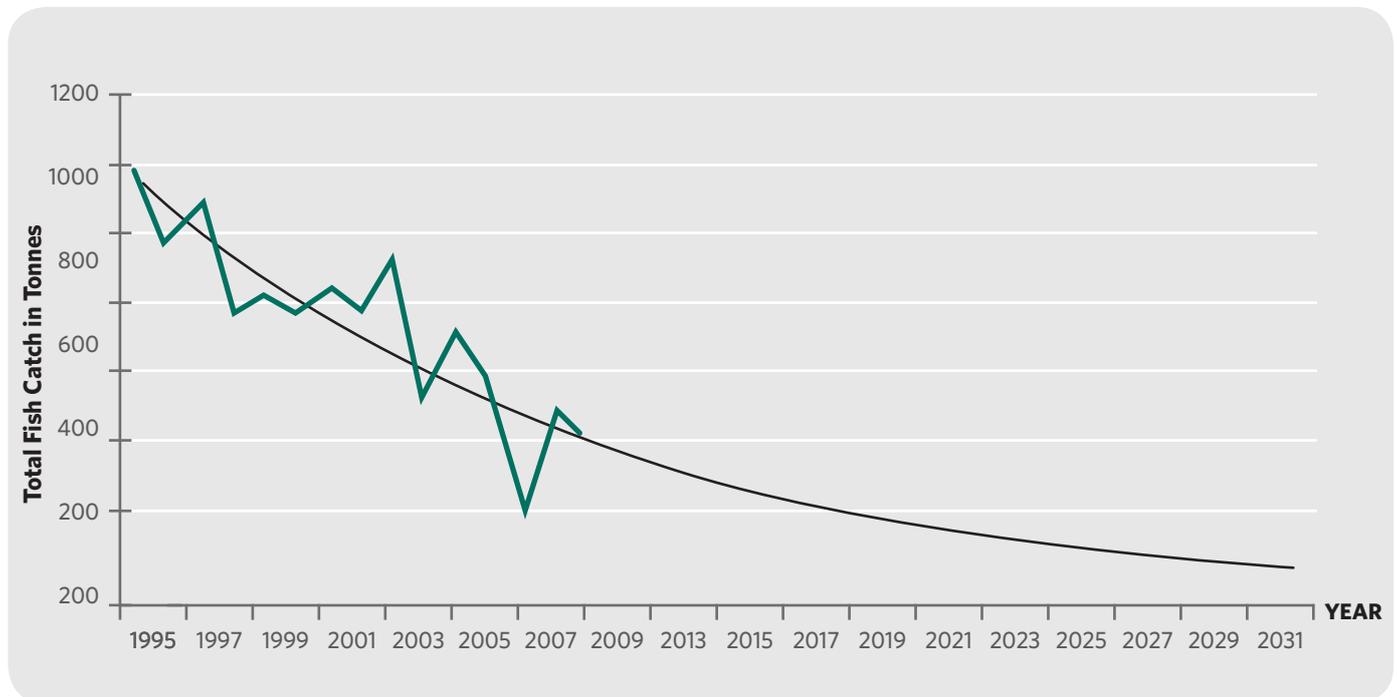
14.1.4 Inadequate Basic Services

Underdeveloped public services including water, sanitation and waste management are major environmental challenges for Agalega and St. Brandon.

Water Supply

The key issues of concern in this sector include inadequate water collection and storage, contamination of groundwater, especially from salt water intrusion and absence of monitoring of water resources. Agalega and St. Brandon do not have piped water¹⁹⁷ supply and rely on rainwater and underground water for domestic consumption. In Agalega, the depth of water table is less than 1 m, thus putting groundwater at risk from sea water intrusion and untreated sewage¹⁹⁸. As a result, there is a need to develop wastewater management policies and strategies for more effective pollution control. Rainwater harvesting is a common practice and water is collected through run-offs from roof tops. The stored water is chlorinated for drinking purposes.

Figure 14.3: Fish catch in St. Brandon (1995 - 2009) and projections till 2030



Source: Ministry of Fisheries and Rodrigues

The majority of the islets of St. Brandon do not have potable water supply and there is no rainwater harvesting systems. The sizes of the islets are too small to allow the formation of a fresh water table separated from sea water. On these islets, rainwater infiltrates through the permeable upper sandy formations and finds its way to the brackish water table, which is unfit for human consumption.

○ Solid waste disposal

Though the level of consumption is still low in Agalega, solid waste is disposed in open dumping grounds, thus presenting risks to health and leading to pollution of ground water. The Outer Islands do not have a policy and strategy on solid waste management. In this context, there is a need to develop an integrated solid waste management plan to minimise environmental impacts and safeguard public health.

○ Electricity Supply

There is no national power grid on Agalega. The inhabitants rely on diesel-fuelled generators for electrical supply, which is provided free of charge to the three villages on a 24-hour basis. However, the diesel generators are a source of air pollution and can contribute to respiratory diseases. Furthermore, another challenge is the price of the fuel and the cost of transport to Agalega, which are both increasing significantly annually. There is a strong need to exploit renewable sources of energy in order to support new economic and social development of the local people and the tourism industry.

