

Co
MA
Env
005

IUCN Library

ENVIRONMENTAL SYNOPSIS

1993

MAURITIUS



IUCN
The World Conservation Union

IUCN - THE WORLD CONSERVATION UNION

Founded in 1948, IUCN - The World Conservation Union brings together States, government agencies and a diverse range of non-governmental organisations in a unique world partnership: some 720 members in all, spread across 118 countries.

As a Union, IUCN seeks to serve its members — to represent their views on the world stage and to provide them with the concepts, strategies and technical support they need to achieve their goals. Through its six Commissions, IUCN draws together over 5000 expert volunteers in project teams and action groups. A central secretariat coordinates the IUCN Programme and leads initiatives on the conservation and sustainable use of the world's biological diversity and the management of habitats and natural resources, as well as providing a range of services. The Union has helped many countries to prepare National Conservation Strategies, and demonstrates the application of its knowledge through the field projects it supervises. Operations are increasingly decentralised and are carried forward by an expanding network of regional and country offices, located primarily in developing countries.

IUCN seeks above all to work with its members to achieve development that is sustainable and that provides a lasting improvement in the quality of life for people all over the world.

This Environmental Synopsis was produced in collaboration with the Commission of the European Communities under contract 7-5040/91/28.

Any opinions, findings, conclusions or recommendations expressed in this publication do not necessarily reflect the official policy of the EC. Likewise the designation of geographical entities do not imply the expression of any opinion on the part of participating organisations concerning the legal status of any country, territory or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

MAURITIUS AT A GLANCE

Despite the pressures of human activities, the Republic of Mauritius remains one of the jewels of the natural world. The dodo may have long since vanished but Mauritius still has hundreds of endemic plants and several endemic birds, reptiles, land snails and molluscs. Nevertheless, with over 500 people per km² on the main island, the Republic faces continual pressure to use agricultural land for housing.

Among the factors causing environmental problems:

- After 300 years of logging, agricultural encroachment and clearing for sugar or tea plantations, only 30% of Mauritius now has forests
- Fertilizer use is 60 times the African average, three times higher even than in Europe. Pesticide use is at one of the highest rates in the world
- Up to 6km² each year is being converted from agriculture to other uses

At the same time, the Republic of Mauritius can point to several positive developments that favour conservation of its natural resources:

- None of its environmental problems are overwhelming
- Environmentally based tourism is becoming more important to the economy
- The Republic has already achieved several outstanding successes in wildlife conservation
- A number of local NGOs have sprung up in the past decade to promote conservation awareness
- Bagasse (sugar-cane waste) is being promoted as an energy source, reducing the fuel import bill

CONTENTS

	Page
PREFACE	1
FACT SHEET	2
Natural Resources	2
Demography	2
Health and Education	3
Industry and Pollution	3
Economic Indicators	3
KEY ISSUES	4
INSTITUTIONAL CONTEXT	7
Environmental Institutions	7
Environmental Policies and Standards	8
National and International Organizations	8
Legislation Concerning Natural Resources Management and Environmental Protection	8
Environmental Training Institutes and Training Capacity	10
Cultural Aspects of Resource Utilisation	10
STATE OF THE ENVIRONMENT	11
Inventory of Natural Resources	11
Industry	18
Demography and Urbanisation	20
ANALYSIS OF POLLUTION AND DEGRADATION PROCESSES	22
Water Pollution and Water Shortage	22
Soil Erosion and Degradation	22
Deforestation	23
Biodiversity	23
Marine Environment and the Coastal Zone	25
Urban Environment	25
Energy Issues	26
Industry	26
BIBLIOGRAPHY	28
NOTE ON DATA SOURCES	33
ANNEX I	34
ANNEX II	35

PREFACE

This environmental overview of Mauritius was requested by the Commission of the European Communities — specifically the Directorate-General for Development (DG VIII A/1).

It was prepared on the basis of a desk-top study of information to hand as a briefing for CEC officials. Wherever possible the most recent figures and information were employed as sources¹.

After the introductory Fact Sheet and outline of Key Issues, the report is divided into three chapters. The first deals with institutional infrastructure, especially in the environmental context, together with national and international legislation and training opportunities. The second reviews the country's natural resources. The final chapter evaluates the nation's ecological heritage and considers its past, current and foreseeable environmental problems. Because the information changes so rapidly, no attempt has been made to provide a comprehensive survey of international organisations working in Mauritius. Instead, the reader is advised to contact the organisations themselves for an up-to-date summary of activities.

The IUCN team responsible for the preparation of this Synopsis included: Jeremy Carew-Reid, R. David Stone, Peter Hulm, Paul A. Driver, Claire Santer, John Watkin, and Brian Johnston. Additional editorial assistance was provided by Anthony J. Curnow, Adrienne Jackson, Paul E. Ress, Gamini Senevirate and Wendy Lubetkin.

Acknowledgments are due to many people for assistance, especially those within the IUCN Commissions, World Conservation Monitoring Centre (WCMC), library staff at the United Nations (Geneva), and World Health Organization (Geneva). Maps have been provided by WCMC. The cover illustration was designed by Christine Bass. Text design and layout was by Madlen Tschopp. Particular thanks are due to Wendy Strahm, Mauritius, and John Hartley, Jersey Wildlife Preservation Trust, for their comments on an earlier draft of this synopsis.

¹ A note on the data sources follows the detailed reference list. Within the text, individual sources are indicated by the number of the reference inside brackets, e.g. [24]. Metric weights and measurements are used throughout. A billion refers to 1,000,000,000.

FACT SHEET

Natural Resources

Land area: 1865km² (Mauritius); 109km² (Rodrigues)

Climate: Maritime subtropical. Mean annual temperature 25°C at sea level, 20°C on upland plateau. Rodrigues has a mean temperature of 24°C in the coastal region; upland areas 3°C cooler. Hot season December to April, cool season June to September. Frequent cyclones during hot season

Rainfall: Annual average rainfall on Mauritius is 900mm on west coast to 1700mm on south-east coast and reaching 4300mm in the uplands. Rodrigues has an annual rainfall of 1000-1600mm/year

Ecological zones: The Republic lies entirely within the Afrotropical biogeographical zone

Languages: French and English (official), Creole, Hindi, Urdu, Hakka, Bojpoori

Main towns: Port-Louis (capital) 141,870 inhabitants; Beau Bassin/Rose Hill 94,236; Curepipe 66,704; Quatre Bornes 65,759; Vacoas Phoenix 56,335 (1990 population estimates). Port Mathurin is the main town on Rodrigues

Currency: Mauritian rupee = 100 cents. Exchange rate December 1992: 16.2 rupees = US\$1 and 25.71 rupees = UK£1

Measures: Metric system

Land use: Area under cultivation 1070km²; arable land 54%; permanent pasture 4%; woodland 31%; other land (including irrigated land) 7% (1990)

Land annually cleared for agriculture: Negligible on both Mauritius and Rodrigues

Protected areas: Four categories of protected areas are recognised on Mauritius (biosphere, nature, mountain and river reserves) encompassing 4585ha (2.4% of land). Rodrigues has four declared nature reserves: two islets and two mainland reserves covering less than 50ha

Agriculture: The main food crops are potatoes, maize (especially on Rodrigues), and vegetables. Rice is a major staple but is not grown locally. Cash crops are sugar, tea and tobacco

Livestock: Cattle 34,000; pigs 10,000; sheep 7000; goats 96,000; chickens 2 million (1991)

Fisheries: 14,657 tonnes of which just 50 tonnes were derived from inland sources (1990)

Mining: 800,000 tonnes coral sand p.a. (300,000 from lagoons); 13,000 tonnes of eolianite, fossil coral and coral rubble for lime manufacture; 3000 tonnes sea salt by evaporation

Demography

Population size: 1.08 million (1990) (Mauritius 1,036,833; Rodrigues 37,814; other islands 500)

Population growth: 1.23% per annum (1985-1990)

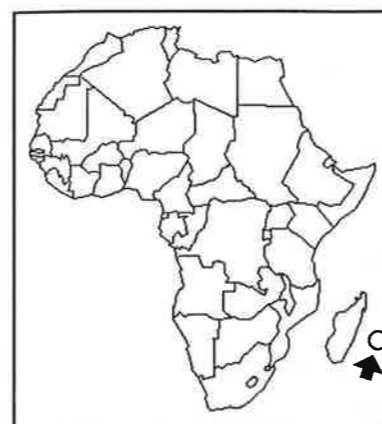
Projected population in 2025: 1.6 million

Age distribution: Under 15 years 29.3%; 15-65 years 65.5%; over 65 years 5.2% (1990)

Fertility rate: 1.94 (1985-1990)

Gender ratio: Female 50.6%; male 49.4% (1990)

Spatial distribution: Urban 42%; rural 58% (1989)



Spatial distribution: Urban 42%; rural 58% (1989)

Urbanisation rate: 1.3% of population a year (1990)

Health and Education

Infant mortality (deaths/1000 live births): 22 (1985-1990)

Mortality of under-5s (per 1000 live births): 30 (1987)

Life expectancy: 69 years; males 66.3; females 71.7 (1985-1990)

Access to safe drinking water (% of population): 98%; urban 100%; rural 98% (1986-1987)

Access to sanitation services (% of population): 97%; urban 100%; rural 95% (1986-1987)

Access to health service (% of population): 100% (1986-1987)

Enrolment in education (1989):

Level	Number enrolled	% male	% female
Primary	137,929	51	49
Secondary	78,776	51	49
University	2,179	66	34

Industry and Pollution

Main industries: Textiles, sugar and tourism. Manufacturing of beverages, chemicals, rubber, plastic, mineral and metal products, paints and fertilizers

Energy: *Types:* hydro-electric (24%), thermal (54%), bagasse (22%), kerosene, wood and charcoal

Pollution: Pesticides, fertilizers, urban sewage, industrial effluents, sedimentation, thermal pollution

Economic Indicators

GDP: US\$2068 million (1989)

GDP per capita: US\$1910 (1989)

GDP growth rate: 6.2% (1980-1989)

Agricultural % of GDP: 12.6% (1990)

Exports at current market prices: US\$1741 million (1991)

Imports at current market prices: US\$1894 million (1991)

Total official development assistance: US\$57.1 million (1989)

Total external debt: US\$991 million — of which long-term debt amounted to US\$960 million in 1991

Sources: [6, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 30, 50, 52, 53, 54, 55, 56, 57, 58 and 59]

Note: Statistics refer to combined data for Mauritius, Rodrigues and other islands of the Republic, unless otherwise stated.

