

WESTERN INDIAN OCEAN ENVIRONMENT OUTLOOK



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Western Indian Ocean Environment Outlook





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Preface

The *Western Indian Ocean Environment Outlook* (WIOEO) report is part of a United Nations Environment Programme (UNEP) project to produce state of the environment assessments for the countries of the Caribbean, Indian Ocean and Pacific, funded by DG VIII of the European Commission (EC). The objective of the WIOEO is to provide information on the state of the environment in the Western Indian Ocean, help identify regional environmental concerns, and highlight policy priorities.

The report comes at a critical time for these island countries, as the international community reviews agreements reached at the Global Conference on the Sustainable Development of Small Island Developing States (SIDS), held in Barbados in 1994. The WIOEO will provide a forum for the promotion of issues of priority importance to SIDS at the United Nations General Assembly Special Session (UNGASS) and subsequent fora. The analysis produced as a result of the project could also provide another opportunity to focus SIDS priorities. It could serve as a basis for SIDS to revisit their own national and regional priorities with regard to the programming of development assistance which they receive from various donors. The report could also play a role in the consultations between SIDS and donors, for instance during the ongoing post-Lomé negotiations.

This report provides an overview of the state of the environment (SOE), focusing on the Lomé countries of the Western Indian Ocean – the Federal Islamic Republic of Comoros, Madagascar, Mauritius and Seychelles – (Réunion, which is an overseas department of France, is not included), followed by a review of current policy responses including multilateral environmental agreements, and regional and national policy initiatives already undertaken in the region. A concluding chapter takes a look into the future

at emerging environmental issues in the region, which should be addressed and require further research, as well as proposing some alternative policies.

The production of the Caribbean, Western Indian Ocean and Pacific Islands environment outlooks closely followed the process established for the production of UNEP's *Global Environment Outlook* (GEO) report. GEO uses a regional and global participatory assessment and reporting process. This participatory process is crucial in ensuring that the assessment involves stakeholders and experts from all over the world and from every discipline that relates to environment and development. As with GEO, the Caribbean, Western Indian Ocean and Pacific Islands environment outlooks aim to incorporate regional views and perspectives and to build consensus on priority issues and actions through dialogue among policy-makers and scientists at the regional and global levels.

The main components of the GEO process are the collaborating centres, regional policy consultations, international working groups and the UN System-wide Earthwatch (Box 0.1). The main partner for the production of the *Western Indian Ocean Environment Outlook* was the Indian Ocean Commission (IOC or Commission de l'Océan Indien (COI)) and a network of national co-ordinators from each country. The WIOEO report is based on existing published reports, documents and data available for the region. Although many national-level and some regional-level reports exist, there is very little published work to draw on that examines environmental issues affecting the countries of the region in an integrated manner. It is therefore hoped that this study will make a valuable contribution to sustainable development planning in the region.

Box 0.1: The GEO process

The production of the Caribbean, Western Indian Ocean and Pacific Islands environment outlooks closely followed the process set up for the production of UNEP's *Global Environment Outlook* (GEO) publication. Both *GEO-1* (published in 1997) and *GEO-2000* (published in 1999) were produced using a regional and participatory process. This process was of crucial importance in ensuring that the assessment involved stakeholders and experts from all over the world and from every discipline relating to environmental and development issues. As with GEO, the Caribbean, Western Indian Ocean and Pacific Islands environment outlooks aim to incorporate regional views and perspectives and to build consensus on priority issues and actions through dialogue among policy-makers and scientists at both regional and global levels. The main components of the GEO process are:

- GEO Collaborating Centres
- Regional policy consultations
- International working groups
- UN System-wide Earthwatch

GEO Collaborating Centres are multi-disciplinary centres of excellence from all the regions which form a co-ordinated network for making policy-relevant assessments. The GEO 2000 network consists of some 25 such Collaborating Centres. The three Collaborating Centres chosen to help implement the UNEP/EC project were:

- the University of the West Indies, Centre for Environment and Development (UWI-CED), Kingston, Jamaica;
- the Indian Ocean Commission, Quatre-Bornes, Mauritius, and
- the South Pacific Regional Environmental Programme (SPREP), Apia, Western Samoa.

Regional policy consultations were held in each of the subregions to ensure the participation of all the stakeholders, especially policy-makers, regional organizations and NGOs. Regional consultations not only provide a forum in which governments are able to provide inputs into the GEO process, but also stimulate dialogue between scientists and policy-makers – a crucial step in ensuring that assessments are geared towards policy formulation and action planning.

The regional consultations provided advice and feedback from governments and scientists on the early drafts of the reports. As with the regional consultations for the GEO reports, the consultations for the Caribbean, Western Indian Ocean and Pacific Islands environment outlooks provided inputs that resulted in substantial improvement to the respective documents.

International working groups on modelling, scenarios, data and policy provided technical support to the GEO process by developing and recommending methodologies for achieving harmonized and integrated assessments.

United Nations System-wide Earthwatch ensures the participation of UN agencies in the GEO process.

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This report has been compiled with the help of numerous institutions and individuals. UNEP would like to thank the European Commission, Directorate-General for Development for their financial and substantive support, in particular Francisco Granell, Artur Runge Metzger, Amos Tincani, Maria Savvaides-Polyzou and our consultant in Brussels, Heli Tuononen.

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Essential guidance was provided by a dedicated team of UNEO staff managing the Global Environment Outlook Process. Numerous colleagues at UNEP also contributed to the report including Anna Stabrawa, Marion Cheatle, Bob Kakuyo, Berna Bayindir and Kaveh Zahedi. Thanks also go to Veerle Vandeweerd and Dan Claasen.

Finally, we owe a special thanks to the participants of the Indian Ocean Regional Consultation, whose guidance enabled us to improve the document enormously. A full list of these participants, together with the names of other individuals who contributed significantly, is included at the end of this report.

Introduction



It is widely recognized that islands, especially small island states, have many common features which make them economically, ecologically and geopolitically vulnerable to external shocks, and therefore that they function at a disadvantage compared to larger states. Some of the features that give rise to this vulnerability include small size, isolation from major markets, ecological fragility, geographic dispersion and limited resources (Commonwealth Secretariat 1997).

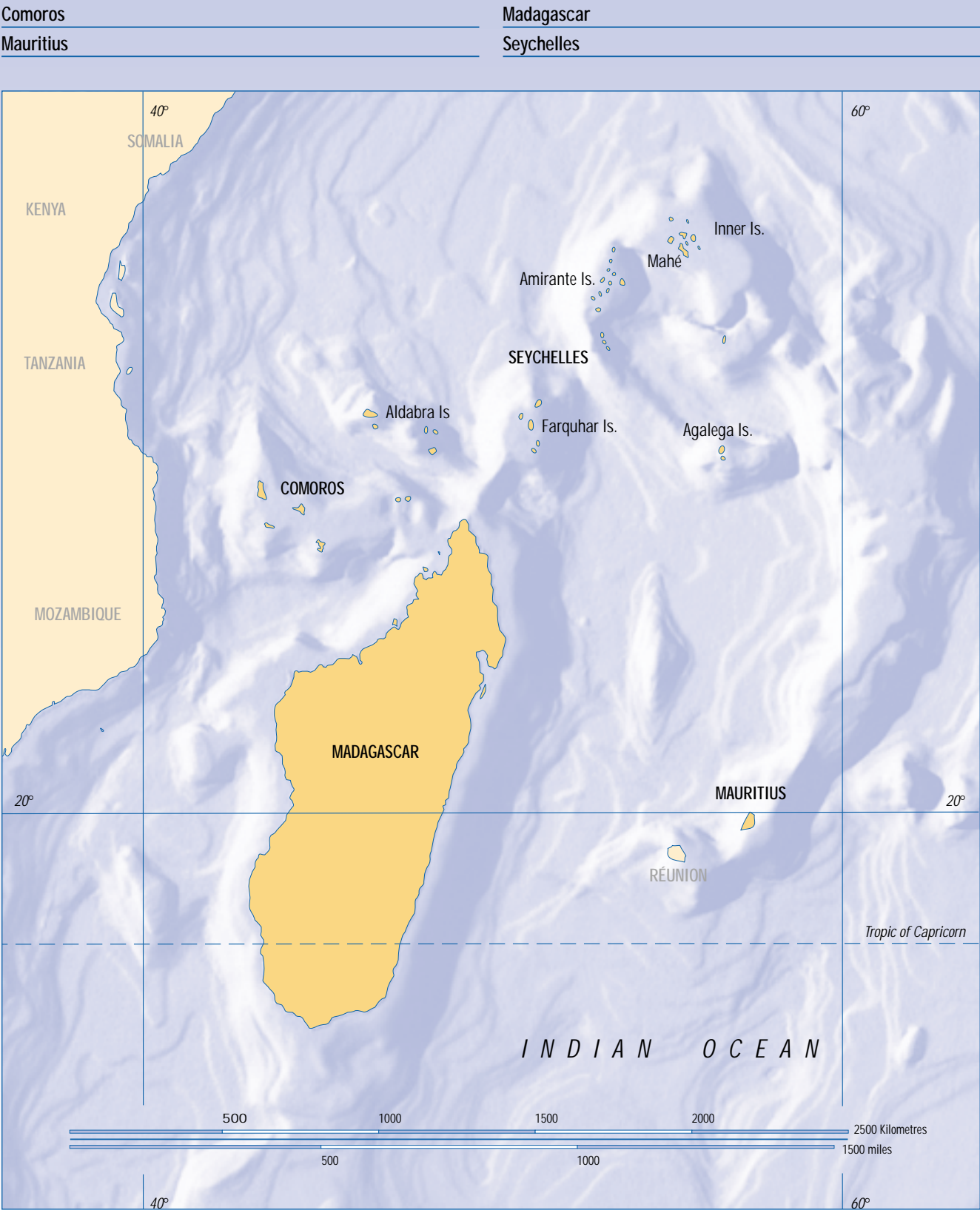
The special problems of small island developing states (SIDS) have been specifically addressed by members of the global community since the beginning of the 1990s, first by the 1992 UN Conference on Environment and Sustainable Development (UNCED) in Chapter 17 of *Agenda 21*, and later through the UN Global Conference on the Sustainable Development of SIDS, held in Barbados in 1994, which drew up the Barbados Programme of Action (POA) for the Sustainable Development of SIDS. Progress on implementation of the Barbados POA has been reviewed by the UN Commission for Sustainable Development (CSD) in 1996, 1998 and April 1999, and by the UN General Assembly Special Session on the implementation of *Agenda 21* in 1997. A full review, five years after Barbados, will be undertaken by a special session of the UN General Assembly in September 1999 (see UNEP's Islands website <http://www.unep.ch/islands.html>). In addition to the work of the United Nations (eg Department of Economic and Social Affairs (DESA), United Nations Environment Programme (UNEP), United Nations Development

Programme (UNDP), Food and Agriculture Organization (FAO) and the Economic Commissions) other initiatives include provisions to support island states under the Lomé Convention, work by the Commonwealth Secretariat (Commonwealth Secretariat 1997), and the World Bank and the activities of regional intergovernmental organizations (e.g. the Indian Ocean Commission (IOC)).