14.1.5 Future Development

According to a 2001 World Bank Report¹⁹⁹, no major economic activities are recommended on the islands, except ecotourism projects and fishing activities within the sustainable limits of 680 tonnes of fish per year. There is a need to develop an ecotourism development strategy geared towards sustainable development of the tourism sector for St. Brandon and Agalega integrating environmental protection.

14.1.6 State and Trends in terrestrial, Marine and Coastal Biodiversity

The terrestrial and marine biodiversity of the Outer Islands contains a rich genetic diversity in a relatively pristine state. However, no complete inventory of biodiversity resources has been undertaken and there are no biodiversity management and monitoring plans. Furthermore, an impediment to data collection is the lack of frequent transport, shortness of visits and weather constraints.

Coastal and Marine Resources

St. Brandon area supports a valuable and fragile marine biodiversity, which is still in pristine condition with abundant large reef fish, corals and sea creatures. Sea turtles are found in most of the waters adjoining the islets. The sandy beaches of the islets of St. Brandon are the nesting grounds for Green turtles and Hawksbill turtles throughout the year. These species were declared protected in 1983 and are considered as endangered. However, there has been a sharp decline in their numbers and are now rarely seen due to intense hunting activities (Blue Print on St Brandon, 2002). Up till now, no new study on the biodiversity of the outer islands has been carried out.

St. Brandon is also an important seabird site. The populations of seabirds appear to be in decline due to poaching and predation from introduced rats. The most abundant²⁰⁰ species is the Sooty Tern (*Sterna fuscata*) and four other species of global or regional importance. The site is not a protected area but still holds impressive seabird



Coastal environment of St Brandon
Courtesy: <http://www.gov.mu>

populations because of its remoteness and the difficulty of landing on some of the islets. As for Agalega, most of the seabirds disappeared in the 1940's due to purposeful nest destruction, poaching and predators. However, some seabirds are now seen on the island, suggesting that re-colonisation may be occurring.

A common problem to both of these islands is the accumulation of marine debris on their coasts. Marine debris comprise plastics, flip-flops, glass and nylon fishing nets and when these break down, they release harmful substance in the lagoon (Bouwman et al., 2011).

Terrestrial Ecosystems

The natural vegetation of St. Brandon has suffered from the introduction of invasive plant and animal species, particularly on those islets where human activity is more intense. Plants and animals are introduced continuously as there are no quarantine measures for the Outer Islands. In Agalega, a host of invasive²⁰¹ species have been introduced, with the most invasive one being the Acacia (*Leucaena leucoceph*). Yellow Wasps (*Polistes hebraeus*) have also been introduced through bottle crates and these

¹⁹⁹ A study was conducted in 1997 on St. Brandon by the World Bank and the Swedish Development Cooperation Agency.

²⁰⁰ Additional nesting seabird species are Lesser Frigatebird (*Fregata minor*), Greater Frigatebird (*Fregata Ariel*), Wedge-tailed Shearwater (*Puffinus pacificus*), Masked Booby (*Sula dactylatra*) and Red-tailed Tropicbird (*Phaethon lepturus*).

²⁰¹ Some 214 plant species have been surveyed on Agalega, 30 of which are native to Agalega (not endemic) and the rest (184) are introduced species, of which 50% (92) are invasive. Introduced species includes 61 ornamental plants, 39 vegetables, and 25 fruit trees

could have been easily prevented from entering the island. Agalega is also home to an endemic lizard, *Phelsuma agalegae*, which however merits further scientific research.

● 14.2 PROGRESS

◎ 14.2.1 Institutional and Legal Framework

The Outer Islands Development Corporation (OIDC) is responsible for the management of the Outer Islands of Mauritius, including the ways and means to promote their economic and social enhancement. The Outer Islands Development Corporation Act 1982 is the legal framework overseeing management of the islands. The Agalega Island Council set up in 2004, works in close collaboration with the OIDC for the social development of Agalega.

◎ 14.2.2 Policies and Programmes in Agalega

Over the last fifteen years, the following measures have been taken to improve the standard of living of the Agaleans. Many of these initiatives are eco-friendly and contribute to the environmental sustainability of the island.

○ Renewable Energy Projects

The Mauritius Research Council and the OIDC are investigating the use of coconut oil as biofuel to generate electricity. Projects are also planned to generate electricity using various mixtures of coconut oil/diesel. These projects are part of the "Energy Self-Sufficiency of Agalega – Biofuels²⁰² and Solar energy" programme.