KEY ISSUES

Background

The Republic of Mauritius, a member of the British Commonwealth, is a group of islands located at latitude 20°S and longitude 57°W, some 800km from the south-eastern coast of Madagascar (Fig. 1). The principal island, Mauritius, is of volcanic origin. The other main island is Rodrigues. Other smaller islets and banks (not illustrated) include the Cargados Carajos Shoals, or St Brandon (which covers several thousand km², although the total area of the reef does not exceed 190km²), and Agalega, a coral atoll. Saya de Malha and the Chagos Archipelago are important fishing banks of the Republic. These islands are part of the Mascarene group, which also includes the island of Réunion, a dependency of France.²

The Republic of Mauritius is still considered one of the jewels of the natural world, but the country we see today is only a shadow of its former splendour. As in so many other places, the arrival of human settlers (in the 16th and 17th centuries) had a devastating effect on an environment which had developed in isolation. Animals were killed for food and sport, and the rich ebony forests were felled for timber or to create space for vast sugar-cane plantations. Many species were driven to extinction (the dodo being the classic and most quoted example); introduced plants and animals competed with and sometimes replaced native species. Today the islands continue to experience considerable pressures from pollution (land, water and air) and population growth, but there is no protected areas system, and existing environmental legislation is ineffective.

Population

With an estimated population of 1.036 million on its 1865km², Mauritius stands out as one of the most densely populated agricultural islands of the world, and the pressures on its land resources are tremendous. The value of land for housing is so high that there is constant pressure to use agricultural land for development. In 1986 it was estimated that 3-6km² of land were being converted annually from agriculture to other uses.

Ecosystems in peril

Biogeographically, although the islands are part of the Mascarene group (see above), there are some links to Madagascar on the main islands and Indo-Pacific and Oceanic affinities on the remote coralline islands.

Despite their small size and the havoc wreaked on them by early human settlers, the Mascarene islands are still home to an extraordinary range of species. The integrity of the islands' distinctive ecosystems are threatened by rapid population growth, overcrowding, degradation of habitat and the displacement of native species by exotic animals such as rabbits, goats, pigs, deer, monkeys, rats and giant snails, and exotic plants including strawberry, guava and privet.

² In this Synopsis we refer to the island groups as the Republic or the islands, reserving Mauritius for references to the main island

The conservation and rehabilitation of offshore island ecosystems is considered a priority by national and international conservation bodies because they are home to critical populations of endemic species, are less susceptible to invasion from exotic species, and are easier to protect and manage. Spectacular successes have already been achieved on Round Island (following the eradication of introduced goats and rabbits) and Ile aux Aigrettes. A comprehensive management plan is needed for each islet of conservation concern. Leasing such sites to a responsible NGO, as on Ile aux Aigrettes, is an approach which should be considered for other islets as well.

Pollution — Industry

Rapid economic development has resulted in a proliferation of industries using a range of potentially hazardous materials whose effects on the environment are either unknown or unappreciated. Industries are often sited with little regard for the environment, and wastes — solid or liquid — are rarely, if ever, treated effectively. While there is visual evidence of severe pollution from industrial zones, sewage outfalls and regions of intense tourism development, there are no data on levels of pollution for the terrestrial, freshwater or marine ecosystems.

Continuing dependence on agriculture

Agriculture has been the backbone of the economy of Mauritius for nearly 150 years. While it is no longer the country's primary foreign exchange earner, about 25% of the population are engaged in agricultural activities, which occupy some 1000km² of land, 90% of which is planted with sugar cane.

Two key concerns are the impact of agricultural practices on the environment, and the need for sustainable management of the agricultural system itself. Cultivation practices have not yet had a significant adverse effect on the environment and soil erosion is localised. The main issue is the excessive levels of fertilizer and pesticide being applied to crops. Recent estimates suggest that fertilizer application in Mauritius averages 600kg/ha: that is three times higher than average rates of application in permanently cropped land in western Europe, and 60 times the average rate in Africa. Pesticide use is also extremely high, with application rates averaging 44kg/ha (per cropping cycle) — probably the highest in the world [25]. In addition to reducing soil fertility it could also lead to pesticide-resistant species.

Improved legislation relating to the environment

Existing institutional and statutory arrangements for environmental management and protection have largely been developed on a sector-by-sector basis, over a long period. A comprehensive review of the Republic's legislative needs related to the environment is needed, on the basis of which a complete and cohesive legislative framework for environmental protection and management should be developed [3].

Fortunately, the environmental problems are not yet of overwhelming proportions. Concern about the state of the environment is growing, especially in view of the importance of tourism to the economy and its dependence on the natural environment. It is therefore an opportune

time to act on environmental concerns. Action taken now should be effective in preventing future problems.

INSTITUTIONAL CONTEXT

Environmental Institutions

One major problem in the Republic is that responsibility for the environment is divided among several different ministries.

In 1987 the government established a National Environment Committee, made up of representatives from seven ministries: Industry; Youth and Sports; Health; Agriculture, Fisheries and Natural Resources; Works; Local Government; and Education, Arts and Culture.

Although the Republic of Mauritius has a Ministry of the Environment to address such problems as pollution, waste disposal and litter, the responsibility for conservation lies with the Ministry of Agriculture, Fisheries and Natural Resources (MAFNR). In an effort to expand the capabilities of the Ministry of the Environment, a new Department of the Environment was created in 1989 and will play a major coordinating role in the implementation of the Environmental Protection Act (1991).

The Forestry Service established on the island of Mauritius in 1777 is the oldest in the Commonwealth. Today the Forestry Service is the department of MAFNR responsible for managing conservation and nature reserves and for overseeing all silvicultural operations within the Crown forest estate (government-owned lands). It protects water supply and soils, privately-owned mountain and river reserves and it manages state-owned nature reserves, plantations, national forests and *pas géométriques*³ [31, 32]. The role of the Forestry Service, however, is changing. A new National Park and Wildlife Service (NPWS) is being set up within the Ministry of Agriculture. It will take over the management of nature reserves once National Park legislation is passed. In the interim, a "Conservation Unit" has already assumed many of the former responsibilities of the Forest Service, including the CITES authority (see Legislation).

The Fisheries Division of the MAFNR is responsible for management of the marine environment including reserved fishing areas. In practice, it has also assumed the guardianship and maintenance of those islets that have been declared nature reserves [28]. Together with the Forestry Service, the Fisheries Division is also responsible for the conservation of mangroves, although no management plan has yet been prepared for this ecosystem.

The Nature Reserves Board, established under the Forests and Reserves Act of 1983, advises the Minister of Agriculture, Fisheries and Natural Resources on all matters relating to the creation and management of nature reserves.

³ *Pas géométrique* is a narrow belt (theoretically 250 French feet in width) around the coast that is state-owned.

Environmental Policies and Standards

Until recently the Republic of Mauritius lacked a comprehensive national policy for government action on the environment that took into consideration the relationship between environment and development. The government recently adopted a National Conservation Strategy, whose objectives include ensuring the sustainable utilisation of species and ecosystems (marine and wildlife, forests and grazing lands) [29]. In conjunction with this strategy, marine conservation policy supports the establishment of specially protected areas to preserve the marine environment and its resources. It encourages the formulation and/or enforcement of appropriate legislation, and it provides for the development of management plans for important marine areas [29]. The approved forest policy, under which the Crown forest estate is managed, aims to reserve forest areas which will supply in perpetuity all forest produce required by the people for agricultural, domestic and industrial purposes, and to cooperate with other land interests for the successful management of the forest estate [32].

National and International Organisations

Since the early 1970s many international organisations have worked with the government to promote conservation. The European Development Fund has provided financial assistance to Mauritius through the Indian Ocean Commission (see Legislation). UNDP is also gradually increasing its involvement in the activities of the Commission. Other international agencies represented in Mauritius include the World Bank and the British ODA.

The main NGO contributors have been the Jersey Wildlife Preservation Trust (JWPT), IUCN, World Wide Fund For Nature (WWF), Birdlife (formerly the International Council for Bird Preservation — ICBP) and the Peregrine Fund. These organisations have focused on the conservation of rare birds and plant species unique to the islands. The International Centre for Conservation Education (ICCE) is becoming increasingly active in the Republic.

Over the past decade a number of local NGOs have developed. The Mauritius Wildlife Appeal Fund (MWAF) concentrates on wildlife conservation and has started a Wildlife Supporter's club to promote awareness. MWAF is also responsible for management of Ile aux Aigrettes Nature Reserve. The Society for the Protection and Conservation of the Environment (SPACE) is a lobby group which also provides education and information on the environment. Friends of the Earth (FOE) focuses on pollution and aesthetic environmental problems, such as roadside planting. Organisations such as the Wildlife Clubs of Mauritius and Mauritius Wildlife Clubs get schools involved in conservation. The Mauritius Marine Conservation Society (MMCS) is also active in the marine environment.

Legislation Concerning Natural Resource Management and Environmental Protection

The Republic of Mauritius is a signatory of the Law of the Sea, as well as the Convention on Fishing and Conservation of Nature and Natural Resources. Mauritius also participates in the UNESCO Man and the Biosphere Programme, under which one site was designated a Biosphere Reserve in 1977. It is a member of the (CITES) Convention on International

Trade in Endangered Species of Wild Fauna and Flora, the (Rome) Convention on Plant Protection (1951), and the (Washington) Convention on the Regulation of Whaling (1956). Mauritius is not party to the (World Heritage) Convention Concerning the Protection of the World Cultural and Natural Heritage nor to the (Ramsar) Convention on Wetlands of International Importance especially as Waterfowl Habitat.

At a regional level, the Republic is signatory to the African Convention on the Conservation of Nature and Natural Resources (African Convention), which defines several categories of protected area. Mauritius was one of the founding members, in 1982, of the Indian Ocean Commission, a sub-regional organisation regrouping the islands of the South-West Indian Ocean. One of the main objectives of this commission is to promote cooperation in the fields of agriculture, marine fisheries and the conservation of resources and ecosystems.

Some 25 Acts that deal with various aspects of environmental protection and natural resource management are currently in force. Considered together they nonetheless fall short of providing a comprehensive and consistent legal framework for effective action; many are inconsistent, some outdated and others duplicative. Where legislation does exist, enforcement is lacking, penalties are low, and there is inadequate accountability. A comprehensive review of the Republic's environmental legislation is needed.

In part, the complexity of the existing legislation is the result of a long history. The first comprehensive game law, providing protection for certain species and restricting hunting, was proclaimed in October 1767 [26], followed by the Game Ordinance of 1869 and Rodrigues Game Regulations in 1883. Additional laws were passed, culminating in Wildlife Act No. 33, 1983, which amends and consolidates laws relating to game and fish, and makes stronger provision for the protection of wildlife. Under this Act, the Minister may prohibit the hunting of game in any specified area.

The Ancient Monuments and National Reserves Ordinance of 1944 provided for establishment of nature reserves on public or private lands and the appointment of an advisory Ancient Monuments and Nature Reserves Board. This Act was replaced by the National Monuments Act No. 9 in 1985, which makes provision for nature reserves and the creation of a new National Monuments Board. The Forest and Reserves Act No. 41 (1983) and its amendment (The Forests and Reserves (Amendment) Act No. 1 (1986), consolidate and repeal earlier laws. They provide for the creation and management of road and nature reserves, national forests and the protection of privately-owned mountain and river reserves. They also contain regulations on the use of unsurveyed forest, set out procedures to deal with offenses concerning forest resources and reserves, and provide for the establishment of a Nature Reserves Board. The Crown Land (Amendment) Act No. 6 (1986) and the Pas Géométrique (Amendment) Act No. 7 (1986) give powers to the Minister of Housing, Lands and the Environment (MHLE) to evict squatters on Crown lands and *pas géométriques* [32].