The island states of the Western Indian Ocean share commonalities in terms of natural resources, cultural linkages, export commodities, insularity and vulnerability. Historically, the islands were settled by Europeans, followed by indentured labour from Africa and South Asia. Culturally, this region is composed of diverse ethnic groups, with a mosaic of customs and traditions. The island states of the region also have great physical differences and contrasts – they are a melting pot of races, religions and cultures, which have followed very different development paths, particularly in the last ten years.

- The Federal Islamic Republic of Comoros (hereafter referred to as 'Comoros') is an archipelago of three islands with a predominantly rural, largely homogenous population, highly indebted and dependent on agriculture and external assistance.
- Madagascar is the world's fourth-largest island, with unique flora and fauna, rich in natural resources, including minerals, with considerable development potential but high levels of poverty and population growth.

Figure 0.1: Island states covered by the *Western Indian Ocean Environment Outlook*



- Mauritius, one of the most densely populated countries in the world, has in the last few decades been transformed from an agrarian economy with high population growth, to a modern, medium-income country with lower population growth and high levels of education and welfare.
- Seychelles, made up of 115 islands, has a unique ecology, pristine environment and tourist attractions, and the highest Human Development Index ranking in Africa, but is particularly vulnerable to external economic conditions because of its small size and high dependence on external markets (see Box 1.1).

Sustainable development is a major challenge for the countries of the region, and will continue to be so in the third millennium. With increasing globalization, which means liberalization of trade, deregulation of financial markets, the spread of the transnational production of goods and services, and of new technologies, particularly information technologies (Commonwealth Secretariat 1997), comes growing interdependence and increasing vulnerability. Within the context of the trend in globalization, the island states of the Western Indian Ocean have recognized their vulnerability to new trade issues and environmental threats. This has prompted the setting up of, or participation in, global and regional organizations such as the Alliance of Small Island States (AOSIS), the Indian Ocean Commission (IOC), the Southern African Development Community (SADC), the Common Market for East and Southern Africa (COMESA), and the Indian Ocean Rim Association for Regional Co-operation (IORARC). These organizations provide important fora for the island states of the region to voice their collective opinions and take action on matters of regional importance.

State of the Environment



Background

Although the islands of the Western Indian Ocean differ substantially in size and level of development, they share common environmental features which have a profound influence on their development:

- their capital of biodiversity is of global significance;
- they are highly dependent on their marine and coastal resources;
- tourism, based on the natural resource endowment, is increasingly important for their economic development;
- they are vulnerable to natural disasters, climate change and sea-level rise;
- their insularity and small size make them economically highly dependent on and vulnerable to external forces such as globalization and climate change;
- their rugged, in some cases mountainous, topography means that soil conservation and watershed management require special attention;
- they have rapidly urbanizing populations, and in most cases high population densities.

The sustainability of island states is quite different from that of the larger continents. The former are more prone to natural calamities such as cyclones, tidal waves and other problems linked to the coastal zone because of their high coastal index, a measure of insularity calculated by dividing the length of the

shoreline by the land area (UNEP 1991) and sea-level risk (evaluated as the percentage of the land area less than five metres above sea-level, divided by ten to give a single digit (UNEP 1991). This problem is further exacerbated by the stress placed on their environment by high population densities and the drive for economic development. Socio-economic factors therefore, are one of the principal driving forces having a profound impact on the state of the environment, and must be addressed as part of any sustainable development strategy.

Socio-economic context

In most socio-economic aspects, the four island states in this region can be divided into two groups, illustrated by their rankings in the UNDP Human Development Index (HDI). Seychelles and Mauritius are countries with a high HDI ranking, placed first and second respectively as the highest-ranked African economies in the index. Comoros and Madagascar fall into the category of countries with a low HDI ranking (Table 1.1) and are classified as Least Developed Countries (LDCs) (UNDP 1998).

Population and poverty are two key factors that commonly exert pressure on the natural environment (UNDP 1998, SADC 1996). In this region, Comoros and Madagascar have both experienced high population growth with rates of over 3 per cent, which are projected to continue into the next millennium (Figure 1.1). The total

Table 1.1: Development indicators

	Comoros	Madagascar	Mauritius	Seychelles
UNDP HDI ranking	141 (low)	153 (low)	61 (high)	56 (high)
Total fertility rate 1995	5.8	5.9	2.3	n.a.
Infant mortality rate per 1 000 live births 1996	115 ⁽¹⁾	100	20	9 ⁽²⁾
Adult literacy rate (%) 1995	57.3	45.8	82.9	88.0
Life expectancy at birth (years) 1995	56.5	57.6	70.9	72
Percentage of population with access to (1990–96):				
Safe water	53	34	98	76 ⁽⁴⁾
Sanitation	33	41	100	78 ⁽⁴⁾
Health care	82 ⁽³⁾	38	100	99 ⁽³⁾

Sources: UNDP Human Development Report 1998, except (1) PNUD 1998. (2) UNDP 1997b. (3) UNCHS 1996, 1982 figures for health in Comoros; 1984 figures for health in Seychelles. (4) Republic of Seychelles 1997a (1994 Census figures). Note: n.a. = not available.

population of the region was about 16.9 million in 1998: it is estimated that this figure will more than double to exceed 43 million by 2050 (UN Population Division 1998). Poverty exists in all countries of the region, but is most widespread in Madagascar, where over 70 per cent of the population is considered to be below the income poverty line of US\$1 a day (République de Madagascar/MFE 1996, UNDP 1998). Poverty affects on average 50 per cent of society in Comoros, with a maximum of 62 per cent in Anjouan island (RFIC/PNUD 1997). Twelve per cent of the population of Mauritius is deprived of longevity, knowledge and a decent standard of living – the three key deprivations according to UNDP's Human Poverty Index (HPI) – compared to 48 per cent in Madagascar (UNDP 1998). Although Seychelles is a middle-income country, which has made substantial progress in reducing poverty, levels remain high for a country with its income level. It was estimated that in 1994 19 per cent of households were below the basic poverty line, and 7 per cent below the absolute poverty line (UNDP 1997b).

Most other key development indicators such as fertility levels and child mortality rates, literacy, life expectancy, access to health care, clean water and sanitation show a similar picture (Table 1.1): that of a wealthier, better educated population living longer with greater access to services and facilities in Seychelles and Mauritius, and a poorer, less educated population with higher fertility levels and child mortality rates as well as poorer access to health services and facilities such as clean water and sanitation in Comoros and Madagascar.

The example of Mauritius puts these indicators into context. In the period from the 1960s to 1990s Mauritius was transformed from a typically poor,

agrarian economy with high population growth and moderate life expectancy, to a modern, low fertility country with high levels of education and welfare. During the same period, the level of wealth increased ten-fold, with good prospects for further development. However, careful sustainable development planning and adjustments to unsustainable development practices are needed to prevent increasing degradation of environmental resources (Ness and Golay 1997).

Both Seychelles and Mauritius have experienced solid economic growth in recent years, with annual growth rates in gross national product (GNP) of 3.3 and 5.7 per cent respectively over the period 1980 to 1995, and similar increases on a per capita basis because of their low population growth rates. In contrast, Comoros' and Madagascar's GNP annual growth rates have been significantly lower, and negative on a per capita basis because of high population growth. In Comoros the combination of poverty and negative economic growth on a per capita basis has compelled the poor and the unemployed to over-fish the coral reefs, destroy primary forests, exploit beach sand, degrade land for shifting cultivation and pollute coastal areas through unplanned settlements (RFIC/PNUD 1997).

A similar pattern is seen in the structure of the economies of the region (Table 1.2). The economies of Comoros and Madagascar are predominantly based on agriculture, which contributed 34 and 39 per cent of GDP respectively in 1995 (RFIC/PNUD 1997 and UNDP 1998) and almost 80 per cent of the labour force is engaged in agricultural activities (UNDP 1998). Services and industry dominate in Mauritius (textiles, tourism, off-shore services) and Seychelles (tourism, re-exports of petroleum, transport, distribution,

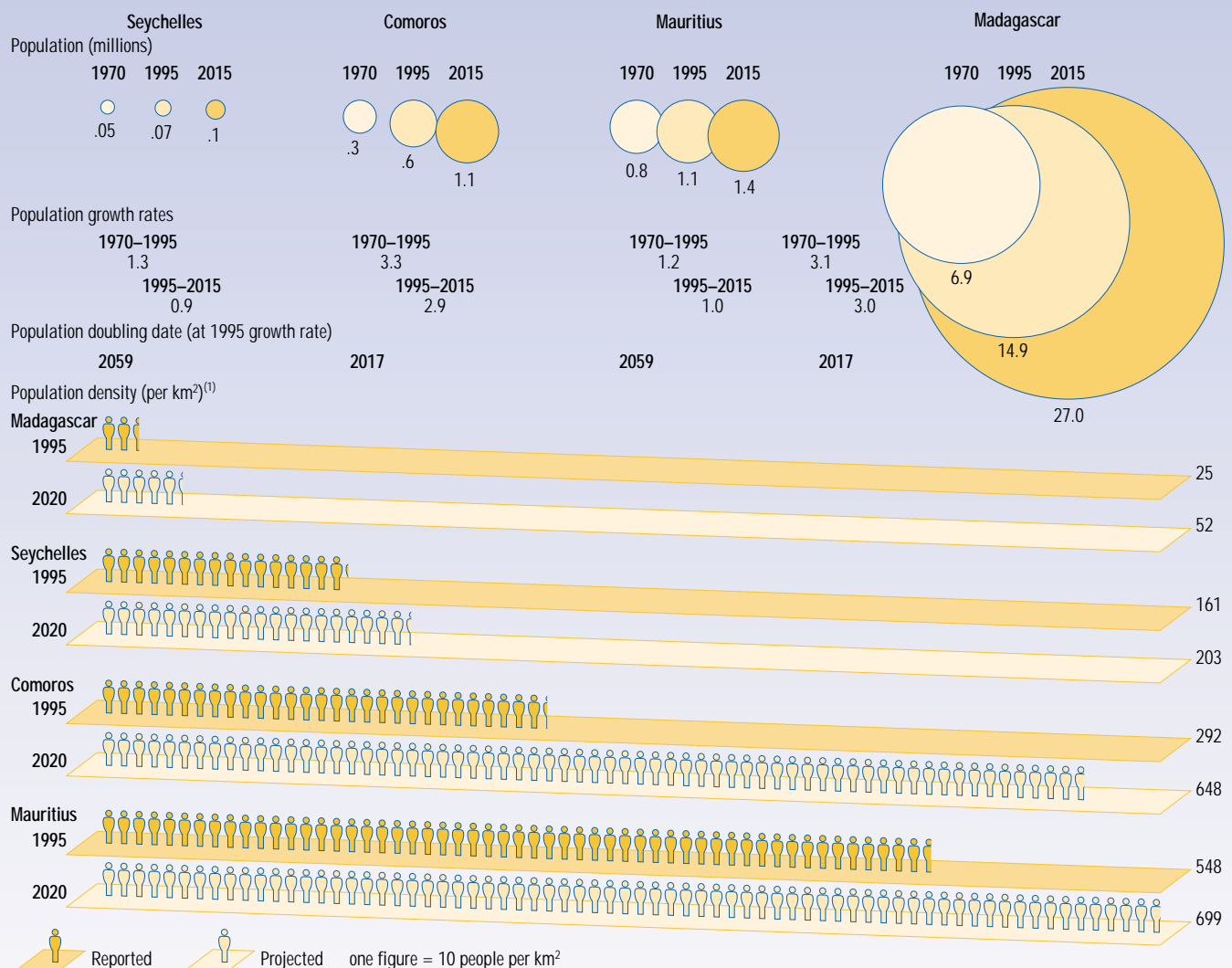
communications, financial and business). However fish and fish products make up 95 per cent of domestic exports and are the second highest foreign exchange earner after tourism in Seychelles (UNDP 1997b). Limited land and water severely constrain agricultural and industrial development, particularly in Comoros and Seychelles. However, all the island states of the region have access to vast areas of marine resources having economic sovereignty over large stretches of the ocean, which extend over exclusive economic zones (EEZ) ranging from 249 000 km² for Comoros (WCMC *et al.* 1999) to 1.7 million km² for Mauritius (Government of Mauritius 1991a).