There are plans to supply 70 photovoltaic panels to the island to reduce its dependence on fossil fuels. It is expected that on successful completion of the project:

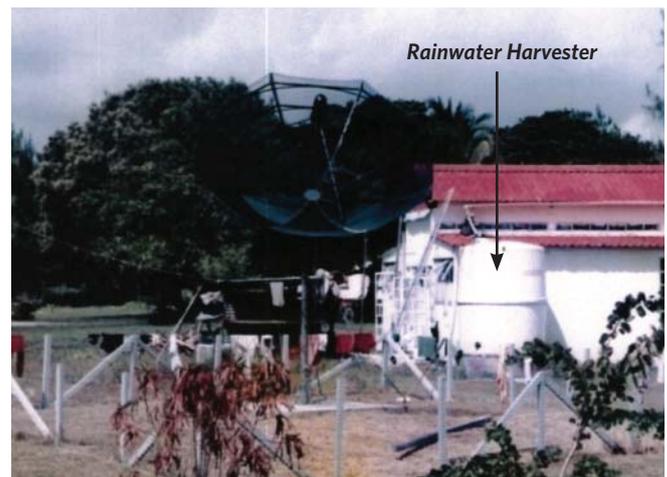
- Diesel import for Agalega will be reduced by 60%
- At least 70 households will depend on solar energy for electrification purposes
- Local inhabitants will be trained for operation and maintenance of the panels
- About 33 tonnes of CO₂ emissions will be offset.

- Agalega will become one of the first islands in the Indian Ocean and African region to move towards self-sufficiency and energy independence.

○ Water Conservation Measures

The mean annual rainfall for Agalega is 1,600 mm with an average monthly rainfall ranging from 46 mm to 272 mm. It rains throughout the year with the driest months being August and September with about 50 to 60 mm of rainfall.

Water shortage in Agalega is addressed through the use of domestic rainwater harvesters. Most of the housing units are equipped with rainwater harvesting system with chlorination.



Rainwater harvesting system in Agalega

Courtesy: Outer Islands Development Corporation

○ Construction of a Tsunami Refugee Centre

A tsunami refugee centre has been built on Agalega in case of tsunami and other natural calamities. The building has been constructed on a height of five metres and is sited at a minimum floor level of four to five metres above high water mark to disseminate the wave energy. The building is surrounded by retaining walls. A tide gauge has been installed to monitor sea level and detect tsunamis in Agalega.

²⁰² Presently, one tractor, out of the ten in Agalega is being run by coconut oil.

14.2.3 Policies and Programmes in St. Brandon

Over the past 20 years, much progress has been made on the island, especially the fishing industry.

Blue Print for the Management of St. Brandon

A Blue Print on future economic development for St. Brandon was prepared in 2002 so as to manage and develop the islets with better land use, improvement in services, environmental protection, fisheries management, tourism development and diversification of the economy. The Blue-print has been approved by Government in 2004 and needs to be implemented. The salient issues in the Blue Print which are based on recommendations made in the World Bank Report 2001 are as follows:

- Declaration of St. Brandon as a Marine Protected Area.
- Division of the Archipelago into five distinct zones with specific recommendations for the sound management of each zone.
- No major economic activities to be carried out on the Archipelago except fishing within the sustainable limits of 680 tons of fish per year.
- No resort or hotel accommodation or supporting infrastructure such as harbours and runways to be set anywhere in St. Brandon.
- The Fisheries Division and the National Parks and Conservation Service to monitor at least once every year the populations of birds, turtles and fish.
- Restoration of the native fauna through eradication of introduced animals.
- Reinforcement of the Coast Guard Service on St. Brandon by the provision of patrol vessels and through training of officers.

Fisheries Management Plan and Surveillance for St. Brandon

In order to exploit the fisheries resources in a sustainable way, fishing activities in the area of St. Brandon is managed through a precautionary approach via a Fisheries Management Plan, which includes strict control on the number of licences issued and the fishing methods used. Six vessels have been granted licences to operate in the St. Brandon area at any one time and the fishing methods authorised are basket traps and hand lining.

The Coast Guard aircraft carries out regular aerial surveillance against illegal fishing at St. Brandon and adjoining areas on a fortnightly basis. Limited patrol of adjoining lagoons is carried out by means of an inflatable boat.

Coastal Rehabilitation Works

In 1995, gabion was installed on Ile Raphael to prevent the shoreline from being washed away.

● 14.3 PROSPECTS

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO FOR AGALEGA)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Absence of a land management plan	Develop a land management plan	<i>Sustainable use of land resources</i>
Inadequate water collection and storage	Promote rainwater harvesting and increase freshwater collection and storage	<i>Increased access to water</i>
Absence of data and monitoring of natural and environmental resources	Undertake regular inventories, surveys and monitoring of resources	<i>Adequate information for decision making</i>
Decrease in terrestrial and marine biodiversity	Develop biodiversity management plan	<i>Ecological integrity of biodiversity preserved</i>
Inadequate wastewater management systems	Develop wastewater management practices	<i>Environmental impacts minimized and public health safeguarded</i>
Inadequate solid waste management systems	Develop an integrated waste management plan	<i>Sanitation services improved</i>
Future tourism development	Develop an ecotourism strategy	<i>Sound ecotourism development</i>
Low penetration of renewable energy	Promote renewable energy	<i>60% reduction in diesel import and energy self-sufficiency achieved</i>
Climate change and sea level rise	Develop and implement climate change adaptation programmes	<i>Increased resilience to climate change</i>

TOWARDS MAURICE ILE DURABLE (BEST CASE SCENARIO FOR ST. BRANDON)