The Maritime Zones Act (1977) legislates for protection of the marine environment through creation of designated areas and historic waters. The Fisheries Act (1980) provides for the creation of reserved areas. This Act also regulates the trading and sale of fish, licensing, the use of fishing equipment, and determines closed seasons, offenses and penalties. The

Fisheries Regulations (1983) under the Fisheries Act, provide for six reserved areas, which are still to be established.

Environmental Training Institutes and Training Capacity

The UK-based International Centre for Conservation Education (ICCE) has trained three Mauritians, two of whom have returned to start wildlife clubs. The third is being trained in England to work for the Mauritius Institute of Education (MIE). The Jersey Wildlife Preservation Trust has trained one Mauritian in the field of wildlife management. Several grants for overseas training will be available as part of the National Park programme.

MIE establishes the curriculum for all schools. Environmental Studies are already included in the syllabus but need to be expanded and improved [50].

Cultural Aspects of Resource Utilisation

The history of the Republic has been a tale of successive colonisations from the Portuguese discovery in 1510 until independence in 1968, producing a diverse population. The stranglehold of the slave-worked sugar industry on the economy had an obvious impact on the islands' environment. But the Mascarene group of islands are also famous among biologists as the home of the dodo, a turkey-sized group (related to the pigeon) which in thousands of years of isolation evolved as three species of flightless birds. In the absence of natural enemies on the islands, they proved unable to defend themselves against introduced predators such as humans, rats, dogs and pigs. On Mauritius the dodo was extinct by 1681, by 1750 on Réunion and by about 1800 on Rodriguez.

STATE OF THE ENVIRONMENT

Inventory of Natural Resources

Ecological zones

All of the Republic lies within the Afrotropical biogeographical zone. On the individual islands, ecological differences are determined by altitude.

Water

The island of Mauritius is relatively well endowed with freshwater resources (Fig. 2), having 92 rivers, about 232 streams, two natural and five artificial lakes. The groundwater resources in its seven major basins have been exploited by boreholes since the 1950s for the massive development of the sugar-cane industry and later for the growing industrial base, especially for textile dyeing. A survey carried out in December 1990 by the Central Water Authority revealed that there were 239 boreholes and small wells operating in Mauritius [8].

There are about 150km² of irrigated land in Mauritius.

Little of the islands' upland marsh habitat remains, apart from a few scattered examples at Petrin and Plaine Champagne which are protected as a nature reserve [28].

Forest

Before the arrival of humans, Mauritius was covered with three main forest types: in the north, a rather open, dry, palm forest; in the lowlands, a semi-wet evergreen forest rich in black ebony; and wet forest in the uplands [49]. Stunted heath and dwarf forest were also found at high elevations. Today these natural forests have been reduced to less than 1% of their original cover [21, 35, 42, 45, 46, 47, 48]. Common species in the lowland forests were *Diospyros tessellaria*, *Elaeodendron orientale*, *Stadtmannia oppositifolia* and *Foetidia mauritiana*. Lowland forest is currently largely restricted to the western slopes of the mountains between Mt du Rempart and Chamarel, with the best examples being found at the base of Trois Mamelles and Mt Brise Fer and at the mouth of the Tamarin Gorge [9].

The upland forests of Mauritius used to cover the fertile uplands of the Plaine Wilhelms and the south. Now these forests are mostly restricted to an area in the south-west around the Black River Gorges. The upper canopy of these forests, which may reach 17-20m in height, includes *Mimusops maxima*, *M. petiolaris*, *Diospyros tessellaria*, *Calophyllum tacamahaca*, *Canarium paniculatum* and *Sideroxylon grandiflorum*. A dense, lower canopy at about 15m is formed by tree genera such as *Tabernaemontana*, *Aphloia*, *Eugenia*, *Tambourissa*, *Erythrospermum*, *Antirhea* and *Nuxia*. Lianas, orchids and tree ferns are also commonly found in this layer [49]. A third layer is formed at about 5m, where *Colea* and *Psathura* are among the more characteristic plant genera.

The inexorable process of forest destruction began in the 17th century when the forests were first logged by the Dutch for ebony. Logging and deforestation continued under French rule in the 18th century for shipbuilding and agriculture, and under British rule in the 19th

century, chiefly for land to grow sugar and to establish upland settlements. The 20th century has witnessed even more deforestation for sugar, tea and pine plantations, and for the extraction of timber during the two world wars [27].

Twelve species of ebony once existed on Mauritius, but most have now stopped regenerating naturally, with the exception of one population found on the offshore islet, Ile aux Aigrettes [44]. An estimated 45% of the island is now under sugar cane production, with tea cultivation replacing this at higher elevations [28].

Other islands of the Republic experienced similar patterns of deforestation. The island of Rodrigues was covered by evergreen forest before people arrived in 1691, but by 1874 the island was already described as "destitute of any forest growth save in unfrequented and more inaccessible parts in the recesses of the valleys". Today no intact patches of native forest remain and many endemic species are either extinct or represented by less than ten individuals [34].

Of the estimated 564km² of forest remaining on Mauritius (see Fig. 3), almost 220km² is State-owned, the remainder being in private ownership. Details are given in Table 1.

Table 1. The Forest Area of Mauritius [8]

Category	Area (ha)	Total area (ha)
Crown Forest Lands		
a) Plantations	11,916	11,916
b) Nature reserves		
i) on the mainland	4,018	
ii) islets	567	4,585
c) Unplantable, protective or to be planted		4,710
Sub-total		21,211
Pas Géométriques		
a) Plantations (estimated)	211	
b) Leased for grazing/planting	230	
c) Unproductive (rocky)	211	
Sub-total		652
Privately owned Forest Lands		
a) Reserves protected by law		
i) mountain reserves	3,800	
ii) river reserves	2,740	6,540
b) Estimated forest lands including scrub and grazing lands		28,000
Sub-total		34,540
Total		56,403

On Mauritius, mangroves are found on the east, south-east and north-east coasts and are relatively abundant in the region of Ile d'Ambre and Ile aux Cerfs. Mangroves have disappeared almost completely from the west coast and the government has made it a priority to re-establish mangroves where they have been eliminated [29].

Agriculture

Mauritius is a predominantly agricultural country, although the proportion of land under agriculture has steadily decreased over the last few decades, falling from almost 57% in 1965 to 48% in 1986 (Table 2). This is due mainly to urbanisation and the development of industries and infrastructure.

Table 2. Land use in Mauritius [8]

	Area (ha)		Percentage	
	1965	1986	1965	1986
Agriculture	106,228	90,065	56.95	48.29
Sugar cane	97,973	83,289	52.53	44.65
Tea	6,232	3,776	3.34	2.02
Tobacco, food & other crops	2,023	3,000	1.08	1.60
Forests, scrub, grasslands and grazing lands (*)	64,465	65,330	34.57	35.02
Planted forests	6,775	6,774	3.63	3.63
Natural forests	2,387	2,388	1.28	1.27
Savanna, grasslands, etc.	7,446	7,446	4.00	4.00
Scrub & other forests	42,857	48,772	25.66	26.15
Built up areas	11,857	25,500	6.36	13.67
Others (reservoirs, roads)	3,925	5,605	2.12	3.02
Total Island	186,500	186,500	100.00	100.00

(*) The accuracy of these figures has been questioned [50] in view of the fact that large areas of native scrub were cut down during the 1970s under a World Bank programme to plant pines.

Sugar cane remains the dominant crop of the island, covering an estimated 45% of its total area, or about 90% of the cultivated land. There are 19 "miller planters" (large sugar estates) which cultivate about 55% of the total sugar area and account for a substantially higher proportion of final sugar production as a result of their much higher yields. Some 33,000 small planters cultivate the remaining area, and their cane is processed by the miller planters [2].

The first serious attempt to diversify the agricultural sector was made in the late 1960s and early 1970s with the introduction of tea [2]. Tea is now the second most important agricultural export and is grown on about 34km². Among the other crops grown as part of a diversification programme are potatoes, maize, groundnuts, beans, and tomatoes.

The rising cost of agricultural investments, low guaranteed prices, and labour and land shortages have played a significant role in decreasing crop yields [24]. Figures for 1991 indicate that food crop production fell by 3.5%, contrasting with an increase of 15.2% in 1989 and 5.7% in 1990 [24]. Potato, tomato and maize production fell by 10.2%, 18.8% and 6.6%, respectively. Production of most other crops also dropped significantly, largely as a result of drought and crop diseases. Cyclones also have had a devastating effect on crops such as sugar cane.

The Republic of Mauritius has a long history of biological pest control dating back to 1762 when the Indian mynah bird (*Acridotheras tristis*) was introduced to control the red locust. Since the early 1900s a variety of parasitic species have been introduced to control stem-borers, scale insects and white grubs in sugar cane. The success of this programme has meant that, unlike most countries, it does not use any insecticides on sugar cane. Similar initiatives have been developed for livestock and crop pests. Despite its impressive record of applied biological control, the country nonetheless remains a heavy user of herbicides on cane, as well as insecticides on other crops. The high overall rates (44kg/ha, possibly the highest in the world), together with inefficient application techniques, are major causes of environmental concern.

Livestock

After three consecutive years of decline, cattle production rose by almost 21% in 1991, although that was still less than 50% of the 1987 level [24]. The number of cattle farmers continues to decline as casual farmers move into the manufacturing and tourism sectors for a more secure employment and steady income. The lack of grazing land, problems in obtaining fodder, and the rising cost of cattle feed have adversely affected both meat and milk production over the last few years. Over 80% of dairy products and 90% of beef consumed must now be imported.

Attempts are being made to boost the production of farmed venison (estimated at over 300 tonnes in 1990), which is regarded as having great potential in both home and export markets [2].

Fisheries

Despite the Republic's location, fishing has not been a major activity for Mauritians. Marine resources are exploited in the lagoon and off-lagoon areas of Mauritius; the lagoon and off-lagoon areas of Rodrigues; the lagoon area around Agalega; and the banks along the Mauritius-Seychelles ridge, stretching from St Brandon to Saya de Malha and around the Chagos Archipelago.

The lagoon and off-lagoon fisheries are artisanal, taking a wide range of species, dominated by the Siganidae (rabbit fish) (13%), Mullidae/Scaridae (goat/parrot fishes) (12%), the Lethrinidae (11%), octopus (10%) and shark (0.2%) [8].

The annual catch (tonnes) from the artisanal sector for 1988-1990 is shown in Table 3 [8].