International tourism is increasingly important for economic development in the region. Seychelles is highly

dependent on this sector (EIU 1998), with tourism contributing 15 per cent of GDP, 70–75 per cent of foreign exchange earnings and employing 20 per cent of the labour force (Republic of Seychelles 1997a; UNDP 1997b). Tourism contributed about 4.4 per cent of GDP and 18 per cent of foreign exchange earnings for Mauritius in 1996/97 (UNDP 1997a). Both countries have concentrated on attracting high-spending tourists by promoting an 'up-market' image as well as their climate and unique environment in order to increase expenditure per tourist and per tourist-night (FAO 1997a). Comoros and Madagascar are also trying to develop this sector, and most countries are interested in developing ecotourism.

Good environmental quality is essential both for the high value-added tourism strategy pursued by Mauritius

Figure 1.1: Population trends



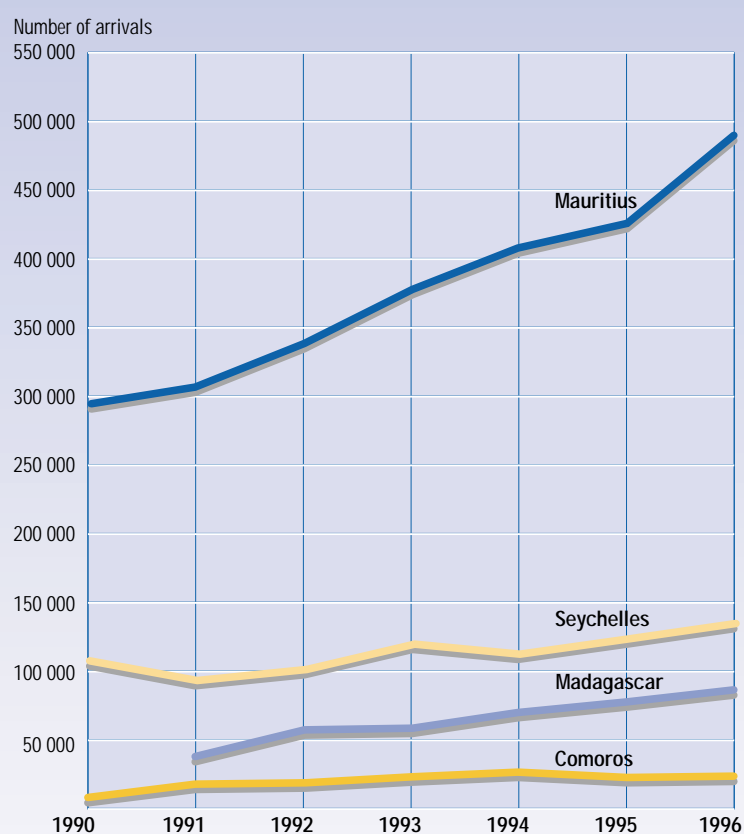
Source: UNDP, 1998 except (1) from FAO 1997a.

Table 1.2: Economic indicators

	Comoros	Madagascar	Mauritius	Seychelles
GNP in US\$ billions (1995) ⁽¹⁾	0.2	3.2	3.8	0.5
GNP per capita (1995) ⁽¹⁾	470	230	3 380	6 620
GNP annual growth rate (%) 1980–95 ⁽¹⁾				
Total	2.0	-0.1	5.7	3.3
Per capita	-0.7	-3.0	4.6	2.3
	Comoros ⁽²⁾	Madagascar ⁽³⁾	Mauritius ⁽⁴⁾	Seychelles ⁽⁵⁾
GDP in US\$ billions (1995)	0.2	3	4	0.5
GDP (%) 1995				
Agriculture	39	34	10	4
Industry	4	13	33	22
Services	57	53	52	59
Tourism	n.a.	n.a.	4.4	15
Total	100	100	100	100
Exports as % of GDP (1995)	19	23	58	18
Imports as % of GDP (1995)	44	31	62	54

Sources: (1) UNDP, 1998. (2) RFIC/PNUD, 1997. (3) UNDP 1998. (4) UNDP 1997a. 1996 figures for tourism. (5) UNDP 1997b. Note: n.a. = not available.

Figure 1.2: Tourist arrivals 1990–97



Source: (1) RFIC 1997a. (2) République de Madagascar/MFE 1997. (3) UNDP 1997a. (4) Central Bank of Seychelles 1996.

and Seychelles so far, and for the further development of ecotourism by all the countries of the region. Given that tourist arrivals have risen steadily in all these countries (Figure 1.2) the importance of this sector, and the pressures it exerts on the natural resource base, primarily on the coastal zone, are likely to increase. Seychelles and Mauritius have recognized the threat posed to the tourist sector and their economies from serious environmental degradation. Maintaining the quality of the natural environment requires strict control of all development, as well as of the environmental carrying capacity, and the private sector is expected to play a key role in sustainable development of this sector in the coming years. Both countries are continuing the strategy of concentrating on high quality, high yielding tourism and establishing a ceiling on tourist numbers (Republic of Seychelles 1997a; GOM/ERM 1998a).

Economically important mineral resources are present only in Madagascar (e.g. precious stones, mica, chrome, bauxite, iron and graphite). However, due to lack of capacities, this potential has not yet been exploited significantly (République de Madagascar 1997). Mineral deposits in the form of polymetallic nodules have been found in the EEZs of both Seychelles (EIU 1998) and Mauritius, but due to the great depths at which they are found exploitation is unlikely to occur in the near future (Government of Mauritius 1991a).

Box 1.1: Economic vulnerability: the example of Seychelles

Most countries of the Western Indian Ocean have fragile economies with a weak economic base and are highly dependent on their natural resources as well as predetermined forces, including access to markets, mainly in Europe, and fluctuations in world prices for export commodities.

Although Seychelles is classified as a middle-income country with a per capita GNP of US\$6 850 in 1996 (World Bank 1998), its economy is very susceptible to changes in the external environment, mainly due to its almost exclusive dependence on tourism and fishing as the principal foreign exchange earners (UNDP 1997b). Both of these fluctuate based on demand, and are very vulnerable to external natural or man-made shocks such as economic recession, exchange rate fluctuations, war, drought and natural disasters. With its limited production base and geographical isolation, the Seychelles economy is characterized by a high level of openness and import dependence, and is vulnerable to external economic shocks. The oil crisis of the 1970s, world recession in the 1980s and the Gulf War of the early 1990s all impacted heavily on Seychelles by raising essential import prices, decreasing tourism and contributing to a decline in foreign exchange earnings. The country has consistently run a trade deficit, with imports far outstripping exports, reflected in high import bills and severe foreign exchange shortages. In 1995, more than 90 per cent of production inputs and consumption goods were imported, and imports accounted for nearly half of GDP (Republic of Seychelles 1996 quoted in UNEP 1998a). Based on its trade openness, export concentration, peripherality and dependence on imported energy, Seychelles has been ranked as the third most economically vulnerable country in the world (Briguglio 1997). This measure of vulnerability is however contested by some economists as there is no consensus on the best way to calculate economic vulnerability. Work is in progress to develop an Environmental Vulnerability Index, and a Composite Vulnerability Index as requested under the Barbados Programme of Action (See <http://www.sopac.org.fj/evi/evistudy.html> and Chapter 3).

The smallness of the economy and the limited resource base makes diversification of the economy extremely difficult. Nevertheless, diversification is a priority for the government which is being pursued through the promotion of the Seychelles International Trade Zone (SITZ), offshore business and other services, and a set of fiscal measures to encourage both local and foreign investment (UNDP 1997b).

Land and Food

With its vast land area of almost 600 000 km², Madagascar, the fourth-largest island in the world, is by far the largest land mass in the region, in contrast the three other island states comprise archipelagos made up of between 3 and 115 islands with a maximum total land area of about 2 000 km² (Figure 1.3). A common feature, however, is rugged or mountainous topography which, combined with the deforestation that has taken place in the last 20 years or more, means that soil conservation and watershed management require special attention (World Bank 1995). A large part of the total area of these islands is unsuitable for agriculture.

Soil erosion and degradation is a problem in most countries of the region. Madagascar is particularly prone, with 'hot spots' being the Central Highlands, which feature the most intensified agricultural production, and the mountainous eastern zone which contains much of the country's remaining biologically rich tropical rainforest. This area is at risk because of intense forest clearance for cultivation due to population pressure (ONE 1997a) and lack of erosion control techniques, which are compounded by frequent severe cyclones (World Bank 1995). A large percentage of south-western Madagascar's drylands are particularly susceptible to water erosion, and experience a high severity of degradation by nutrient depletion due to the shortening of fallow periods, and the destruction of natural xerophytic thorn forest. The extension of cattle raising into the area exacerbates the problem (UNEP 1997). The combination of population pressure, inappropriate agricultural and livestock practices and deforestation

have severely diminished soil fertility in Comoros (RFIC 1998), and each rainy season is accompanied by huge but as yet unquantified losses of soil (UNEP 1998c). In Seychelles soil erosion due to deforestation dates back to the last century. Large amounts of earth are being washed onto beaches and into the sea due to large-scale construction projects. In 1996 and 1997 heavy rains caused major landslides and soil erosion on the islands of Mahé, Praslin and La Digue (Shah 1997b, UNEP 1998a).

With the exception of Seychelles, agriculture is the dominant land use, for both subsistence and export crops which are important to all the economies in the region, and for livestock in Madagascar. Unsuitable topography for agriculture is an important limiting factor, particularly in the case of Seychelles and much of Madagascar where approximately 16 per cent of the land area is arable, but only 5 per cent is presently cultivated (Alexandratos 1995) mainly because of the mountainous terrain. There is a shortage of arable land in the region, with only an average of about 0.1 ha per capita available (UNDP 1997c), and unsustainable practices such as slash-and-burn shifting cultivation dominate in Madagascar and Comoros. The best land is often reserved for export crops such as sugar, copra, sisal, vanilla, coffee and ylang-ylang (a fragrance of which Comoros is the world's largest supplier). With growing pressure on land for subsistence farming, there is increasing deforestation, shifting cultivation, soil erosion and declining soil productivity, compared to 50 years ago (ONE and INSTAT 1994, RFIC/PNUD 1997).