ISSUES	FUTURE ACTIONS	EXPECTED RESULTS BY 2030
Over exploitation of fish stocks	Declaration of St. Brandon as Marine Protected Area and strict adherence to Fisheries Management Plan	<i>Sustainable fish catch</i>
Inadequate water collection and storage	Promote rainwater harvesting	<i>Increased access to water</i>
Absence of monitoring and inventory of terrestrial and marine resources	Undertake regular inventories/ surveys of terrestrial and marine resources	<i>Adequate information for decision making</i>
Decrease in sea turtles and seabirds population	Develop and implement biodiversity management plan	<i>Ecological integrity of biodiversity preserved</i>
Future tourism development	Develop an ecotourism strategy	<i>Sound ecotourism development</i>
Introduction of invasive plant species due to lack of quarantine measures	Adoption of quarantine measures on the island	<i>Population of invasive species decreased</i>
Climate change and sea level rise	Develop and implement climate change adaptation programmes	<i>Increased resilience to climate change</i>

14.3.1 Policy Options for the Future

The size and distance of the Outer Islands and their small populations present special challenges for delivering basic services, promoting development and environmental management. The very fragile nature of their ecologies makes them of special interest for research and for monitoring the impact of changes that will take place in Agalega and St. Brandon.

The will and capacity of Mauritius to manage the resources of Agalega and St. Brandon for the well-being of present and future generations are important issues. In the Best Case Scenario, Mauritius recognizes the importance of an integrated and effective planning and management regime for the outer islands. Government also recognises the need to preserve and protect the marine and terrestrial biodiversity, which constitute important natural and economic resources. If remedial measures are not taken now, many of the resources would be further depleted or destroyed.

Government has identified some key strategies for the sustainable development of the Outer Islands through proper and rational management of land use, water resources, biodiversity, waste and natural and man-made disasters in the 2007 National Environment Policy (NEP). The NEP has come up with the following strategies and policies, which if effectively implemented will help to enhance environmental protection and mainstream environmental concerns into economic development activities in Agalega and St. Brandon.

Land-Use Management

- Develop appropriate land management plans.
- Streamline the grant of leases.
- Monitor impact of development activities.
- Allow only low impact eco-tourism projects.

Water Resources Management

- Develop appropriate sustainable water resources management to meet present and future demand.
- Introduce and develop wastewater management practices that minimize environmental impact and safeguard public health.
- Introduce water monitoring.
- Promote rainwater harvesting.
- Investigate innovative methods of freshwater collection and storage.

Conservation and Sustainable Use of Biodiversity

- Protect and manage marine and terrestrial biodiversity in a sustainable way.
- Undertake regular inventories of fauna and flora.
- Develop biodiversity management plans.
- Consider the designation of some of the islets as World Heritage sites.

Marine and Coastal Zone Management

- Monitor fisheries resources and adjust fisheries quota accordingly on a regular basis.
- Regulate marine resource exploitation.
- Respect the 30 metres setback for infrastructure development.
- Create marine parks.
- Monitor beach erosion.

The Built Environment

- Define architectural guidelines in line with the specificities of the Outer Islands.
- Optimise the use of local materials, especially renewable ones, in construction.
- Consider the promotion of sustainable buildings.

○ Environment and Health

- Consider the introduction of composting of organic wastes in Outer Islands.
- Plan the import and sustainable use of chemicals and products to minimise the generation of hazardous waste.

○ Energy and Environment

- Encourage the use of renewable energy.

○ Waste Minimisation

- Develop an integrated waste management plan for Outer Islands.
- Set up a proper sanitary landfill.
- Organise awareness campaigns on waste reduction initiatives, recycling and proper disposal.
- Develop appropriate schemes for the export of bulky and hazardous waste such as waste oil, tyres and batteries for recycling.

○ Natural and Man-Made Disasters Management

- Operationalise an Oil Spill Contingency Plan for Outer Islands.
- Build awareness of the local population with regard to response and evacuation strategies in the event of disasters.

○ Environmental Education and Awareness

- Develop an action plan on environmental education for implementation at school level.

Implementation of the strategies and policies set out in the NEP and the Blue Print for St. Brandon, together with the adoption of the following measures will pave the way towards the sustainable development of the Outer Islands:

- Development and implementation of a climate change adaptation programme to increase resilience to climate change.
- Development of an ecotourism strategy to promote sound ecotourism.

Faced with the various constraints that are inherent to Small Island Developing States and the need to redesign the architecture of the economy, the Outer Islands have no other choice than to adopt the path of sustainable development. The implementation of the above action-oriented strategies will help to achieve this aim. However, this relies on effective governance, partnerships between all stakeholders, an integrated planning and an effective enforcement mechanism.

Chapter Summary

CHALLENGES FOR AGALEGA AND ST. BRANDON

The major challenges facing the Outer Islands are:

- ▶ Absence of a land management plan.
- ▶ Inadequate water collection and storage, wastewater and solid waste management systems.
- ▶ Loss of marine and terrestrial biodiversity and introduction of invasive species due to lack of quarantine measures.
- ▶ Impacts of climate change and sea level rise.
- ▶ Overexploitation of fish stocks.