Table 3. Recorded Catch from Artisanal Fisheries (tonnes)

Year	Mauritius	Rodrigues	Agalega	Total
1988	1,549	1,900	30	3,479
1989	1,544	1,900	30	3,474
1990	1,500	1,900	30	3,430

Preliminary assessment of the Republic's maximum sustainable yield is around 1699 tonnes annually. The lagoon of Rodrigues is, however, heavily exploited. An artisanal prawn fishery in Rodrigues lands approximately 2000kg of prawns per annum.

Offshore fish production rose by over 37% during 1991, following a decline in the previous three years. This increase was mainly due to a 70% rise in tuna production made possible with the operation of an additional fishing vessel [24]. Details of the total fish production from Mauritius are given in Table 4.

Table 4. Fish Production from Mauritius (tonnes, in wet weight equivalent) [2].

Location	1985	1986	1987	1988	1989	1990
High seas	11,629	11,907	13,790	13,428	12,232	11,395
of which: banks	5,013	5,989	6,844	6,000	4,980	—
Coastal	2,034	2,062	2,297	2,430	2,564	2,525
Fish farms	35	46	62	67	65	65
Total	13,698	14,015	16,149	15,925	14,861	13,985

Protected areas and wildlife

Efforts to conserve Mauritian forests date back to the late 1800s, with the establishment of the current mountain and river reserves to protect watersheds [26]. The first nature reserves provided for in the Ancient Monuments and National Reserves Ordinance (1944) were established in 1951 to protect a number of different vegetation types [26, 27]. The selection of the reserves was based primarily on botanical considerations and did not necessarily reflect the distribution of other species [28]. They were extended in the 1970s, the most significant expansion being the linkage of Macchabee and Bel Ombre to create a new nature reserve of 36km². The Republic's other reserves were all established in the early 1980s. Today protected areas, including nature reserves (46km²) and privately-owned mountain (38km²) and river (27km²) reserves, cover about 6% of the total area (see Fig. 4).

IUCN-sponsored reports have put forward a number of recommendations for action in the past decade [4, 5, 22]. These recommendations include intensified management of the

Macchabee/Bel Ombre Nature Reserve to prevent further habitat degradation, and protective measures for certain woodland sites on Rodrigues and Agalega. The Four-year Plan for Social and Economic Development 1971-1975 contains an outline proposal for the establishment of a national park in the Mare aux Vacoas-Black River Gorges area [38]. The Black River Gorges National Park will probably be created in the near future with assistance from the World Bank, thereby protecting an important reservoir of lowland wet evergreen forest. Other reports have proposed increasing the number of nature reserves to protect native vegetation, and developing management plans for such reserves and potential national parks [28, 29]. The restoration of the flora and fauna of Round Island was given priority in the government's 1985 White Paper [20, 29, 37]. A ten-year management plan for the island was drawn up in 1989, and reintroduction of native species once found on the island has since begun [33].

Mauritius is surrounded by 300km² of fringing reef, much of which is threatened by sedimentation, pollution, and tourist trade exploitation [4]. The situation has prompted detailed surveys of the reef ecosystem, and the subsequent recommendation that it be protected and managed through a system of marine nature reserves [29]. Proposals for the creation of three marine national parks have existed for over a decade [38]. Other recommendations have included the creation of special marine areas around Ile aux Aigrettes and Ile Marianne to protect the molluscan fauna, the creation of turtle reserves at Pearl and Fregate islands in the St Brandon Shoal [29] and the designation of Ile du Nord, Ile Paul, Ile Poulailleur, Ile Puit à Eau, Petit Capitaine and Grande Capitaine as bird sanctuaries [43]. It has been suggested that in addition to the creation of marine protected areas, a coastal zone management plan should be developed to deal with the mounting pressure on coastal wildlife [4]. To alleviate the problem of overfishing, reserved fishing areas were established in 1983. Lagoon fisheries have been particularly affected and the government is considering delineating important shallow areas of the lagoons, especially in reserved fishing areas, where all forms of fishing will be prohibited [29]. Marine resources are currently being studied by the University of Mauritius under its Mauritius 2000 Programme [39] and in a second project, supported by UNESCO, which is mapping the reefs, lagoons and coastal systems to assess the status of reefs [20].

Threats to the integrity of the protected areas system include degradation of habitat and displacement of native flora and fauna by introduced animals such as rabbits, goats, pigs, deer, monkeys, rats and giant snails, and by exotic plants such as strawberry guava (*Psidium cattleianum*) and privet (*Ligustrum robustum*) [40, 41]. An increasing human population also represents a major threat to the region's protected areas. Rodrigues has been under pressure from cattle encroachment and slash-and-burn agriculture [29, 33]. Because of their destructive impact on native habitats goats and rabbits have been eradicated from Round Island over the past decade [20].

Although protected areas legislation and policy have generally been adequate for the country's needs, they have evolved piecemeal without a view to the overall national picture [28, 36]. As a result of this *ad hoc* approach, gaps remain in the body of existing legislation. One is the lack of formal gazetting of land for forestry or wildlands. Apart from nature reserves, which play a conservation role, and privately-owned mountain and river reserves, which serve a predominantly protective function, Crown lands have loosely been regarded as forest

reserves by the Forestry Service, available for afforestation until they were required for some other purpose.

Legislation on the creation, protection and management of marine nature reserves and turtle reserves is expected in the near future, and is needed to safeguard these critical ecosystems. Regulations on the protection of mangroves are also to be more strictly enforced [29]. Other reports [28, 42] have recommended an enabling act (National Parks and Nature Conservation Act) which would allow the creation of national parks. To date, this recommendation has not been taken further, although this could change once Black River Gorges National Park is established.

There are a number of constraints on protected areas management in the Republic. The Forestry Service suffers from high labour and transport costs, staff vacancies at all levels, high absenteeism among labourers and inadequate technical training for foresters [28, 31]. Fisheries laws are not always enforced because of a lack of manpower and equipment [36]. This situation has improved, however, since the number of coastguard officers was recently increased [20]. An expansion of the protected areas network to include marine nature reserves, turtle reserves and national parks may necessitate the constitution of new boards and departments to ensure effective management and protection [28]. Over the long term, however, the government will have to commit time and additional financial resources to protected area management programmes if their success is to be ensured.

Non-renewable resources

Coral sand is mined from the lagoon beds and inland deposits along the coast. In 1990 about 800,000 tonnes of sand were mined, of which 300,000 came from lagoons. Most was used by the construction industry. Sand mining in lagoons is highly damaging to the ecosystem particularly because it leads to the sedimentation on corals. Government policy is to phase out marine mining and encourage the use of rock sand [8].

Some 8000 tonnes of lime are manufactured annually from 13,000 tonnes of eolianite, fossil coral and coral rubble.

Salt is produced by solar evaporation of saltwater, at a rate of 3000 tonnes per annum, in pans between Tamarin and Riverine Noire on the west coast of Mauritius.

Manganese nodules can be found at a depth of 3000m in the Mauritius EEZ, but exploitation is unlikely in the foreseeable future.

Industry

Main industrial sectors

Before 1960 sugar constituted almost the entire manufacturing sector, with some 8000 people employed in the sugar mills. Over the years, the production of several sugar cane by-products (molasses, rum, ethyl alcohol, acetic acid from molasses, and particle board from bagasse) has increased [2]. There are plans to further expand the use of sugar cane by-products to produce livestock feed and bagasse-generated electricity (already taking place on some estates).

In view of the limited domestic market and the need to reduce dependence on the sugar sector, the government adopted a policy of export promotion by developing the Republic's Export Processing Zone (EPZ), which concentrates on labour-intensive processing of imported goods for the export market [1]. Investors (local and foreign) within the EPZ are offered an attractive package of incentives by the government. In 1971 when the scheme was introduced, five new firms and 1000 jobs were created. By 1989, 91,600 people were employed, although there has been a decline in numbers during recent years partly as a result of low productivity rates, increased competition, slow rates of modernisation and high absenteeism rates. The industrial sector in general remains heavily dependent on imported materials.

Although the government is keen to diversify, the EPZ continues to be dominated by one industry — clothing and textiles — which, in 1990, accounted for more than 89% of the jobs and 83% of EPZ exports [1, 2]. The Republic is the world's third largest supplier of woollens, a fact that has important consequences for the environment (see Analysis of Pollution and Degradation Processes). The government's newly stated policy — backed by a 1991 White Paper on industrial diversification — is to give priority to investment in non-clothing industries, particularly electronics [2].

Other EPZ industries and products currently include diamond cutting, spectacles, rattan furniture, watches, canned tuna, industrial chemicals, razor blades, chicken hatcheries, gloves, tyres, electronics, footwear and marble.

Tourism is the Republic's third most important source of foreign exchange, after sugar and textiles. Arrivals of foreign tourists increased from 27,650 in 1970 to 213,00 in 1987 and to 263,400 in 1989. In 1989, the latest year for which the United Nations have definite figures, earnings amounted to about US\$184 million. The government has plans to expand tourism even further, although in an attempt to limit environmental damage, the government stopped issuing permits to build new hotels in 1990. Despite such controls, some construction work continues.

Location of industry

There are three main industrial zones in the Republic: Plaine Lauzun, Coromande and Vacoas/Phoenix. The majority of dye houses (textile manufacturers) are located within these development zones, although others are scattered around the island. A number of other, smaller industries are also located within these main industrial zones.