Madagascar is the only country in the region with significant livestock production – approximately ten million head of cattle, and permanent pasture

occupying 41 per cent of the land (République de Madagascar 1997; ONE 1997a). Keeping livestock is an activity that has strong social and cultural significance. There is little livestock production elsewhere in the region, and most countries import much of their meat and livestock supplies.

Land tenure varies significantly throughout the region. In Comoros, land tenure is complex because of the lack of a system of registration, and the fact that three types of laws apply concurrently (colonial, customary and Islamic) (RFIC 1998). Land tenure is also complex in Madagascar as land is generally owned through inheritance without title deeds, often resulting in conflicts between rural people and local or foreign investors (FAO 1997a). In Seychelles it has been estimated that about 70 per cent of the land is owned by the government (Republic of Seychelles 1997b), following nationalization in the 1970s and 1980s, and is leased to smallholders (UNDP 1997b). However, with the return to democracy in 1993, land is gradually being returned to its original owners. By contrast, in Mauritius, about 90 per cent of land is privately owned (Government of Mauritius 1991a). Lack of security of land tenure and property rights is an important factor in the non-sustainable use of

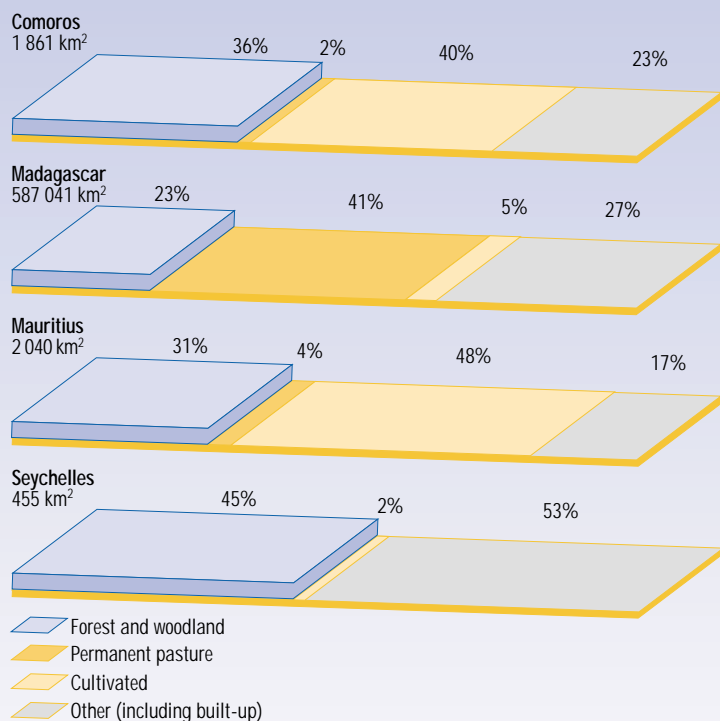
land resources. Improving the sustainability of agriculture, including farming methods and marketing, diversification into high-value non-traditional export crops, land registration and reviewing land tenure are all necessary in order to protect the remaining fragile ecosystems of these islands.

Population is one of the most significant factors exerting pressure on limited land resources; Mauritius is one of the most densely populated countries in the world with a density of about 550 people per square kilometre (Box 1.2), while in Comoros population densities are projected to more than double by the year 2020 to about 650/km². Although population density in Madagascar is low, at 25/km², it is predicted to double by the year 2020 (FAO 1997a) and is still significant because so much of the country is unsuitable for agriculture, and highest population densities are concentrated in the eastern part of the country where there is the greatest remaining tropical forest cover. In Seychelles, scarcity of land for human settlement has resulted in land reclamation on the east coast of Mahé since the 1970s. About 200 ha of land have been reclaimed using dredged reef and calcareous materials, but in the process the longest uninterrupted reef in Mahé, previously stretching for 27 km, was partially destroyed as was live coral due to siltation (Shah 1997b). The largest land reclamation project so far began in January 1999, with a view to reclaiming 395 ha of land.

Urbanization and industrial development are increasing pressure on the limited land resources, and the greatest concentrations of population and economic activity tend to be concentrated on the lowland coastal zones. Almost 20 per cent of the land in Seychelles is under urban or industrial development (including planned development) (Republic of Seychelles 1997b). Due to its steep topography, most of the human settlements and activities occur within the narrow coastal strip on the three main islands (Mahé, Praslin and La Digue). Despite an acute shortage of land to meet demands of development the government has maintained a conservationist approach to land use management with protected areas covering 46 per cent of the land area (Republic of Seychelles, 1997b).

Food security is a serious issue in the region, as all the countries spend significant amounts of foreign exchange on food imports, which account for between 11 and 40 per cent of all imports (UNDP 1998, UNDP 1997a, UNDP 1997b, UNEP 1998c). Mauritius is the only country in the region that produced more food on a

Figure 1.3: Total land area and use



Source: (1) RFIC 1997a. (2) République de Madagascar/MFE 1997. (3) UNDP 1997a. (4) Central Bank of Seychelles 1996.

Box 1.2: The land situation in Mauritius

Mauritius is one of the most densely populated countries in the world, with around 550 people per square kilometre, projected to increase to almost 700/km² by the year 2020 (FAO 1997a). Ninety per cent of land is privately owned; while the remaining 10 per cent of public land (such as forests, nature reserves and a narrow strip of land around the coast known as Pas Geometriques) is under heavy pressure from competing hotel, recreational and conservation uses, often giving rise to land use conflicts. The pressure on this scarce prime land is such that recreational and conservation areas are being seriously threatened along beach fronts. Soil erosion threatens the lagoons, reefs and coastal habitats, as does the lack of proper waste management facilities.

Mauritius has gone through the gradual conversion of forests, forest reserves and riverbanks to agricultural land for sugar cane cultivation. Agriculture accounts for almost half of the total land area with sugar cane occupying over 40 per cent of all land use and 89 per cent of cultivated land. Sugar cane production accounted for 62 per cent of the agricultural sector's contribution to GDP in 1996 and 25 per cent of exports (UNDP 1997a). Inadequate protection of the top soil after land clearing and agricultural mechanization has increased soil erosion and resulted in declining soil productivity. Consequently, intensive farming practices, with minimal concern for water contamination and soil pollution, have become the norm for both large and small sugar cane and food crop farmers. Sugar production over the last 30 years has been supported by increasing use of inorganic fertilizers, pesticides and herbicides. Average annual levels of fertilizer application have been estimated to be as high as 600kg/ha, five times higher than the world average of 113 kg/ha. (Government of Mauritius 1991a, WRI *et al.* 1998). There is little control over pesticide residues on farm produce that reaches the market, thus exposing the consumer to health risks. Rivers are now devoid of fresh water prawns and endemic fish due to the effects of pesticide contamination, fertilizer leachates, siltation and eutrophication.

Source: Government of Mauritius, 1991a

per capita basis in 1996 than in 1980 (20 per cent more compared to 21 per cent less in Comoros and 26 per cent less in Madagascar) (UNDP 1998). Nevertheless, food security is a matter of continuing concern as Mauritius still imports 75 per cent of food items (ADB 1997). Madagascar, a net exporter of rice in the early 1970s, has been turned into a net importer even though rice is traditionally the main staple food in the country. Though agriculture is the main economic sector in Comoros, much of the food is imported (more than 40 per cent of all imports in 1996) (UNEP 1998c). Seychelles imports much of its staple food, meat protein, milk and milk products, vegetables and fruits (15 per cent of the import bill) (UNDP 1997b). To counteract increasing food import bills, long-term food security measures need to be devised in the region using the concept of regional complementarity and intra-regional trade.

Land is therefore a critical but deteriorating resource, and pressures are likely to continue increasing throughout the region, particularly in Comoros, Seychelles and Mauritius. Measures aimed at balancing the conflicting demands of population growth, food security, environment and development considerations are becoming increasingly important. The development strategy followed by Mauritius has been reasonably successful in transforming the country from an agricultural to an industrial society; the challenge is for this to continue (Bheenick 1990) while at the same time protecting environmental resources in the region.

Forests

It has been estimated that tropical moist forest originally covered much of Madagascar, Seychelles, Mauritius and Comoros (ONE and INSTAT 1994; Republic of Seychelles 1990; WCMC *et al.* 1992), however this coverage has shrunk dramatically from around three-quarters of the land surface of the region to less than a quarter. Furthermore, deforestation is still occurring, particularly in Comoros and Madagascar (Table 1.3). In the early 1990s the average annual rate of deforestation varied from 0 per cent in Mauritius and Seychelles, to close to 1 per cent in Madagascar (UNDP 1998; World Bank 1995), while in Comoros it has reached the alarming rate of 5.6 per cent (UNDP 1998). However, it is not only the area of forest that is important but also forest health, genetic diversity and age profile, known as forest quality. A host of indigenous tree species found more than 50 years ago, such as tatamaca, ebony and baobab, have become almost extinct in the region. Today, the rich dense forests of the past century that provided habitats for thousands of plant species and a wide variety of insects, birds and wild animals have given way to settlements, road infrastructure, farming, open woodlands and pastures.

While forest loss has been mainly due to land clearance for agriculture, commercial timber exploitation and urbanization in all the islands of the region, in Madagascar and Comoros forest degradation is more linked to poverty and use of biomass (fuelwood and charcoal) for daily domestic energy needs by the majority rural population. In Madagascar 84 per cent of households depended on fuelwood and charcoal in 1990 (UNDP 1998), rising to 93 per cent of the urban and 96 per cent of the rural population by 1993 (ONE 1997a). An increase in the per capita rate of deforestation from 0.39 ha in 1991 to 4.31 ha in 1994 has been linked to

Table 1.3: Forest indicators

	Comoros ⁽¹⁾	Madagascar ⁽²⁾	Mauritius ⁽³⁾	Seychelles ⁽⁴⁾
Area of forest and woodland (km ²)	665	132 600	632	205
Forest and woodland as a percentage of total land area	36	23	31	45
Annual rate of deforestation ⁽⁵⁾				
1980–85	n.a.	2.0	2.0	n.a.
1990–95	5.6	0.8	0	0

Sources: (1) RFIC/PNUD, 1997. (2) UNDP 1998 and ONE, 1997a (3) UNDP 1997a and Government of Mauritius, 1991a. (4) UNDP 1997b. (5) WCMC *et al.* 1992, p262.
Note: n.a. = not available.

increasing poverty in rural areas due to price inflation. When the exchange rate was floated in 1994 more of the population resorted to slash-and-burn (*tavy*) agriculture, with a steep rise in land clearance and use of fuelwood and charcoal (ONE 1997a). By contrast, in Seychelles only about 8 per cent of households were using fuelwood as a supplementary energy source for domestic purposes in 1994 (Republic of Seychelles 1997b).