PROGRESS

In order to promote sustainable development of Agalega and St. Brandon, the following initiatives have been taken by Government:

~ *Agalega*

- ▶ Provision of electricity to three villages on a 24 hour basis.
- ▶ Installation of rainwater harvesters for water conservation.
- ▶ Construction of a tsunami refugee centre and installation of a tide gauge.

~ *St. Brandon*

- ▶ Development of Blue Print for St. Brandon.
- ▶ Strict control on number of fishing licences and methods used.
- ▶ Aerial surveillance on St. Brandon and adjoining areas on a fortnightly basis by Coast Guard Aircraft.
- ▶ Coastal rehabilitation works on Raphael Island.

PROSPECTS

There are still major improvements to be done in order to promote development and reduce the degradation of the natural resources of Agalega and St. Brandon. The main actions are to:

- ▶ Develop land, biodiversity, solid waste and wastewater management plans.
- ▶ Promote rainwater harvesting systems and investigate innovative methods of freshwater collection and storage.
- ▶ Undertake regular inventory and monitoring of water, biodiversity and marine resources.
- ▶ Promote renewable energy development and use.
- ▶ Make greater use of biofuels in Agalega from coconuts to reduce imports of fuel for electricity and transport.
- ▶ Promote low impact ecotourism projects.
- ▶ Develop and implement a climate change adaptation strategy.
- ▶ Monitor fisheries resources and create marine parks.
- ▶ Adopt quarantine measures to prevent introduction of invasive species.
- ▶ Declare St. Brandon as a Marine Protected Area.
- ▶ Ensure strict adherence to St. Brandon Fisheries Management Plan.
- ▶ Increase surveillance against illegal fishing in St. Brandon and adjoining areas.

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Conclusion

The Mauritius Environment Outlook report traces the changing state of the environment of Mauritius since 1990, the prospects for environmental management for the next twenty years and the implications of these trends for further economic and social development.

STATE IN 1990

The population of Mauritius was about 1 million, with on average 0.2 hectares of land per person, compared with a global average of 2.6 ha. Economic growth in the 1980s and 1990s enabled Mauritius to transform itself from a low-income country with a mono-crop economy to a middle-income country with a four-pillar economic base, namely: manufacturing, sugar, tourism and financial services. As the economy grew, the standard of living of the Mauritian population started to improve leading to an increase in consumption and production patterns. Concurrently, steps were also taken to address emerging environmental problems which affected social wellbeing and which could otherwise constrain economic growth. In this respect, the institutional, legal and policy framework for environmental protection and management was established.

Natural Resources

In 1990, air, freshwater, land, coastal and marine resources, inland biodiversity and offshore islets were being affected by uncontrolled development. Legislation, standards and comprehensive strategies, physical planning framework and monitoring programmes for the protection of these resources were inadequate or lacking.

Sugar cane and backyard waste burning were common practices, Chlorofluorocarbons and leaded petrol were still in use and industrial activities were causing localised air pollution. Freshwater, coastal and marine resources were impacted by sewage, industrial effluents, agricultural runoffs, dumping of solid waste, tourism development and marine based pollution, amongst others. The importance of ecosystems such as wetlands was largely overlooked, while fishing and extraction of coral sand for construction were fully exploited.

Some measures were however taken to prohibit removal and sale of corals and shells and control or ban certain fishing activities. Human activities, invasive alien species and littering impacted mainland and offshore islets biodiversity. Nonetheless, biodiversity protection was an important issue and conservation programmes were initiated for safeguarding biodiversity.

Emerging Challenges

Changing consumption patterns and economic activities have been accompanied by a corresponding increase in energy demand, chemicals use and waste generation. Waste was disposed in open dumps with no environmental safeguards and waste collection services were irregular, resulting in accumulation of waste and proliferation of unauthorised dumps. Electricity generation was fossil fuel intensive. Mauritius was also a heavy user of agricultural chemicals. The impacts of climate change on the island were also not fully realised. In 1990, 300,000 tourists visited the country. However, tourism development was not planned and its effects in the island's environment started to be felt.

Outer Islands

Soil erosion, land degradation, siltation of the lagoon and overfishing were the most common environmental problems in Rodrigues. Furthermore, physical planning was restricted to meet immediate requirements rather than long term needs.

PRESENT STATE AND ENVIRONMENT OUTLOOK TO 2030

Since 1990, the population has increased by about 300,000 to 1.3 million, with land reduced to 0.16 ha per person. Mauritius has reached a Developing Country status, which has been possible due to sustained growth in the tourism, financial services, construction and manufacturing sectors. Emerging economic sectors include the ICT/BPO and seafood sectors, the IRS/real estate, energy industries and the health and education hubs. The economy has grown by over 4% a year during the past twenty years and the standard of living has increased by 10% in that period.

Mauritius has also made considerable progress in environmental management and the range of policies is now more advanced compared to 1990. Comprehensive environmental policies and strategies and an umbrella legislative framework, which enables strategic level decision-making, development control, pollution prevention, prosecution and standards development amongst others are in place. Additionally, mainstreaming environmental concerns in sectoral plans and a more holistic approach to development and planning have contributed to shift environment from the periphery to the core of decision making. However, data on environmental resources, monitoring and enforcement need to be strengthened for better policy formulation and decision making.