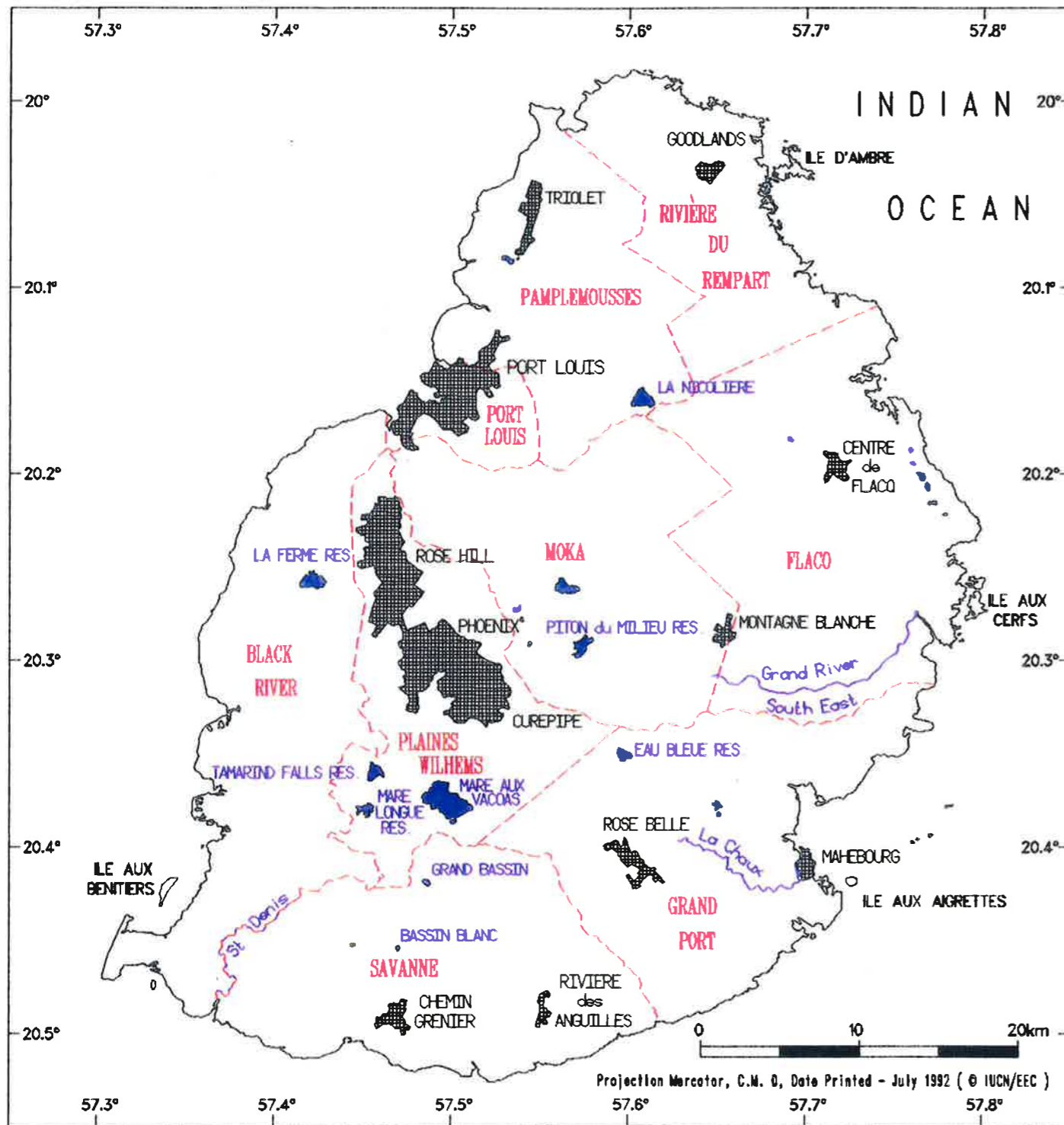


Figure 1. Administrative Boundaries and major towns of Mauritius.

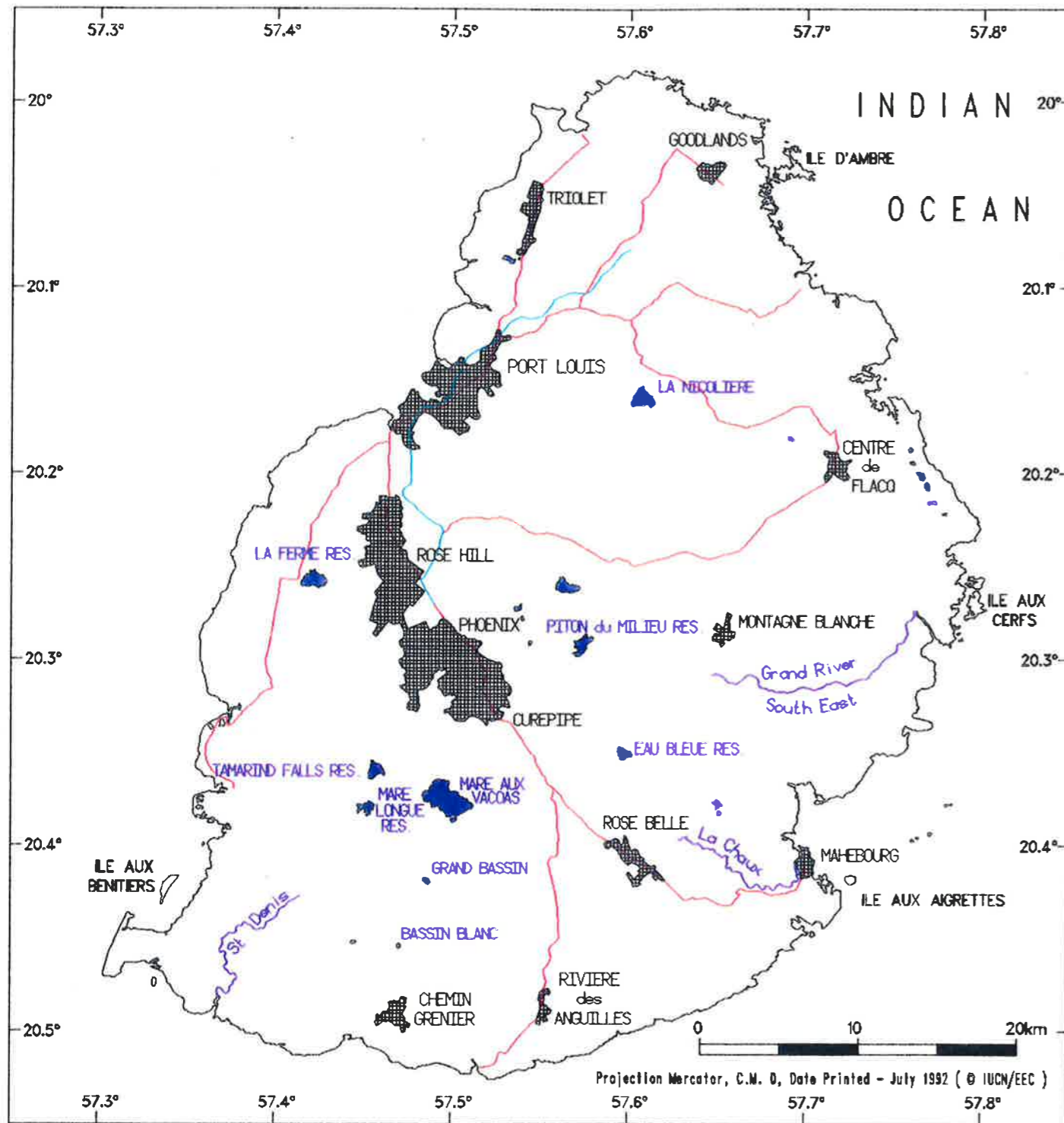


Figure 2. Major communication routes in Mauritius: Motorway , Main Roads , Rivers .

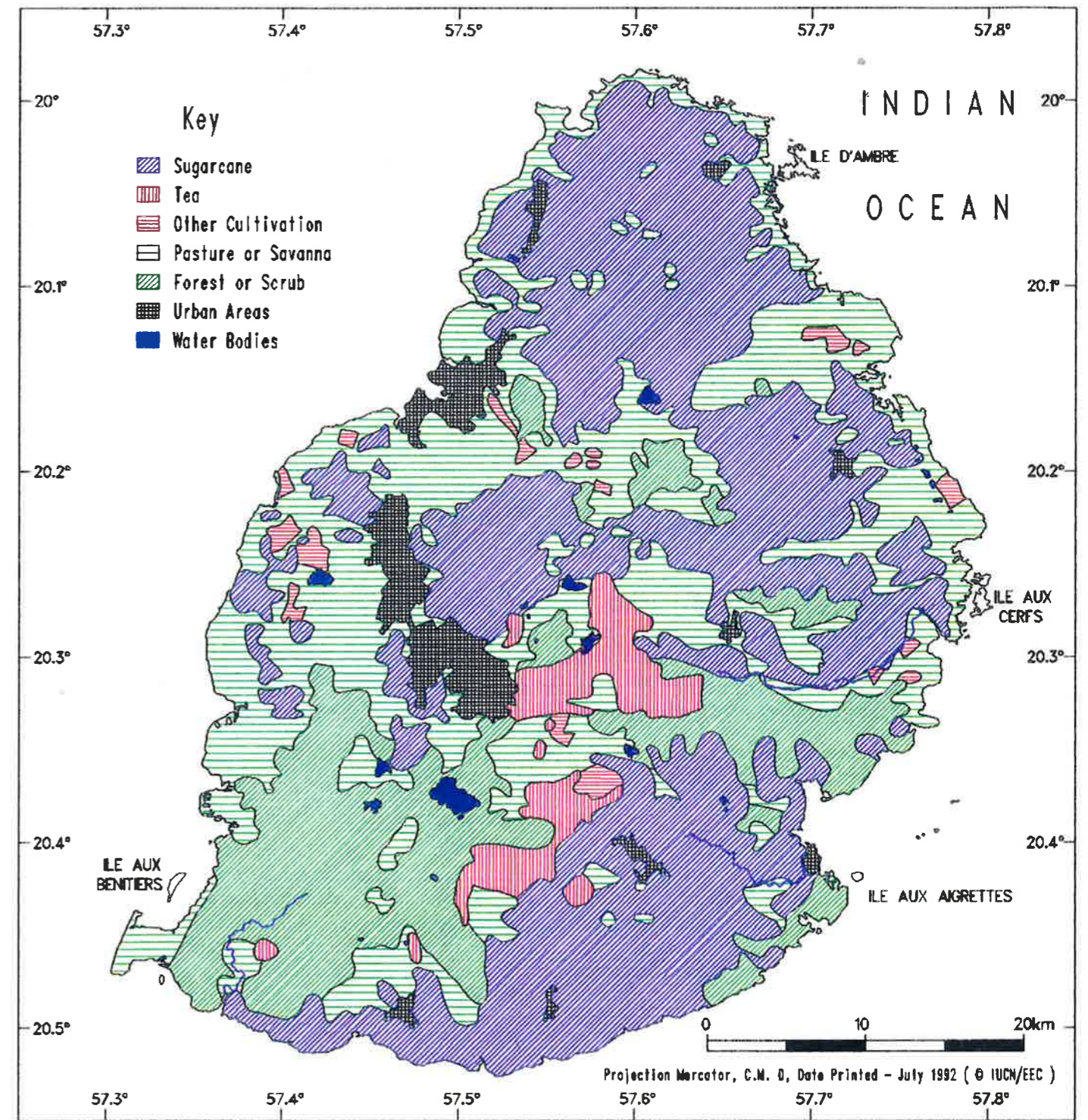


Figure 3. Vegetation / Land Use pattern of Mauritius. See text and Annex I for further details.

Institutional Context

Energy sources and consumption

Present energy production capacity in Mauritius includes hydro-electric sources (60MW), thermal (205MW) and gas turbines (46MW) (Table 5). An additional 48MW diesel-fired/coal-fired power station was to be installed in 1992, although there are no indications as yet that this has taken place. There are also plans to commission a 40MW diesel-fired power station and, by 2000, another 50MW coal-fired power station [8].

Table 5. Electricity Production 1985-1990 (GWh) [30]

Year	GWh	Hydro		Thermal		Bagasse	
		GWh	%	GWh	%	GWh	%
1985	391	113	29	171	44	107	27
1986	438	110	25	209	48	119	27
1987	487	147	30	235	48	105	22
1988	545	104	19	336	62	105	19
1989	584	148	25	321	55	115	20
1990	667	98	15	469	70	100	15

A concessional loan of US\$15 million has been pledged by the World Bank's General Environment Trust Fund to finance projects aimed at promoting energy generation from the sugar cane by-product, bagasse. This is intended to help reduce the islands' fuel import bill, which was the equivalent of over 10% of export revenues in 1991 [23]. The project is being initiated at Union St Aubin sugar estate.