Estimates of land area currently covered by forest and woodland vary widely from about 25 per cent in Madagascar and 30 per cent in Comoros and Mauritius, to about 78 per cent of the principal islands of Seychelles (Mahé, Praslin, La Digue, Silhouette and Curieuse), of which 20 per cent is in protected areas (Republic of Seychelles 1997b). In Madagascar, forest cover has been reduced by 50 per cent in the last 50 years (WCMC *et al.* 1992), although it still has the highest percentage of original forest left (estimates range between 15 and 37 per cent) (WCMC *et al.* 1992). Less than 30 per cent of natural forest is left in Comoros (RFIC/MDRPE 1996; Tilot 1996), while the estimate for Mauritius is only about 1.3 per cent (Government of Mauritius 1991a).

The best preserved areas of natural forest and most endemic forest species that have survived in the region are often found on higher ground, for example the mountain mist forest found in the Morne Seychellois National Park in Seychelles. In Comoros, the only pockets of primary forests occur at high altitude, in areas that are inaccessible, generally situated between 500m and 2 000m. Between 1983 and 1993, the area under primary forests fell from 12 000 ha to less than 10 000 ha in Grand Comoros (COI 1996c). Illegal exploitation of forest trees including young trees for the distillation of ylang-ylang, charcoal production (RFIC 1998, Bheenick 1990) and furniture making is impacting upon forest sustainability and often creating conflicts with local villagers. Although about 31 per cent of Mauritius is under forest, woodland or scrub (UNDP 1997a), only 1.3

per cent of that is natural forest, mostly within the Black River National Park (Government of Mauritius 1991a).

Habitat degradation within primary forest areas is occurring in the form of prolific invasion of shrubs, bushes and exotic species, such as Chinese guava and privet in the upland forests and *liane cerf* and *poivre marron* in the lowland forests of Mauritius. To overcome this, sites have been designated as Conservation Management Areas where endemic species are allowed to flourish following the removal of exotic species and the fencing of these areas to keep away browsing animals (National Parks and Conservation Service personal communication 1999). What were at one time dense rich forests covering extensive areas in the central uplands and the south-east plains of Madagascar are today significantly degraded due to over-exploitation for commercial timber for export and slash-and-burn land clearing for shifting cultivation and pasture.

Deforestation is intensifying soil erosion on steep slopes, resulting in siltation of fresh water ecosystems, lagoons, and water reservoirs, as well as resulting in the loss of biodiversity in all the countries of the region (UNEP 1998a, b, c, d). The problems of deforestation and lack of access to clean water are also linked: in Comoros deforestation is regarded as the primary cause of the drying up of water courses and increasing land degradation (RFIC/PNUD 1997).

Reafforestation efforts taking place in the region are inadequate: for instance it is estimated that during the last ten years, only approximately 500 ha have been reafforested in Comoros and even then, these trees are exploited when still young (RFIC/PNUD 1997). There is very little reafforestation taking place in Madagascar, where it reached a peak of about 20 000 ha per annum in the 1970s, but had diminished to 1 576 ha in 1994 (République de Madagascar 1997; ONE 1997a). Most of this reafforestation is for energy production (40 per cent), crafts (37 per cent) and industry (23 per cent) (ONE 1997a).

The area of forest plantations ranges from about 2 per cent of forest area on Madagascar to 11 per cent in Seychelles (ONE 1997a; Republic of Seychelles 1997b), however plantations are largely from imported exotic species such as *pinus*, *eucalyptus* and *casuarina* (FAO 1997) which do not have the same ecological or aesthetic value as native forest. Overall, the area of forest plantation is not sufficient to meet demand for wood and wood products. Madagascar is the only significant producer of roundwood in the region, with about 603 million cubic metres (ONE 1997a). No more than a quarter of demand is met by domestic supply in Seychelles, and three-quarters of that is used in building construction and furniture making. This means that Seychelles has to import about 75 per cent of its wood (Republic of Seychelles 1997b), while the figure for Mauritius is about 70 per cent (Government of Mauritius 1991a). Imports of roundwood to Mauritius increased by 841 per cent in the period 1993–95 compared with ten years previously (WRI *et al.* 1998).

Overall, still more needs to be done in the Western Indian Ocean region to protect the remaining primary forests, to satisfy demand for fuelwood and wood products, and to substitute biomass with cleaner, more efficient sources of renewable energy, which should all contribute to a reduction and reversal of deforestation, as






well as protecting watersheds, thereby improving water availability and reducing soil erosion.

Biodiversity

All the islands of the region are well-known centres of endemism, and most are important centres of plant diversity. Madagascar, which can be regarded as an island continent rather than as an oceanic island, is the most endemic-rich country in Africa and the sixth in the world, with almost 700 endemic vertebrate species. Biodiversity in Seychelles is characterized by high rates of endemism and relatively low species diversity due to its relative isolation from large land masses (Republic of Seychelles 1997b), and it has the highest degree of amphibian endemism of any island group in the world (WCMC *et al.* 1992). The flora of Mauritius contains some important genetic resources with the potential to provide direct economic benefits (GOM/ERM 1998c). About one in six plant species grow on oceanic islands, and one in three of all known threatened plant species are island endemics, illustrating the measure of diversity and fragility of island ecosystems, and therefore their importance in plant conservation (WCMC *et al.* 1992).

A significant number of these plant and particularly animal species are threatened with extinction (Table 1.4),

Table 1.4: Endemic and threatened species

	Higher plants 	Mammals 	Birds 	Reptiles 	Amphibians 
Comoros					
Known species	721	17	99	25	n.a.
Endemic	136	2	15	11	0
Threatened (%)	10 (1.4)	3	6	2	0
Madagascar					
Known species	9 500	167	271	363	190
Endemic	5 000 – 8 000	113	135	256	176
Threatened (%)	490 (5)	46	28	17	2
Mauritius					
Known species	750	4	27	11	0
Endemic	329	2	9	9	0
Threatened (%)	536 (71)	4	10	6	0
Seychelles					
Known species	250	26	126	15	12
Endemic	250	2	12	13	11
Threatened (%)	124 (50)	2	9	4	4

Sources: All higher plant data: IUCN 1998 except threatened plant data: WCMC 1999 (represents numbers of nationally, rather than globally, threatened species). Known animal species: Comoros: RFIC 1998; Madagascar known animal and endemic species: République de Madagascar 1997b; Mauritius: WRI *et al.* 1998; Seychelles: WCMC *et al.* 1992 (except known mammals: Republic of Seychelles 1997b). Endemic species: WCMC unpublished data, 1999. Threatened animals: IUCN 1996. Note: n.a. = not available.

and many endemic species have already become extinct. The major causes of species extinction in this region have been identified as habitat loss, mainly due to commercial land-use practices, and the introduction of alien species (IUCN 1990). Damage to the indigenous flora of most of the islands in the Western Indian Ocean region occurred during European colonization, when large areas were cleared for cash crops such as coconut plantations in Seychelles, and coffee in Madagascar. With the exception of some of the more remote islands, the natural vegetation of Mauritius has been largely destroyed, mainly due to clearing land for sugar plantations. In addition, island flora evolved in the absence of grazing animals such as goats, and therefore few endemic plants have defences against grazing animals.

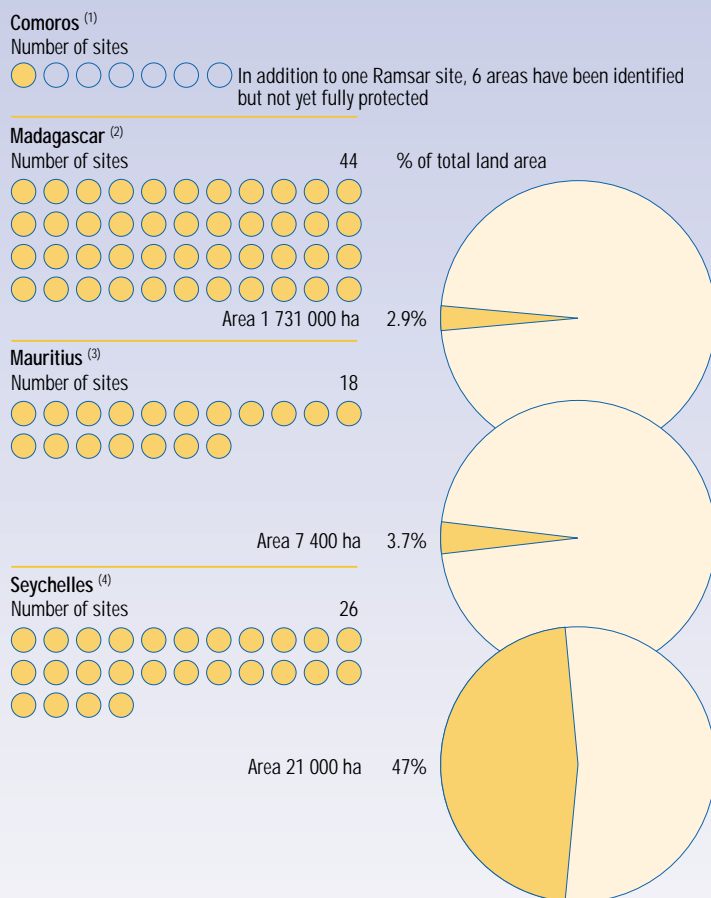
Madagascar has been identified as one of 18 'hot spots' globally in terms of areas of high concentration of

endemic species undergoing unusually high rates of habitat modification (Myers 1988 and 1990 in WCMC *et al.* 1992). It has the greatest number of mammals in the region threatened with extinction (46), and many of these are forest-dwelling lemurs, for which forest habitat destruction is the main threat (IUCN 1998, Harcourt and Thornback 1990 in WCMC *et al.* 1992). Madagascar also has the highest number of threatened reptiles in the region (17), while Seychelles has the greatest number of amphibians threatened with extinction (4) (IUCN 1996).

The problem of introduced exotic species is particularly severe and destructive in island ecosystems since they can out-compete the native flora. Mauritius and Seychelles are ranked second and third in the world for having the highest percentage of their native plants threatened globally (39 and 31 per cent respectively) (IUCN 1998). Taken at the level of nationally threatened, these figures are even higher at 71 per cent for Mauritius and 50 per cent for Seychelles (Table 1.4). In Mauritius the rich vegetation covering the hills includes large numbers of introduced plants such as travellers palm from Madagascar, and Chinese guava and privet from Asia. Conservation Management Areas – where separate plots of a few hectares are weeded of exotic species to encourage the native vegetation – have been established in an effort to save the indigenous endemic flora (National Parks and Conservation Service, personal communication 1999). The situation is similar on the Mauritian island of Rodrigues, with 43 out of 50 endemic species threatened and 27 of them endangered or extinct. Endemic plant species in Seychelles include the *coco de mer*, the jellyfish tree, the *bois rouge*, the giant and very rare *bois de fer*, the capucin, and the insect-eating pitcher plant found in the higher parts of Mahé. While 78 endemic plant species are threatened in Seychelles overall (IUCN 1998), the important flora on the coral island of Aldabra is intact and effectively protected as a nature reserve (WCMC *et al.* 1992). Estimates of plant species in Madagascar are in the order of 9 500 with rates of endemism ranging between 55 and 80 per cent (République de Madagascar 1997; IUCN 1998 and 1990). Comoros has some of the least studied biota of the Indian Ocean region including at least 720 plant species, of which 136 are endemic (IUCN 1998). No detailed assessment of endemic flora has yet been done and this is a priority to establish which species are threatened (RFIC 1998).