AIR

A series of projects have been undertaken to improve air quality such as phasing out of leaded petrol, importing cleaner diesel, banning chlorofluorocarbons and monitoring vehicular emissions among others. Regulations and standards on air quality have been promulgated and are being reviewed. Air quality monitoring and enforcement are undertaken but are not adequate due to lack of technical capacity. Continuous time series data on air quality is therefore lacking, but preliminary work has been undertaken to set up a network of air monitoring stations and to develop an air quality index.

Policy Options for the Future

- Promulgate standards for ambient air quality and stack emissions for sector specific activities.
- Establish a network of air quality monitoring stations and develop an air quality index.

- Set up an Air Pollution Control Unit for systematic air quality monitoring and enforcement.
- Introduce the polluter pays principle and economic instruments to trigger technological innovations, cleaner technologies and pollution control strategies in industry.
- Import cleaner fuel and green vehicles.

FRESHWATER

Mauritius is a water-stressed country and a number of activities put pressure on freshwater resources. Enforcement of legislation to reduce pollution in the water sector is inadequate. However, significant investment has been made to increase supply and improve water quality. An Integrated Water Resources Management Plan has been developed and actions are being taken to reduce unaccounted for water. Currently, 29% of the population is connected to the sewerage network and there are plans to increase connection to 50% by 2015.

Policy Options for the Future

- Set up and operationalise the Water Authority to enhance overall water management.
- Promote the Integrated Water Resources Management approach and sustainable watershed management.
- Achieve significant water conservation in domestic and agricultural sectors and adopt sustainable consumption and cleaner production in industry in order to reduce water consumption and pollution loads.
- Reduce unaccounted-for-water to 20% by 2030.
- Implement the National Sewerage Programme by connecting 80% of the population to the sewerage network by 2030 and optimise reuse of treated wastewater.
- Develop and implement a water quality indexing system for surface waters.
- Review water related legislation and improve enforcement mechanisms for water resources protection.

LAND

A physical planning framework comprising of strategies, planning guidelines and legislation has been developed and is being implemented. A national digital cadastre is under preparation. Development on Environmentally Sensitive Areas and along the coastline is controlled. However, urban expansion, including land requirements for housing, industry, tourism, infrastructure development and leisure activities are putting pressures on scarce land resources

Policy Options for the Future

- Develop integrated land planning and strengthen enforcement of planning guidelines and legislation.
- Reform planning guidelines to take into consideration emerging issues such as: additional requirements for space for housing, hotel development and infrastructure, waste disposal and the impacts of climate change and sea level rise.
- Ensure sound development practices in sensitive areas and along the coastal zone in line with the Study on Environmentally Sensitive Areas and the Integrated Coastal Zone Management Framework.
- Progressively decentralise work places and commercial activities from Port Louis to reduce traffic flow and improve the road network and introduce mass transit systems, pedestrian routes and cycle ways to complete the transport alternatives.

SOLID WASTE MANAGEMENT

Efficient waste collection services are provided island-wide. The waste management system is well organised with a network of transfer stations and an engineered sanitary landfill for waste disposal. Waste generation is currently at 1 kg/head/day and increasing waste amounts are putting pressure on the disposal facility. Waste characterisation has not been undertaken during the last six years. Furthermore, there is no comprehensive strategy and legislation on waste, no waste sorting policy and recycling levels are low.

Policy Options for the Future

- Develop and implement an Integrated Waste Management Strategy.
- Introduce waste management legislation with obligations for waste reduction, sorting, reuse and recycling.

- Introduce a waste sorting scheme at national level.
- Set up civic amenity centres and material recovery centres at existing transfer stations to optimize collection of recyclable waste.
- Increase recycling rate and promote backyard composting to divert waste from the already saturated landfill.

COASTAL & MARINE RESOURCES

Urban expansion, land reclamation and clearing, tourism development, climate change and sea level rise are having negative impacts on fragile coastal and marine resources. Some 7 km of beach have been affected by erosion and there is insufficient development control monitoring and enforcement. In general, coastal water quality is good, but coral cover in the lagoon is about 40%, while in off-lagoon it is about 30%. Policies and strategies have been adopted for better management of coastal and marine resources and a comprehensive legal framework for coastal management is in place. Sand mining has been banned since 2001 and coastal rehabilitation work undertaken to reduce erosion. Marine parks and fishing reserves have also been proclaimed.

Policy Options for the Future

- Implement recommendations of the Integrated Coastal Zone Management Framework and the Study on Environmentally Sensitive Areas.
- Promote sound development practices in the coastal zone by ensuring strict adherence of coastal development to Outline Planning Schemes and Planning Policy Guidance.
- Implement Local Area Action Plans for the five pressure zones: Grand Baie, Ile D'Ambre, Le Morne, Belle Mare and South Coast.
- Implement the Blue Flag programme for sustainable development at beaches.
- Strictly implement fisheries management measures in the lagoon and in the Exclusive Economic Zone.
- Declare more Marine Protected Areas.