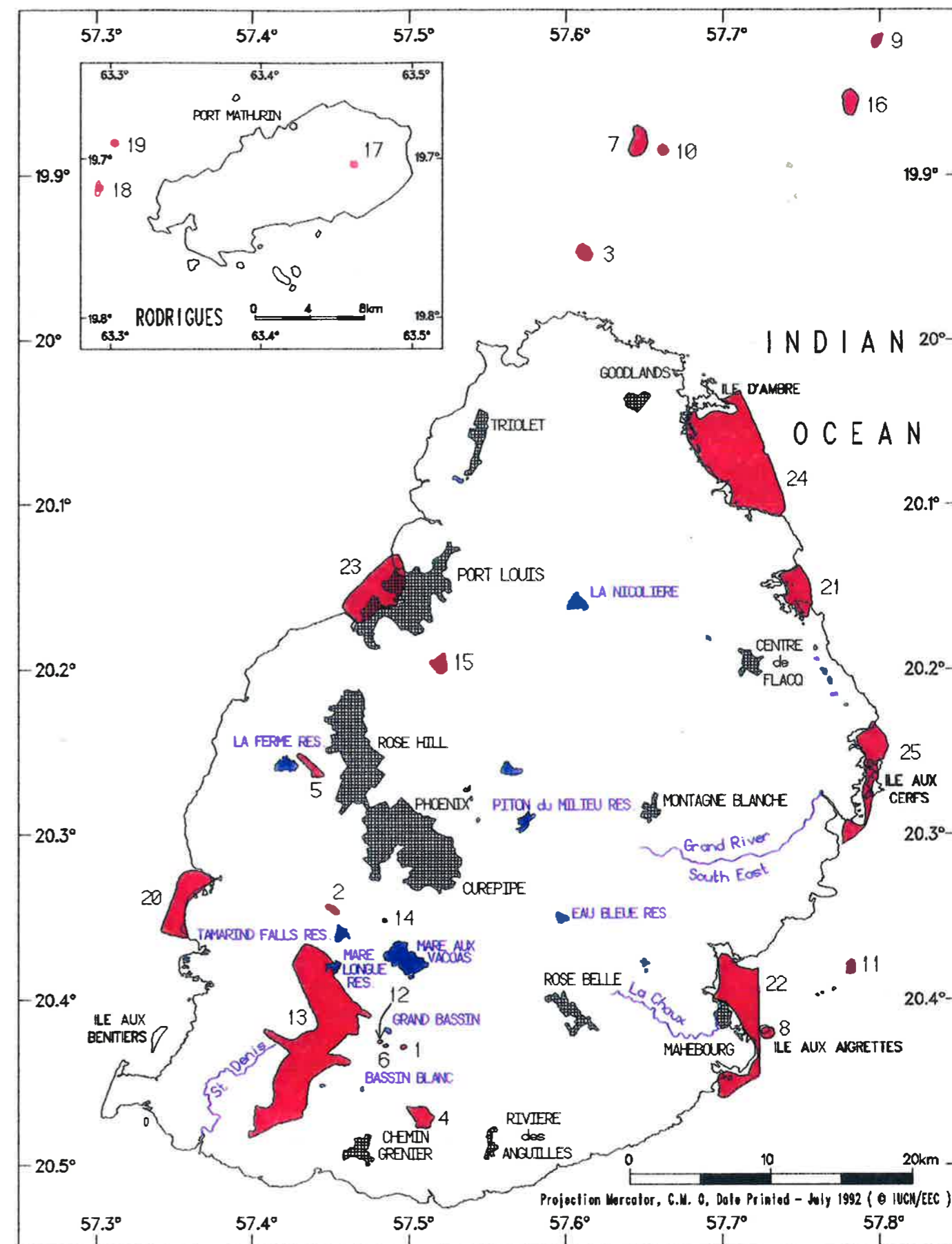


Figure 4. Protected Areas of Mauritius.
See text and Annex II for further details.

Demography and Urbanisation

Demographic pattern

On Mauritius the population is concentrated in a belt of towns between the capital, Port Louis, and Curepipe on the high central plateau (see Fig. 2). The principal urban development on Rodrigues is Port Mathurin situated on the north coast. Agalega has a population of about 300 inhabitants engaged mainly on coconut plantations.

The average household size is now 4.4, compared with 4.8 in 1983 and 5.4 in 1972 (see Population Growth). The number of households is increasing more rapidly than the population, creating a greater need for housing [8]. This, in turn, is leading to the growth of urban centres and additional pressures on the land and other natural resources.

Mauritians trace their origins to three continents: Europe, Asia and Africa. The largest communal group is that of the Hindu Indo-Mauritians (about 52% of the population), while Muslim Indo-Mauritians account for about 17%. The majority of the Hindu Indo-Mauritians live in the rural areas and many work in the sugar cane fields. The remainder are urban dwellers, working in industry, commerce and the civil service. The Mauritians of mixed African and French descent, known as Creoles and accounting for some 27% of the population, are employed mostly as skilled workers in industry and the service sector [2].

Population growth

Mauritius has experienced an interesting pattern of population development during the past 30 years. During the 1960s the Republic had one of the highest population growth rates in the world. Then, between 1963 and 1972, Mauritian fertility levels declined from more than six to just above three children per woman — one of the most rapid transitions recorded to date. The decline took place during a period of social development and in the complete absence of economic growth. After the stagnation of the 1970s, the economy enjoyed unprecedented growth in 1984 which also had an impact on the population, as well as on the environment (see also Analysis of Pollution and Degradation Processes).

Although the government's policies are believed to have helped lower the population growth rate significantly, Mauritius is still one of the world's most densely populated countries [6]. Official policy is to decrease the growth rate even further through family planning, health education, information programmes, and by social and economic measures: improving the status of women, creating employment and re-organizing the agricultural sector. The government's overriding policy objective is to achieve a population growth rate compatible with the country's limited land and natural resources.

Abortion is illegal [50]. The government has implied that future efforts in population policy may be constrained by the country's overwhelming dependence on its sugar industry as a source of revenue, pointing out that the Republic suffers from inequality in its terms of trade with developed nations [6]. Recently the government voiced concern over the decreasing birth rate, worrying that there will not be enough workers to run the new factories. Already Mauritius is facing a labour shortage (labour is being imported from China) and future population policy may not be one of control.

Internal and external migration

With the main island already quite densely populated, official policy is to decelerate internal migration and to maintain immigration at the current low levels [6].

Extent, density and distribution of urbanisation

Efforts to cope with urban population growth include a national housing policy and a national physical plan to promote a better distribution of housing and improve inter-urban and intra-urban traffic flows [6]. Although the government does not aim to adjust patterns of spatial distribution for demographic reasons, it does promote rural development and regional development policies for underdeveloped regions with the objectives of preserving agriculturally productive land and modernising towns and main villages [6].

The constant pressure on remaining agricultural land from urbanisation has also led the government to create a Land Conversion Tax, and permission must be obtained from the Ministry of Agriculture before construction can take place on existing agricultural lands.

Health issues

The Republic of Mauritius has a National Health Service which provides care for the entire population. Official policy aims to make the service more equitable by increasing the number of delivery points in rural areas and by integrating curative, promotional and preventive services [6]. Emphasis is placed on primary health care. Specific measures include the extension and enlargement of maternal and child health services by the Ministry of Health, and programmes for nutrition, environmental sanitation and clean water supply [6].

Major health problems come from non-communicable diseases: for example, cardiovascular ailments and diabetes. The level of AIDS is also increasing but only 11 cases were reported by March 1992, the last date for which WHO has figures [54]. The water-borne disease schistosomiasis is still prevalent in Mauritius, whereas malaria now appears to have been successfully controlled.

The health situation differs quite significantly between Mauritius and Rodrigues, with Rodrigues having a much higher mortality rate and lower access to sanitation and health education [50].

ANALYSIS OF POLLUTION AND DEGRADATION PROCESSES

Water Pollution and Water Shortage

The increasing demand for water during the past 20 years from the agricultural, industrial and private sectors has exerted a great pressure on the Republic's freshwater sources. As a result there has been a slight deterioration in both the quality and quantity of the inland water resources [8].

Although no quantitative data are available at present, people are aware of an increased level of water pollution. One of the main reasons for this has been the over-use of fertilizers to increase crop production; an estimated 600kg are applied per hectare in some regions. Runoff during storms must therefore be considerable.

Domestic effluent from non-sewered towns and rural areas in the immediate vicinity of aquifers, springs and rivers is a common and increasing source of water pollution, as is the disposal of untreated wastes from many of the island's industries.

The Mare-aux-Vacoas and Piton du Milieu are the two main artificial reservoirs which are exploited for domestic, commercial and industrial uses in Mauritius. These reservoirs are located in the highlands and surrounded by forest lands which are administered by the Forest Department. The importance of protecting catchments was reinforced in the Republic as a result of drought. The area holding the Mare-aux-Vacoas reservoir contains the whole of the catchment areas of Mare-aux-Vacoas and Mare Longue reservoirs and the head waters of the Tamarin, Black River, the Baie du Cap, Rivière des Galets, Rivière Savanne, Rivières des Anguilles, Rivière du Poste and other rivers and streams (not illustrated). Careful management of the remaining forests in these regions is crucial.

Soil Erosion and Degradation

Although soil erosion is not generally thought of as a serious problem on Mauritius, a survey carried out at La Nicolière Reservoir by the Central Water Authority revealed that the water storage capacity had been reduced by siltation [8]. This is likely to become a serious problem, as the island's water resources come under increasing demand from the growing industrial base and the expansion of tourism facilities. Areas of the lagoons have also suffered from siltation. If not prevented, this will smother important corals, and reduce lagoon fish stocks.

Soil erosion problems on the island of Rodrigues are reported to be quite severe, although there are no exact figures available.

The Republic currently ranks as one of the heaviest users of fertilizer and pesticides in the world. Apart from the extremely heavy application rates of herbicides (though no insecticides) on sugar-cane plantations (see Agriculture), the rate of pesticide use on green

vegetables is now estimated to be as much as five times that of the next highest user (Japan). Because most is applied with inefficient sprayers, an estimated 35-80% of the pesticides are lost to the soil. This, in turn, can result in decreased soil fertility (through the destruction of soil micro-organisms responsible for the decomposition of organic materials) as well as the contamination of ground and surface water through leaching and runoff.

Deforestation

Once a heavily wooded country, the Republic of Mauritius has been severely abused by human beings. Most of the country's natural vegetation has been stripped for agricultural purposes. Territorially, the island of Mauritius is divided into two forest divisions (north and south) which are further subdivided into ranges and sections. Rodrigues constitutes a separate range comprised of three small sections.