Island species are particularly vulnerable to extinction caused by competition or predation by introduced species (WCMC *et al.* 1992) and hence

Figure 1.4: National protected areas



Source: (1) RFIC 1998. (2) ANGAP 1998. (3) National Parks & Conservation Service, Mauritius, personal communication 1999. (4) Republic of Seychelles 1997b. N.B. includes eight National Parks, four Special Reserves, two World Heritage Sites, two Protected Areas, four Shell Reserves, and Marine Parks with a total area of 228 km².

introduced animals and plants represent a particularly uncontrollable threat to the biodiversity of these islands. In Mauritius, 62 animal species have become extinct, mainly birds, reptiles and a large number of molluscs; while several species survive only as small populations making them therefore extremely vulnerable to extinction (WCMC *et al.* 1992). The flightless dodo is a well-known example of species extinction brought about by over-exploitation and the introduction of alien species.

Over-harvesting is a major stress factor for some species, as in the case of land tortoises and marine turtles. Historically, Seychelles was renowned for its endemic species of land tortoises which were exploited to the point of extinction between the sixteenth and nineteenth centuries, though the Aldabran giant tortoise (*Dipsochelus gigantea*) still survives in large numbers (Republic of Seychelles 1997b). In the region as a whole, populations of endangered marine species, including most notably the green turtle (*Chelonia mydas*), the hawksbill turtle (*Eretmochelys imbricata*), the 'living-fossil' coelacanth (*Latimeria chalumnae*) and the dugong (*Dugong dugong*) have declined greatly in recent years (Republic of Seychelles 1997b; RFIC 1998).

All the islands of the region are important endemic bird areas, and four islands in Seychelles are bird sanctuaries (Bird Island, Cousin, Aride and Frégate), providing important nesting sites. Islands are important for bird conservation and have suffered the majority of bird extinctions, with a high proportion of threatened island species concentrated in a few geopolitical units, such as Seychelles. As with other species, the most important factor threatening island bird species is habitat destruction (WCMC *et al.* 1992).

Modification of aquatic habitats (drainage, pollution, competition for water), introduced species and commercial exploitation are the principal causes of decline of fresh water fish species, which are regarded as good indicators of trends in aquatic biodiversity. Fish in eastern and central Madagascar have declined severely because of competition from introduced species such as black bass and tilapia, and habitat degradation, particularly as a result of forest clearance (République de Madagascar 1997; WCMC *et al.* 1992).

Natural grasslands are not generally a feature of oceanic islands due to the absence of large wild grazing mammals. Madagascar is the only country in the region with significant grasslands. They are largely man-made and are species poor, with a high proportion of introduced plants (Menaut 1983, quoted in WCMC *et al.*
























1992). Grassland fires, used to clear land at the end of the dry season, are an important contributing factor in the destruction of forests. In 1995 more than 1.2 million ha were destroyed by grassland fires, including 4 900 ha of natural forest and 10 287 ha of plantation forest (République de Madagascar 1997).




Mechanisms used to protect endangered species and ecosystems include protected areas (Figure 1.4), *in-situ* conservation, species management programmes and captive breeding programmes. *In-situ* and *ex-situ* conservation is being undertaken in Madagascar, Mauritius and Seychelles including the control of invasive species and propagation of endemic tree species, as well as various initiatives concerning endangered species (République de Madagascar 1997; Republic of Seychelles 1997; Government of Mauritius 1991a; WCMC *et al.* 1992). Mauritius' captive breeding programme for pink pigeons and the Mauritius kestrel have been acknowledged internationally. An overview of on-going endangered species management programmes is given in Table 1.5.

There is considerable variation between countries in the process of creating and maintaining systems of protected areas, but a major objective is maintaining the diversity of species and ecosystems. All the countries have at least one protected area designated under an international protected area system including: two Biosphere Reserves, one each in Madagascar and Mauritius, three World Heritage sites (two in Seychelles and one in Madagascar), and three Ramsar sites, one in Comoros and two in Madagascar (Ramsar 1999; RFIC 1998). Mauritius signed the Ramsar convention in April 1997 but has not yet designated a Ramsar site (National Parks & Conservation Service, 1999, personal communication). Madagascar has the greatest area of protected land, in 44 sites, while Seychelles has the greatest proportion of total land area protected (47 per cent). Comoros, which has only recently formulated its biodiversity strategy, has identified six areas for protection but requires financial support for implementation (RFIC 1998).

These islands have valuable and unique biodiversity resources, which are increasingly coming under threat from habitat loss, particularly from conversion due to population pressure, alien invasive species and over-exploitation. In recognition of this all countries have formulated or are in the process of formulating (Comoros and Mauritius) biodiversity strategies and action plans to address these issues and protect these valuable resources.

Table 1.5: Examples of endangered species management programmes in the Western Indian Ocean

Species	Distribution	IUCN status	Species management programmes	Estimated wild population
Reptiles				
Boa, Dumeril's Ground	Madagascar		S	X
Boa, Round Island	Mauritius		W	X
Boa, Madagascan Tree	Madagascar		UK	X
Boa, Madagascar	Madagascar		A	X
Gecko, Gunther	Mauritius		W	X
Gecko, Standing's Day	Madagascar		UK	X
Skink Telfair	Mauritius		W	X
Tortoise, Aldabra Giant	Seychelles		Au	155 000
Tortoise, Radiated	Madagascar, Mauritius, Reunion		A, S	2 – 2.5 million
Birds				
Kestrel, Mauritius	Mauritius		P	430 – 520
Parakeet, Echo	Mauritius		W	70 – 80
Pigeon, Mauritius Pink	Mauritius		T	250 – 300
Robin, Seychelles Magpie	Seychelles	 	X	~ 50
Warbler, Seychelles Brush	Seychelles	 	X	~ 250
Mammals				
Fossa	Madagascar		E	X
Fox, Rodrigues Flying	Mauritius		S	350
Bat, Rodrigues Fruit	Mauritius		W	1 500
Lemur, Black	Madagascar		E,J,S,UK	X
Lemur, Mongoose	Comoros, Madagascar		E,S	X
Lemur, Ring-tailed	Madagascar		S	X
Lemur, Ruffed	Madagascar		Au,E,J,S	X

Notes:  = critically endangered;  = endangered;  = vulnerable; A = African Propagation Programme (APP); Au = Australasian Species Management Program; E = European Endangered Programmes (EEP); J = Species Survival Committees Japan (SSCJ); S = North America Species Survival Plan (SSP), UK = United Kingdom Joint Management of Species Committee (JMSC); P=Peregrine Fund (USA); W=World Parrot Trust USA; T=Jersey Wildlife Preservation Trust (JWPT) UK; X = not known. Sources: WRI *et al.* 1998 and National Parks & Conservation Service, Mauritius 1999.

Sources: WRI *et al.* 1998; National Parks & Conservation Service, Mauritius, personal communication 1999; Michelle Martin, Birdlife International, personal communication 1999.

Fresh water

Fresh water, the most critical resource for human survival, is becoming one of the most pressing natural resource issues of the twenty-first century (WRI *et al.* 1998; Johns Hopkins, 1998). Availability of fresh water is a factor compounding the sustainability of socio-economic development of the small states in this region; as population, industrialization and living standards rise so does demand for water which is limited and increasingly threatened by pollution.

The hydrological cycle in this part of the Western Indian Ocean benefits from a humid maritime climate. With the exception of Seychelles, which receives monsoon rains, the countries of the region receive most of their rain during December to April, which is also the cyclone period.

There is a growing water shortage on most of the islands. Comoros has been classified as becoming increasingly 'water short' with per capita fresh water water resources predicted to fall from 1 667 m³ to 760 m³ by the year 2025 (Table 1.6) – 'water short' is defined as an annual water supply of less than 1 000 m³ per person. Mauritius is coming under increasing 'water stress', defined as an annual water supply of between 1 000–1 700 m³ per person; with a predicted fall from 1 970 m³ in 1995 to 1 485 m³ by 2025 (Johns Hopkins, 1998). During the second half of 1998, Seychelles faced one of the most severe water stress situations in the last 20 years, forcing the closure of industry (brewing and fish canning), illustrating the severe impact a prolonged drought can have on the economy as well as water availability. The Seychelles government has since commissioned a water desalination plant to guarantee supply. Only Madagascar has abundant internal

renewable water resources with per capita resources of 20 614 m³ (WRI *et al.* 1998). However these are unevenly distributed due to relief, and very underdeveloped, especially in rural areas and the coastal zone, with the result that most of the country experiences seasonal or quasi-permanent shortages of safe water (UNEP 1998d). The country is also periodically affected by drought, particularly south-west Madagascar, the last one in 1992 causing widespread famine. Little has been done to evaluate Madagascar's water resources, particularly its groundwater resources (ONE and INSTAT 1994).

Reasons for the growing shortage of fresh water include increasing demand and consumption due to population growth and rising standards of living, as well as deforestation and consequent decreased water retention (COI 1996a, b, and c; RFIC/PNUD 1997). Much water is lost through run-off and evapotranspiration, particularly in Seychelles, and through high soil permeability on Grande Comoros which has an almost total absence of surface water (UNEP 1998c). Losses from water distribution networks are also an important factor and can be as high as 50 per cent (Government of Mauritius 1994).

The countries in the region differ significantly in terms of access to safe water and sanitation. About 98 per cent of the population in Mauritius has access to safe water compared to only 44 per cent in Madagascar and 53 per cent in Comoros (UNDP 1998). The quality of the fresh water available to coastal populations in Madagascar is poor, especially in the rural areas, due to an inadequate distribution system as well as inappropriate infrastructure (République de Madagascar/PNUD 1998). Only about 33 per cent of the population of Comoros has access to sanitation services, the lack of which results in increased water-borne

diseases such as diarrhoea and typhoid, as well as pollution of surface and groundwater resources (UNEP/COI 1997).

More than three-quarters of water withdrawals are used for agriculture, mainly for irrigation, with consumption by domestic consumers ranging from 1 to 16 per cent respectively in Madagascar and Mauritius (WRI *et al.* 1998). Principal sources of water pollution are domestic and industrial wastewater, agrochemicals, urban run-off and siltation. Fresh water pollution has become increasingly evident in most countries of the region, for example in Madagascar there is little treatment of industrial wastewater, no control over waste discharge from industrial enterprises, and no legislation preventing pollution (ONE and INSTAT 1994, ONE 1997a), while Comoros has no wastewater treatment system (UNEP 1998c).