INLAND BIODIVERSITY

Pressures from human activities, natural factors and invasive alien species affect inland biodiversity. Although Mauritius is characterised by a high level of endemism, it has the third most endangered terrestrial flora in the world. The extent of native forest of reasonable quality is less than 2% of the total area of the island. Policies and strategies for the conservation and sustainable use of biodiversity have been adopted and are at various stages of implementation. A number of projects and programmes for the conservation of terrestrial flora and fauna are being implemented.

Policy Options for the Future

- Implement recommendations of the National Biodiversity Strategy and Action Plan (2006 - 2015) and the National Invasive Alien Species Action Plan (2010).
- Develop management plans for protected areas and threatened species.
- Extend forest cover.
- Harmonise mandates of authorities involved in biodiversity protection and management.
- Develop and implement an Ecotourism Strategy.
- Enact or review legislation related to biodiversity.

ENERGY

Mauritius is still heavily dependent on fossil fuels, which provide 80% of electricity. There has been a four-fold increase in electricity generation since 1990 and coal is being increasingly used. In general, measures to reduce electricity demand, energy efficiency and energy conservation are limited. Current policies and strategies aim at reducing dependence on fossil fuels, increasing the share of renewable energy and democratising energy supply, amongst others. Incentives are also provided to households, industries and other sectors to set up small renewable energy generating units for electricity production and sale to the national grid.

Policy Options for the Future

- Fully implement recommendations of the Long Term Energy Strategy (2009 - 2025).
- Remove structural barriers impeding the development of renewable energy and increase the share of renewable energy to 35% or more by 2025.

- Set up the Energy Efficiency Management Office, which will promote, coordinate policies and establish procedures to measure, monitor and verify energy efficiency across all sectors.

- Further develop the Small Independent Power Producers programme and upgrade electricity production up to 400 kW.

- Adopt product labelling and energy efficiency standards.

- Investigate and consider the use of innovative renewable energy technologies.

- Introduce E10 (gasoline with 10% ethanol) and E20 (gasoline with 20% ethanol) in the medium term for less emissions from the transport sector.

CLIMATE CHANGE

The issue of climate change took momentum in the 1990s as its impacts became more visible at the global level. Presently, climate change is already apparent in Mauritius with increasing temperatures, decreasing rainfall, rising sea levels and extreme weather events. Climate change is impacting on the coastal zone, water resources, agriculture, fisheries, food security and human health and wellbeing. Implementation of National Climate Change Action Plan has been fragmented and inadequate. However currently, the institutional framework for climate change is in place and a series of national and sectoral policies and programmes have been initiated to adapt to climate change.

Policy Options for the Future

- Develop and implement National Climate Change Mitigation and Adaptation Strategies and Action Plans.

- Integrate and streamline climate change adaptation considerations into core development policy, strategies and plans.

- Promulgate and enforce climate change legislation.

- Assess climate change risks on the economy, in vulnerable areas and on ecosystem services.

- Undertake regular assessment and monitoring of climate change programmes.

- Explore financing options to meet national adaptation costs.

OFFSHORE ISLETS

Islets have great conservation potential due to their unique native flora and fauna. Human interference from tourism and recreational activities as well as the introduction of invasive alien species are important challenges for the ecological integrity of offshore islets. In Mauritius, conservation, management and protection of islets have legislative support and islet-specific strategic management plans have been developed. However, enforcement of existing legislation for islets management is fragmented.

Policy Options for the Future

- Implement the Islets National Park Strategic Plan and islet-specific management plans.
- Develop management plans and extend restoration programmes to other islets.
- Promote ecotourism in a transparent manner, taking into consideration carrying capacity of islets.
- Use islets as a global laboratory of good practice in ecological research, eco-education, conservation and ecotourism.

TOURISM AND ENVIRONMENT

Since 1990, the tourism industry has evolved to become an important economic pillar. However, hotel development and tourist activities are putting pressure on the coastal zone and lagoon ecosystems. This will be further increased with the target of two million tourists by 2015, besides increasing the demand for basic services. However, sustainable tourism is an integral part of national strategies, policies and action plans and actions are being taken to control tourism development and recreational activities.

Policy Options for the Future

- Determine the carrying capacity of the country for setting future targets for the tourism industry and monitor the cumulative impacts of tourism development.
- Strengthen monitoring of coastal hotel projects to ensure strict compliance with EIA licence, planning guidelines and other national strategies.
- Develop an ecotourism strategy.
- Adopt eco-friendly practices, eco-labelling schemes and carbon-offset programmes.
- Establish Environment Management Systems, audits and verification in hotels and IRS.

CHEMICALS AND HAZARDOUS WASTE

Presently, there is no chemical profile and no system for assessing the impacts of chemicals on health and the environment. The management of obsolete chemicals remains a challenge due to lack of capacity. However, the institutional and legal frameworks have been established for management of chemicals and protection of human health and the environment. Similarly, hazardous wastes have not been inventoried since 2003. Currently, there is neither a comprehensive policy on hazardous waste management nor treatment or disposal facility. Despite the enactment of a hazardous waste regulation, its enforcement is poor. Presently, a hazardous waste cell is operational at the sanitary landfill and the setting up of an interim storage facility is in the pipeline.