Although only 560km² of native forest remain today in the Republic, there is still a major dependency on timber products: about 24% of the population depend on wood resources, while an additional 1% depend on charcoal for cooking (Table 6).

Table 6. Number of Households Using Wood and Charcoal on Mauritius [8]

	Total Households	Wood	Charcoal
Urban population	99,441	7,436	2,093
Rural population	131,926	48,223	484
Total	229,367	55,659	2,577

At present, there are about 120km² of plantation. This consists mostly of pine (770km²), *Eucalyptus* and *Casuarina* (190km²), other softwoods (160km²) and a small area of hardwood (8km²). Local timber production can only meet 30% of the national need.

Biodiversity

In the Republic of Mauritius, the list of plants and animals that have become extinct is almost longer than those that have survived. Loss of native habitat and the introduction of alien species have been the main causes of the loss of biodiversity on all islands of the Mascarene group [9].

An estimated 900 plant species occur on the island of Mauritius, of which one-third are thought to be endemic. There are eight endemic genera. The most important area for threatened endemic species of flora and fauna is the Black River Gorge in the Macchabee Bel Ombre Nature Reserve. Many endemic plant species are already extinct and several of those which do survive are known only from a very small number of individuals. The following

species are known from only one plant each: *Dombeya mauritiana*, *Olax psittacorum* and *Albizia vaughanii* [8]. The native flora has suffered because of invasive exotic plants that compete with endemic species for space, light and nutrients. Among the worst offenders are Chinese guava and privet, both of which form dense thickets in the forests. Introduced animals such as deer, wild pigs and monkeys also cause extensive damage to seedlings.

The conservation programme for endangered native flora provides for *in-* and *ex-situ* propagation. A series of small reserves has been established to provide protection for every native plant species in at least one reserve. Active weeding of these reserves is carried out to eliminate alien species. In addition, a list has been drawn up of the top 20 plant species which need to be propagated and saved from extinction. Research on these is already well advanced, with many being re-introduced to their former habitat.

Before the arrival of people, no mammals reached the Mauritian islands apart from five species of bats. One of these, the Rodrigues fruit bat (*Pteropus rodricensis*) has been the subject of a captive breeding programme (less than 80 individuals were left in the wild). The Republic's wildlife had only two small predators (an owl and a kestrel). In fact, some birds, no longer threatened by predation, lost their ability to fly, the now extinct dodo being the classic example.

Of the 43 African birds that are considered to be endangered or vulnerable, 11 (26%) are from the Mascarenes [51]. Of the nine endemic Mauritian bird species, six are classified as endangered. Some of the rarest of these have been the focus of a highly successful captive breeding project at the Black River. These species include the echo parakeet (*Psittacula echo*), the pink pigeon (*Nesoenes mayeri*), and the Mauritius kestrel (*Falco punctatus*). Other species such as the olive white eye (*Zosterops chloronothos*), Mauritius fody (*Foudia rubra*) and cuckoo shrike (*Coracina typica*) are also considered seriously threatened.

Four endemic reptiles survive on mainland Mauritius, six can be found on offshore islets. All of the latter are either rare or endangered [27].

The Republic had 130 species of native land snail, of which 30% have become extinct and another 30% are severely endangered because of habitat destruction and the introduction of the carnivorous snail *Euglandina rosea*.

Sea turtles no longer nest on Mauritius. The hawksbill (*Eretmochelys imbricata*) was once common but is now rare, while the leatherback turtle (*Dermochelys coriacea*) is seldom seen. The dugong (*Dugong dugon*) and the coconut crab (*Birgus latro*) are now extinct in Mauritius [10].

Mauritius is still famous for its rich molluscan fauna, which includes a number of endemic species such as the imperial harp shell (*Harpa costata*) and the cowry (*Cypraea mauritiana*). To date, 263 species have been described, although the actual number is thought to be far in excess of this. Several species are endemic and considered rare.

Large numbers of reef fish are exported, mainly collected by professional divers, for aquaria [10].

With rapid population growth, industrial development, and the expansion of tourism, the pressures on biological resources are intensifying. To cope with the predictable increase in demand for resources, planning and environmental management are required.

Marine Environment and the Coastal Zone

There is no planning framework for marine environmental management in the Republic. Development along the coastline takes place without sufficient consideration of its impact on the marine environment [25]. In addition, marine resources are used without consideration of the interaction between different components of the marine environment. For example, coral sand mining in coastal lagoons has a very direct effect on the marine ecosystem. No monitoring of the marine environment is carried out and there is insufficient data for planning.

Mauritius has traditionally been an agricultural country, with sugar cane and tea as its main cash crops. Although it is widely stated that these developments had a relatively insignificant impact on the marine environment, it is likely they contributed to siltation and pollution from chemical runoff. Over the past 10 years, however, the creation of an Export Processing Zone (see Industrial Sectors) and the rapid development of a tourism infrastructure have had an unquestionable impact on the environment. The marine ecosystem is now threatened with what could become severe pollution from untreated industrial wastes, sewage, solid wastes and shipping. Fish kills have already been reported from many parts of the lagoons. No research, however, has investigated the level of pollutants in these areas.

The marine environments of the islands of St Brandon and Agalega are still relatively undisturbed and clean [8], but the adverse effects of human and natural disturbances on the coastal environment of the island of Rodrigues are severe. Complete deforestation has resulted in serious land erosion, and many lagoons and bays are now seriously threatened by sedimentation. A high percentage of the island's spectacular coral reefs have been killed in the process and fish stocks have also been reduced.

There is an urgent need for improved coastal zone management and planning on Mauritius and its dependencies. The marine environment is probably one of the greatest assets for the country's developing tourism; it should be appreciated and not destroyed. The need for integrated coastal zone management has been addressed in the government's white paper on National Environment Policy [8].

Urban Environment

Sewage collection, treatment and disposal systems are wholly inadequate. The proliferation of polluting industries, increased waste loads generated by the tourism sector (smaller hotels and restaurants), poorly maintained sewage treatment plants, improperly functioning septic tanks and inadequately treated wastes are beginning to affect the quality of water in ground and surface resources and in the coastal areas. Approximately two-thirds of the water-

intensive and polluting industries discharge to public sewer systems that provide minimal or no treatment prior to discharge to the ocean or lagoons [51].

Domestic effluents from the non-sewered towns and rural areas in the immediate vicinity of aquifers, springs and rivers are another common source of pollution. Apart from the two existing sewerage systems (Plaines Wilhems and Port Louis Sewerage) operating under the aegis of the Ministry of Energy, Water Resources and Postal Services, 80% of the houses discharge their waste waters into waste pits [8]. The existing sewerage systems have a limited capacity to accept any increase. Some industries are now required to discharge at off-peak hours. Despite this practice, overflows occur during moderate or heavy rainfall [51].

The Republic has no secure landfills for disposal of toxic sludges and industrial wastes. As a result, these are dumped indiscriminately at uncontrolled areas [51].

Energy Issues

The burning of bagasse, which provides about 20% of the Republic's commercial energy, causes dust emissions. Although some sugar mills have scrubbers, this simply passes on the pollution because the scrubber effluent (gypsum) is discharged to surface water bodies [3].

As the country develops, the demand for electrical power will grow. Hydropower potential has now been fully developed; further generation is most likely to be provided by oil- or coal-fired power stations. These, however, would contribute to global warming by emitting CO₂, one of the greenhouse gases. All opportunities to use renewable energy sources should therefore be exploited. Solar energy provides the best prospects in this field. Biogas development should also be encouraged [8].

Industry

The main sources of industrial pollution are sugar factories and dye houses (textile manufacturers). Wastes from the sugar-cane industry, the most important agro-industry, include: filter mud, molasses, furnace ash, fly ash, waste water and condenser waters. None of the 19 sugar mills has adequate treatment facilities. The discharge of sugar mills' waste has polluted lagoons as well as surface waters. The extent of pollution from this sector is unknown and needs to be investigated. A World Bank project to study the level of pollution from the sugar industry, executed by the Mauritius Sugar Authority, will begin in 1992.

The Baie du Tombeau area is the site of a large number of dye houses, many of which discharge waste products directly into the Lataniers River, onto adjacent land, or into inadequate absorption pits. The few dye houses that do treat their wastes are believed to do so inadequately [25].

Several other industries currently in operation are viewed as significant sources of pollution. Of particular concern are fertilizer, limestone and rock-crushing plants, as well as some of the food processing facilities. The former mainly generate air pollution while the latter are a source of water pollution and odours.

A number of new industries are expected to develop in Mauritius, notably leather tanning and plastic forming. Before these new industries are established, it is imperative that a full assessment of the potential pollution risks associated with them be made [3]. Environmental Impact Assessment (EIA) is a requirement under the Environmental Protection Act 1991, the first schedule of which lists undertakings to which the requirements apply. Most industrial processes are on this list, including leather tanning.

BIBLIOGRAPHY

- 1 Europa. 1991. Mauritius. In: *Africa South of the Sahara*. Europa Publications, Ltd., London, UK.
- 2 The Economist. 1992. *Mauritius, Seychelles Country Profile 1992-1993*. Annual Survey of Political and Economic Background. The Economist Intelligence Unit, London, UK.
- 3 World Bank. 1988. *National Environmental Action Plan for Mauritius*. The World Bank, Washington, D.C., USA
- 4 IUCN. 1990. *Biodiversity in sub-Saharan Africa and its islands: Conservation, Management and Sustainable Use*. Stuart, S.N. and Adams, R.J. (Eds) IUCN, Gland, Switzerland. 242pp.
- 5 IUCN. 1987. *Action strategy for protected areas in the Afrotropical Realm*. IUCN, Gland, Switzerland, and Cambridge, UK.
- 6 United Nations. 1989. *World Population Policies*. Volume I. United Nations, New York, USA.
- 7 IUCN. 1986. *Review of protected area systems in the Afrotropical region*. IUCN/UNEP, Gland, Switzerland. 259pp.
- 8 Government of Mauritius. 1991. *State of the Environment in Mauritius*. A report prepared for presentation at the United Nations Conference on Environment and Development, Rio de Janeiro, Brazil.
- 9 IUCN. 1992. *The Conservation Atlas of Tropical Forests: Africa*. Collins, N.M., Harcourt, C.H. and Sayer, J.A. (Eds) Macmillan Press Ltd., London, UK.
- 10 IUCN/UNEP. 1988. *Coral Reefs of the World II: Indian Ocean, Red Sea and the Gulf*. IUCN, Gland, Switzerland, and UNEP, Nairobi, Kenya. 389pp.
- 11 UNESCO. *Statistical Yearbook*. 1991. United Nations, New York, USA.
- 12 UNEP. 1990. *Environmental Data Report*. UNEP, New York, USA.
- 13 WHO. 1990. *World Health Statistics Annual*. World Health Organization, Geneva, Switzerland.
- 14 United Nations. 1989. *Demographic Yearbook*. United Nations, New York, USA.
- 15 United Nations. 1989. *Compendium of Social Statistics and Indicators*. United Nations, New York, USA.