The major areas for environmental and public health concern in the region are pollution of the surface water, lagoons and groundwater by industrial and domestic effluent, untreated sewage, agricultural and storm run-off. Eutrophication of rivers and estuaries is common in areas where deforestation and intensive farming is carried out, resulting in a proliferation of algal blooms and water hyacinth (Government of Mauritius 1994).

Because of their heavy dependence on underground water resources, islands such as Comoros and Seychelles are very vulnerable in terms of both the quality and the quantity of fresh water supplies. The potential implications of sea-level rise associated with climate change further complicate the fresh water issue. Consequences such as saltwater intrusion and loss of the fresh water lens will affect water quality and may constrain human habitation in some islands, particularly on smaller atolls (Leatherman 1997). Fresh water lens

Table 1.6: Fresh water resources and withdrawals

	Comoros	Madagascar	Mauritius	Seychelles
Total annual renewable water (km ³) (1998) ⁽²⁾	n.a.	337	2.21	n.a.
Per capita renewable water (m ³) ⁽³⁾ :				
1995	1 667	20 614	1 970	n.a.
2025	760	n.a.	1 485	n.a.
Percentage of water resource withdrawn of which ⁽¹⁾ :	n.a.	5	16 ⁽³⁾	n.a.
Domestic withdrawal %	n.a.	1	16	63
Industrial/commercial withdrawal %	n.a.	0	7	25
Agricultural withdrawal %	n.a.	99	77	0
Government withdrawal %	n.a.	n.a.	n.a.	12

Sources: (1) WRI *et al.*, 1996. Water resource withdrawals by sector: Madagascar 1984 figures, Mauritius 1974 figures. (2) Johns Hopkins 1998. (3) UNDP 1998.
Note: n.a. = not available.

are layers of fresh water that sit on top of saline water. They are commonly found on small islands and provide important sources of potable water.

Maintaining the integrity of water resources has been recognized as a priority in the region and responses are being developed. For example, Mauritius has several projects geared towards the improvement of water quality in its second National Environmental Action Plan (GOM/ERM 1998b). Most countries have plans to improve water management, storage and availability of safe water through the construction of dams, reservoirs, sewage and treatment works, as well as the rehabilitation of existing facilities and revision of water tariffs. However, these are major long-term investments and some projects may not be realized due to lack of finance.

Taking into consideration the economic structures and current trends in population growth, urbanization, industrialization, tourism and agriculture, better management of water resources is an urgent necessity for the region in order to avoid future water scarcities and further damage to aquatic systems. This also requires further research in all aspects water resource management.

Coastal and marine resources

The island states of the Western Indian Ocean region are highly dependent on coastal and marine resources, especially because of their contribution to the economy through fishing and tourism. Seychelles is probably the most dependent on these resources and therefore the most vulnerable to any degradation. Tourism contributed 15 per cent to the country's GDP in 1996 and generated between 70 and 75 per cent of foreign exchange earnings, while fishing contributed about 1 per cent to GDP, about 10 per cent of foreign exchange earnings and 83 per cent of export earnings (UNDP 1997b). In Mauritius, tourism contributed about 4.4 per cent of GDP and 18 per cent of foreign exchange earnings in 1996/97 (UNDP 1997a).

These two industries are particularly vulnerable to the impact of major oil spills. The main transportation artery for oil from the Middle East to Europe and the US traverses the Western Indian Ocean region, 30 per cent of the world's petrol, or an estimated 470 million tonnes of oil, is transported annually by tankers along three principal routes (Salm 1996). A further 6.5 million is shipped into countries in the region, rendering the coastal areas highly vulnerable to oil spills from transit shipping or trans-shipment in harbours. There have been five major oil spills in the

last 30 years in the Mozambique channel involving between 20 000 and 90 000 tonnes of hydrocarbons. Oil spills may be caused by cyclones, impacts against reefs or accidents between vessels. However, at the coastal level, spill risks are due to trans-shipment and bunkering (COI 1998a). The Western Indian Ocean countries currently do not have the capability to deal with any potential disasters related to oil spill emergencies, although this issue is now being addressed at the regional level through a World Bank GEF-financed project to combat oil spills (COI 1998a).

Coastal resources

The coastal characteristics of the small islands of the Western Indian Ocean are quite different from those of Madagascar and the African continent. On these small islands, the entire land mass can be considered as being included in the coastal zone in the sense that activities nearly anywhere on the island directly affect the marine environment. Comoros, Mauritius and Seychelles are small in size and the activities of the entire population impact on the coastal environment and lagoon ecosystems. Most of these impacts result from land-based activities, the main ones being habitat degradation due to coastal urbanization and development; mining and unsustainable exploitation of coastal and marine resources; coastal erosion; deforestation and poor agricultural practices giving rise to soil erosion; siltation; and various forms of pollution due to untreated industrial or domestic effluents, and fertilizer run-off. Priority environmental issues as identified through two recent studies covering the Western Indian Ocean region are described in Box 1.3.

The islands share similar coastal ecosystems including beaches and coastal dunes, coral reefs, estuaries, lagoons, mangroves and sea grass beds, which are generally both rich in natural resources and highly productive. All these ecosystems are coming under increasing pressure, especially important habitats such as mangrove forests, coral reefs and seagrass meadows (UNEP 1998d).

Mangrove ecosystems play an important role in coastal protection, stabilizing shorelines and decreasing erosion, in fisheries production, and also provide humans with a wide range of products including food, wood for building and fuel. A total of 654 species of algae, molluscs, crustaceans, echinoderms and fish of economic importance associated with mangroves in the Western Indian Ocean region have been identified (Matthes and Kapetsky 1988 in UNEP 1998d).

Box 1.3: Priority coastal and marine issues in the Western Indian Ocean

An assessment of coastal zone management carried out by the Indian Ocean Commission's Regional Environment Programme (REP/IOC or PRE/COI) in 1996 in its five member states, provides an overall picture of the common environmental problems in the region:

1. Degradation of coastal resources:
 - a) Degradation of reefs
 - b) Coastal erosion
 - c) Declining biodiversity and extinction of species
2. Deterioration of the quality of life and economic loss:

The coastal scenery is changing due to industrialization and urbanization. There is little effective urban planning, and as a result there is a rapid accumulation of nuisances, leading to a deterioration in the quality of life. User conflicts are developing over coastal resources among the communities and business operators (hotels, industries etc.) and also within communities between fishermen and sand miners, for example. Coastal fishery has reached its maximum sustainable yield in the lagoon areas and further development of this activity can only take place outside these areas.

3. The main issues and activities that give rise to this degradation have been identified as:
 - a) Pollution and erosion:
 - Degradation due to pollution (eutrophication) and sedimentation
 - Erosion due to deforestation and mining
 - Regression of beaches
 - b) Urbanization, industrialization and unsustainable extraction of materials.

A Transboundary Diagnostic Analysis (TDA) for the coastal and island states of the Western Indian Ocean which was carried out in 1997–1998 at the request of the First Meeting of the Contracting Parties to the Nairobi Convention, with funds from the Global Environment Facility (GEF), identified the following transboundary environmental problems and issues for the region:

1. Fresh water shortage and contamination.
2. Decreasing harvests of marine and coastal living resources.
3. Loss of critical coastal habitats (mangrove, seagrass beds and coral reefs) and biodiversity.
4. Coastal pollution, including unsanitary conditions of beaches and coastal waters, as well as contamination of coastal living resources by major urban areas.

Sources: PRE/COI 1996 and UNEP 1998d.

Mangrove systems are increasingly under threat from commercial exploitation (aquaculture and wood harvesting) and habitat conversion for urban, industrial and agricultural use. Throughout the region the extent of mangrove habitats is not well known, especially in Comoros (UNEP 1998c) and Seychelles. Madagascar, which has about 327 000 ha of mangrove forest (2 per cent of its forest area) (ONE 1997a) and at least four

protected areas which include mangrove ecosystems (WRI *et al.* 1998, WCMC *et al.* 1992), lost about 40 per cent of its mangroves between 1980 and 1990 (UNDP 1998). Loss of coastal forests in Madagascar has also been significant (UNEP 1998d). In addition to being exploited for wood, these mangrove ecosystems are being disturbed and destroyed for animal collection, for aquaculture, oil prospecting and hotel development.

Table 1.7: Data relating to the coastal zone

	Comoros	Madagascar	Mauritius	Seychelles
Coastal population (millions)	0.6	4.8	1.1	0.07
Percentage of total population	100	32	100	100
Total land area (km ²)	1 861	587 041	2 040	455
Coastline length (km)	340	4 828	177	491
Area of Exclusive Economic Zone (EEZ) (million km ²)	0.249 ⁽¹⁾	1.3 ⁽¹⁾	1.1	1.3

Sources: WRI *et al.* 1994, except (1) WRI *et al.* 1998.

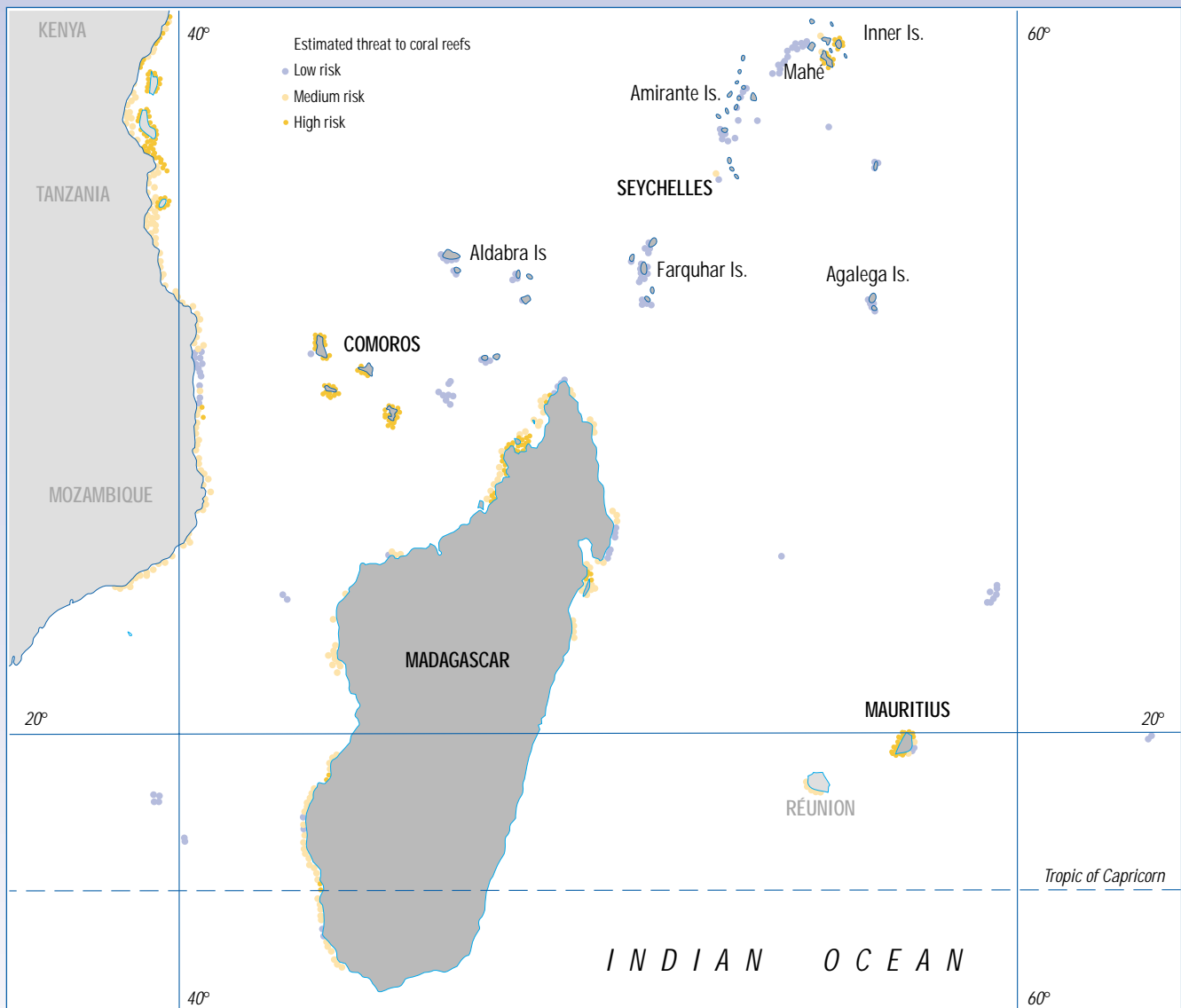
Mauritius has only about 7 ha of mangroves, in six protected areas (WCMC *et al.* 1992). In Seychelles some of the best mangrove forests are still to be found behind beach ridges near open stream mouths, for example the continuous mangrove belt between Port Launay and Port Glaud on the western coast of Mahé, and an extensive mangrove swamp around Turtle Pond lagoon on Curieuse Island (Republic of Seychelles 1997c).