Policy Options for the Future

- Develop a national chemical profile.
- Carry out a capacity assessment and a national priority setting for chemicals management.
- Reinforce the institutional framework for chemical management.
- Undertake occupational health risk assessment and medical surveillance.
- Assess impacts of chemicals on the environment.
- Formulate and implement a hazardous waste management strategy.
- Amend and ensure effective enforcement of the hazardous waste regulations.
- Set up the hazardous waste storage facility by 2012 and ensure separate collection, transport and storage of hazardous waste.

RODRIGUES

In Rodrigues, waste generation is increasing, the dumping site is saturated and waste collection services are not provided to the whole island. However, a new sanitary landfill is being set up and legislation to control waste collection now exist. Some waste are being separately collected and exported to Mauritius for recycling. Soil erosion is still a serious problem, which decreases agricultural productivity and causes siltation in the lagoon. A physical development strategy and local plans have been prepared to control land use. Reforestation and better agricultural practices are being undertaken to curb soil erosion.

Coastal and marine resources are being affected by bad fishing practices, overfishing and siltation. Inadequate legislative framework and capacity prevent efficient conservation of these resources. Policies and legislation have been developed and Marine Protected Areas have been set up to protect coastal and marine resources. Soil sedimentation in the lagoon is being controlled by mangrove propagation and sand extraction is better managed. However, water scarcity still remains a serious concern on the island and has wide-ranging socio-economic impacts. Desalination plants have been set up to increase potable water supply and the construction of a new reservoir is in the pipeline.

Policy Options for the Future

~Waste Management

- Provide regular and efficient waste collection throughout the island.
- Elaborate and adopt a waste management strategy with emphasis on recycling and composting.

~Land and Agriculture

- Implement the policy on land use planning and introduce legislation to regulate land use.
- Set up a land information system.
- Curb soil erosion through afforestation and terracing.

~Water Resources

- Increase community rainwater storage, water hygiene and domestic rainwater harvesting.
- Increase supply, improve the efficiency of the distribution system and promote water use efficiency.

~Coastal and Marine Resources

- Implement the Integrated Coastal Zone Management strategy and the Local Area Action Plan for the East Coast.
- Introduce regulation on protection of marine resources.
- Encourage offshore fishing.

AGALEGA AND ST. BRANDON

Inadequate water collection and storage, wastewater and solid waste management systems, the absence of a land management plan constitute key challenges in Agalega and St. Brandon. The loss of marine and terrestrial biodiversity, overexploitation of fish stocks and climate change and sea level rise are also important issues for consideration. In Agalega, rainwater harvesting is being promoted and a tsunami refugee centre has been constructed. On the other hand, a blueprint has been prepared for St. Brandon, which focuses on environmental protection, fisheries management, land use, tourism development and economic diversification. Steps have also been taken to monitor fishing activities in the Exclusive Economic Zone .

Policy Options for the Future

- Develop a land, biodiversity, solid waste and wastewater management plans.
- Promote rainwater harvesting systems and investigate innovative methods of freshwater collection and storage.
- Undertake regular inventory and monitoring of water, biodiversity and marine resources.
- Promote renewable energy development and use.
- Make greater use of biofuels in Agalega from coconuts to reduce imports of fuel for electricity and transport.
- Promote low impact ecotourism projects.
- Develop and implement a climate change adaptation strategy.
- Monitor fisheries resources and create marine parks.
- Adopt quarantine measures to prevent introduction of invasive species.
- Declare St. Brandon as a Marine Protected Area.
- Ensure strict adherence to St. Brandon Fisheries Management Plan.
- Increase surveillance against illegal fishing in St. Brandon and adjoining areas.

SHIFTING FROM BROAD POLICY TO BOLD ACTION

Since 1990, the policy landscape for environmental management has expanded considerably and there is currently a plethora of national and sectoral policies and strategies. Several soft options are already being used such as awareness raising, setting up of institutions and formulating legislation.

To improve environmental management, human well being and meet sustainable development goals, it is imperative to devote resources to implement existing policies and strategies. Achieving expected benefits depends on more effective linkages between policies and their implementation as well as better coordination between Government departments, local authorities, the private sector, civil society organisations and the community at large. Undeniably, delaying decision-making and implementation may result in irreversible environmental change. Bold decisions are needed not just by Government but in all sectors and at all levels, which also implies achieving a change in mindset whereby the environment is seen as a valuable asset for development.

Improved knowledge is essential for effective implementation of policies. Information on environmental issues is sometimes incomplete and inadequate for sound decision making. As a result, continuous capacity development and institutional strengthening are essential to reinforce human resources for environmental protection. In this regard, sectoral departments and Enforcing Agencies need to build the necessary capacity to address environmental priorities and take greater responsibility for implementing environmental activities. Moreover, improvement in environmental management, through enforcement, monitoring, reporting and further research are also essential.





(Inside Back Cover)

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