- 16 United Nations. 1990. *Handbook of International Trade and Development Statistics*. United Nations, New York, USA.
- 17 UNICEF. 1989. *Statistics on Children in UNICEF-assisted Countries*. UNICEF.
- 18 UNDP. 1991. *Human Development Report*. UNDP, New York, USA.
- 19 World Bank. 1987. *World Debt Tables*. The World Bank, Washington, D.C., USA.
- 20 IUCN. 1992. *Protected Areas of the World: A Review of National Systems. Volume III — Afrotropical*. IUCN, Gland, Switzerland, and Cambridge, UK.
- 21 IUCN/UNEP. 1982. *Conservation of the coastal and marine ecosystems and living resources of the East African region*. UNEP Regional Seas Reports and Studies No. 11. IUCN, Gland, Switzerland, and UNEP, Nairobi, Kenya. 68pp.
- 22 MacKinnon, J. and MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland, and Cambridge, UK/UNEP, Nairobi, Kenya.
- 23 The Economist. 1992. *Madagascar, Mauritius, Seychelles, Comoros Country Report. Analysis of Economic and Political Trends every Quarter*. No 1 1992. The Economist Intelligence Unit, London, UK.
- 24 The Economist. 1992. *Madagascar, Mauritius, Seychelles, Comoros Country Report. Analysis of Economic and Political Trends every Quarter*. No 2 1992. The Economist Intelligence Unit, London, UK.
- 25 World Bank. *Mauritius Environmental Investment Program for Sustainable Development*. The World Bank, Washington, D.C., USA.
- 26 Cheke, A.S. 1987. In: Diamond, A. W. (Ed.) *Mascarene Island Birds. An ecological history of the Mascarene Islands, with particular reference to extinctions and introductions of land vertebrates*. pp5-89. Cambridge University Press, Cambridge.
- 27 Cheke, A. 1987. The legacy of the dodo: conservation in Mauritius. *Oryx* 21: 29-36.
- 28 Proctor, J. and Salm, R. 1975. *Conservation in Mauritius*. Unpublished IUCN/WWF Report to the Government of Mauritius.
- 29 MAFNR. 1985. *White Paper for a national conservation strategy*. Ministry of Agriculture, Fisheries and Natural Resources, Government of Mauritius, Port-Louis. 24pp.

- 30 Venkatasamy, D. 1991. *Philips Atlas for Mauritius*. Editions de l'Océan Indien. George Philip Ltd, London, UK.
- 31 Forestry Service. 1985. *Progress report 1980-1984 by the Forestry Service of the Ministry of Agriculture, Fisheries and Natural Resources*. Forestry Service, Mauritius. 14pp.
- 32 Forestry Service. 1988. *Annual report of the Forestry Service of the Ministry of Agriculture, Fisheries and Natural Resources for the year 1986*. Government of Mauritius, Port-Louis. 31pp.
- 33 Strahm, W. A. 1988. Mondrain Nature Reserve and its Conservation Management. *Proceedings of the Royal Society of Arts and Sciences* 5:1, 133-177.
- 34 Strahm, W.A. 1989. *Plant Red Data Book for Rodrigues*. Koeltz Scientific Books, Königstein, Germany.
- 35 Curry-Lindahl, K. 1971. *Comments on the conservation management, utilisation of the renewable natural resources of Mauritius*. UNESCO. 6pp.
- 36 D'Arifat, C. 1983. *Preparatory legal work for the action plan for the protection and development of the marine environment of the East African region*. UNEP, Port-Louis, Mauritius. 15pp.
- 37 Forestry Service. 1990. *Annual report of the Forestry Service of the Ministry of Agriculture, Fisheries and Natural Resources for the year 1988*. Government of Mauritius, Port-Louis. 29pp.
- 38 Government of Mauritius. 1971. *Four-year plan for social and economic development: 1971-1975 (Volumes I and II)*. Government of Mauritius, Port-Louis.
- 39 Manrakhan, J. 1983. *Some thoughts prompted by a workshop involving the sea and Mauritius*. In: Sparks, D.L. (Ed.) Workshop Final Report, Regional Workshop for Coastal and Marine Management and Protection in East Africa and the Indian Ocean. pp21-30. University of Mauritius, October 1983.
- 40 Owadally, A.W. 1980. Some forest pests and diseases in Mauritius. *Rev. Agric. Sucrière Ile Maurice* 59: 76-94.
- 41 Anon. 1982. *Round Island Expedition Preliminary report*. Jersey Wildlife Preservation Trust UK/Forestry Service, Mauritius/WWF, Gland, Switzerland. 15pp.
- 42 Scott, P. 1973. *Conservation in Mauritius*. IUCN Report to the Prime Minister of Mauritius.

- 43 Staub, F. and Gueho, J. 1968. The Cargados Carajos shoals or St Brandon: resources, avifauna and vegetation. *Proceedings of the Royal Society of Arts and Science Mauritius* 3: 7-46.
- 44 Parnell, J.A.N., Q. Cronk, P.W. Jackson, and W. Strahm. 1989. A study of the ecological history, vegetation and conservation management of Ile aux Aigrettes, Mauritius. *Journal of Tropical Ecology* 5: 355-374.
- 45 Temple, S.A. 1974. Wildlife in Mauritius today. *Oryx* 12: 584-590.
- 46 Temple, S.A., Staub, J.J.F. and Antoine, R. 1974. *Some background information and recommendations on the preservation of the native flora and fauna of Mauritius*. Typescript. 37pp.
- 47 UN/UNESCO/UNEP. 1982. *Marine and coastal area development in the East Africa region*. UNEP Regional Seas Reports and Studies No. 6. 58pp.
- 48 UNEP. 1982. *Environmental problems of the East African region*. UNEP Regional Seas Reports and Studies No. 12. 86pp.
- 49 Vaughan, R.E. and Wiche, P.O. 1937. Studies of the vegetation of Mauritius, I: a preliminary survey of the plant communities. *Journal of Ecology* 25: 289-343.
- 50 Strahm, W. 1992. Personal communication to IUCN. July 1992.
- 51 Collar, N.J. and Stuart, S.N. 1985. *Threatened Birds of Africa and Related Islands. The ICBP/IUCN Red Data Book Part I*. ICBP and IUCN, Cambridge, UK.
- 52 FAO. 1992. *Fisheries Statistics Yearbook: catches and landings. Volume 70*. FAO, Rome, Italy.
- 53 United Nations. 1992. *Statistical Yearbook 1988-1989*. United Nations, New York, USA.
- 54 WHO. 1993. *Global Programme on AIDS. The Current Global Situation of the HIV/AIDS Pandemic*. World Health Organization, Geneva, Switzerland.
- 55 Gale Research. 1991. *Nations of the World*. Gale Research, Inc., Detroit, USA.
- 56 FAO. 1991. *FAO Production Yearbook 1990-1991*. FAO, Rome, Italy.
- 57 World Bank. 1992. *World Debt Tables 1992-1993. External finance for developing countries. Volume 2*. The World Bank, Washington, D.C., USA. 490pp.

- 58 Encyclopedia Britannica. 1992. *Britannica Book of the Year*. Encyclopedia Britannica, Inc. Chicago, USA.

NOTE ON DATA SOURCES

Every effort has been made to ensure that the information in this Environmental Synopsis is as detailed and accurate as possible. Many reports are, themselves, the result of a review of existing data and some issues may therefore be open to different interpretation. This is particularly the case for references [1, 2]. Wherever possible, original data sources have been used as a reference or, failing that, data have been checked against several other sources. Recent national publications such as references [3 and 8] provide general accounts of the state of the environment.

A number of publications are recommended for further in-depth reading on a particular topic. These include the regular country reports of the Economist Intelligence Unit [2, 23, 24] which provide a well-balanced review of the political (historical and present) and economic situations as does the Europa Handbook [1]. A wide selection of useful statistical data are to be found in [6, 11, 12, 13, 14, 15, 16, 17, 18, 19, 30, 53, 55, 56, 57 and 58]. Information on biodiversity, deforestation and wildlife issues have been obtained from a number of publications [4, 5, 9, 10, 20 and 22]. Demographic, health and similar data have been taken from a wide range of sources within the United Nations (including WHO and UNICEF).

One of the prime objectives of this overview has been to highlight gaps in current information in the hope that government and development agencies alike will take the need for fuller information into consideration when planning and implementing future projects. As the reviewers of this Synopsis pointed out, however, many changes are now taking place with regard to the environment in Mauritius, and some of the information in this Synopsis, although accurate at the time of publishing, may change.

ANNEX I

Vegetation Pattern of Mauritius (See also Fig. 3)

Vegetation data were derived from an inset on a map published by the Central Intelligence Agency (1972) *Mauritius - Economic Activity and Land Use*. Conservation areas are mapped from sketch maps held on file at WCMC.

Digitised data are held at the *WCMC Biodiversity Map Library*, WCMC, 219 Huntingdon Road, Cambridge, CB3 0DL, UK.

ANNEX II

Protected Areas of Mauritius (See also Fig. 4)

Map Reference	Name
1	Bois Sec Nature Reserve
2	Cabinet Nature Reserve
3	Coin de Mire Nature Reserve
4	Combo Nature Reserve
5	Corps de Garde Nature Reserve
6	Gouly Pere Nature Reserve
7	Ile Plate Nature Reserve
8	Ile aux Aigrettes Nature Reserve
9	Ile aux Serpents Nature Reserve
10	Ilot Gabriel Nature Reserve
11	Ilot Marianne Nature Reserve
12	Les Mares Nature Reserve
13	Macchabee-Bel Ombre Nature Reserve
14	Perrier Nature Reserve
15	Pouce Nature Reserve
16	Round Island Nature Reserve
17	Grande Montagne Nature Reserve
18	Ile aux Cocos Nature Reserve
19	Ile aux Sables Nature Reserve
20	Black River National Park (proposed)
21	Flacq Fishing Reserve
22	Grand Port-Mahebourg Fishing Reserve
23	Port Louis Fishing Reserve
24	Rivière du Rampart-Poudre d'Or Fishing Reserve
25	Trou d'Eau Douce Fishing Reserve

ACRONYMS

CEC	Commission of the European Communities
EEZ	Exclusive Economic Zone
EPZ	Export Processing Zone
GDP	Gross Domestic Product
GNP	Gross National Product
GWh	Gigawatt-hour(s)
ha	hectare(s)
ICBP	Birdlife (formerly the International Council for Bird Preservation)
ICCE	International Centre for Conservation Education
IUCN	The World Conservation Union
JWPT	Jersey Wildlife Preservation Trust
km	kilometre(s)
MAFNR	Ministry of Agriculture, Fisheries and Natural Resources
MIE	Mauritius Institute of Education
MW	Megawatt(s)
MWAF	Mauritius Wildlife Appeal Fund
NGO	non-governmental organisation
NPWS	National Parks and Wildlife Service
ODA	Overseas Development Administration (United Kingdom)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WWF	World Wide Fund For Nature