Coral reefs and the reef fish biodiversity of the region are increasingly threatened by the destruction of reef areas (Figure 1.5 and Box 1.4) from mining for lime, harvesting of corals for trade and construction,

pollution, destructive fishing practices and siltation from increased erosion. Coral reef degradation is highest near major towns and cities due to land-based activities, sewage discharge and over-exploitation. Areas of coral reef classified as being under greatest threat in the region include the north and western coast of Mauritius, north-western Madagascar (from Nosy Be to Analalava), most of the islands of Mahé, Praslin and La Digue in Seychelles and most of the Comoros islands (Bryant *et al.* 1998).

Coral bleaching, which weakens corals and may ultimately lead to their death, indicates stress from

Figure 1.5: Reefs at risk in the Western Indian Ocean



Source: Bryant *et al.* 1998

Box 1.4: Coral reefs of the Western Indian Ocean

Coral reefs are among the most biologically rich and productive ecosystems on earth, and have been described as the marine equivalent of the rain forests (Bourlière and Harmelin-Vivien 1989 in WCMC *et al.* 1992). Globally, the reef habitats provide people with resources (such as fish and materials) and services (such as tourism and coastal protection) estimated to be worth US\$365 billion each year (Costanza 1997). Coral reefs are estimated to yield 15 tonnes of fish per km² annually. Because reefs offer so many benefits, the cost of destroying one kilometre of reef has been estimated to range from US\$137 000 to almost US\$1.2 million over a 25-year period (WRI *et al.* 1998). An environmental economics study carried out by three Comorian experts between May and November 1998, with technical assistance from the PRE/COI, attempted to determine the economic value of the reefs of Mohéli in Comoros. The first conclusions have assessed the economic value of the reef of Mohéli to be equivalent to at least 1.35 per cent of the GNP of Comoros in 1997 (i.e. about US\$2.5 million) (PRE/COI 1998).

All the islands of the Western Indian Ocean have coral reefs:

- The reefs of Comoros have been very little studied and data on this ecosystem are nearly non-existent. Fringing reefs occur around the three northern islands of Comoros, and Mayotte has a substantial barrier reef. The reefs occupy about 60 per cent of the coast of Grande Comores, 80 per cent in Anjouan and 100 per cent in Mohéli, covering a total area of about 11 000 ha. This ecosystem is subject to several threats, namely: destructive fishing methods using dynamite, erosion of slopes followed by siltation, increased pollution linked to coastal urbanization and the development of commercial or tourist activities, trampling of corals at low tide, over-fishing in the coral reef area, extraction of corals for sale and for jewellery, the discharge of domestic wastes into the sea giving rise to eutrophication, and massive extraction of coral sand for construction purposes. There is no real policy for reef or coastal zone management in the country.
- The Malagasy coral ecosystems are the best known in the region, occupying the largest area, and with the lowest population density on the coastal strip. The main reef formations occur on the south-west, north-east and north-west coasts of Madagascar, extending for more than 1 000 km. Fringing reefs occur in the north and there are extensive but rudimentary fringing reefs on the east coast, where two marine parks have been set up. The barrier reefs along the southern coast extend for 200 km, forming one of the largest true barrier reefs in the world (République de Madagascar-PNUF 1998), and the great reef of Tuléar in the south-west constitutes the most beautiful reef assembly in Madagascar. Coral degradation has been attributed to destructive fishing practices, removal of corals for souvenirs and as construction material, tourist impacts such as coral trampling and anchoring of boats on coral colonies, natural calamities such as cyclones, silting of lagoons and intensive use of inorganic fertilizers by the sugar and cotton industry, leading to eutrophication and suffocation of corals. In some places, human pressure on aquatic reef resources is less than in other countries of the region because of lower population densities.
- Mauritius has a coastal morphology largely dominated by reefs, with 150 km (300 km²) of almost continuous fringing reef around the island of Mauritius, 100 km² of fringing reef around Agalega, and a wide expanse of unbroken reef platform extending 90 km around Rodrigues (WCMC *et al.* 1992). As the premier tourist destination in the Indian Ocean, with more than 500 000 visitors annually, and a population of more than a million largely concentrated on the coast, considerable pressure is being exerted on the biotopes and on coastal resources. In Grand Baie, the most important tourist destination, surveys have revealed that most of the corals are dead and the bay has been turned into sand desert (UNEP 1998b). This has largely been attributed to uncontrolled urbanization and the subsequent percolation of domestic effluents into the lagoon. Cyclones have been the main cause of extensive reef damage on the east and south coasts, leading to soil erosion and siltation which causes smothering of the coral (UNEP 1998b).
- The coral reefs of Seychelles are amongst the most extensive in the world, and are scattered over a vast area of the Western Indian Ocean. The islands of Seychelles have a granitic structure, and emerge from Seychelles plateau (43 000 km² in area) whose mean depth is less than 20 m. On the plateau the coral formations are just below the water surface; elsewhere they form atolls. The largest islands of Mahé, Praslin and la Digue contain 95 per cent of the population, and have the largest fringing reef in the country which have been classified as being under the highest threat and risk of degradation (Bryant *et al.* 1998).

Sources: PRE/COI 1998 and WCMC *et al.* 1992.

changes in natural factors such as water temperature or pollution (Bryant *et al.* 1998). Unprecedented coral bleaching following El Niño was reported in the Indian Ocean reefs during the first half of 1998, due to extremely high ocean temperatures affecting all the countries of the region (NOAA 1998). The increase in sea surface temperature detected was reported to have bleached 80 per cent of the corals in Seychelles with significant coral die-off (Box 1.6), and has probably had a similar impact in other parts of the region. This may have a direct effect on artisanal fishing and on coastal erosion (Shah 1995, 1996, 1997a and 1997b). Bleaching of coral was observed everywhere in Comoros, with an estimated 30 per cent of the reefs affected, most of which are reported to have died. A verification of the increase in

temperature as measured by divers using a diving computer showed an increase of temperature in the order of 1 to 1.5°C (PRE/COI 1998).

Seagrass beds, which are found throughout the region, provide shelter, food and nursery areas for important and valuable fish, shellfish, dugong and turtles. Silting-up of these beds is occurring in Comoros, due to soil erosion and wave action, causing disturbance to herbivorous aquatic species. In Seychelles, seagrass beds are dominant in Platte and Coetivy and Aldabra (Republic of Seychelles 1997c).

The productivity of coastal waters is highly dependent on the health of estuaries, mangroves, coral reefs and seagrass beds as well as the quality of runoff from land and rivers. Coastal fisheries in the region are

made up of artisanal fishing and commercial fishing. Coastal fish production usually far outweighs production from oceanic species such as tuna (see section below on marine resources), but in this part of the Western Indian Ocean coastal fish production seems minuscule for such a large area, and the contributions of coastal and oceanic fisheries are approximately equal (FAO 1997b).

Artisanal fishing is the dominant activity, being an important source of food, employment and income for most coastal communities in the region. About 80 000 fishermen make a living from this sector, which represents 70 per cent of the 120 000 tonnes of fish landed by the island states of the region. Artisanal fishing accounts for more than 80 per cent of the total marine fish catch in Comoros and Madagascar (ORSTOM 1996). The artisanal fish catch is dominated by a relatively limited number of specific fish groups, namely scavengers (barracuda, rabbitfish), pelagic species (sardine and mackerel), crustaceans (crab and lobster) and molluscs (oyster and octopus). Destructive fishing methods, such as dynamite fishing, beach seining, use of poisons and pesticides, have been cited as causes of habitat degradation and loss of biodiversity in Comoros and Madagascar, and have led to over-exploitation of demersal species in shallow waters (UNEP 1998c, 1998d).

Commercial coastal fishing is mainly dependent on shrimp fisheries, for example off the west coast of Madagascar, where coastal marine habitats, including mangroves, have been modified for aquaculture, especially production of prawns. Sixty per cent of Madagascar's lobster catch and 80 per cent of its industrial shrimp catch was exported in 1995, shrimp exports providing the third-largest source of foreign exchange (République de Madagascar-PNUE 1998). Some fisheries, including the shallow water shrimp fishery off Madagascar, the hand-line fishery for demersal stocks on offshore banks between Mauritius and Madagascar, and some stocks including lobster in inshore areas of Seychelles, are believed to be fully fished or over-exploited (WCMC *et al.* 1992; Shah 1995; UNEP 1998a). The heavy exploitation of the inshore coastal fish stocks should cause a shift in the fishing effort towards new areas further out to sea (PRE/COI 1998; UNEP 1998a).

In addition to those already mentioned, a wide range of other coastal resources are exploited both legally and illegally. Activities include live trade in protected animal species, harvesting of turtles for meat and shells, worked and unworked marine souvenirs such as shells and corals for sale to tourists, coral and sand extraction for construction purposes. Impacts include biodiversity

and habitat loss, as well as beach and coastline erosion. Coastal habitat modification in Comoros is mainly the result of sand and coral extraction, in spite of prohibition (Dufresne 1989; Tilot 1996). This has also resulted in erosion, causing the total disappearance of some beaches (UNEP 1998c). In 1997, an estimated 57 587 m³ of coral sand and 64 366 m³ of crushed sand were extracted to meet demand in Grande Comores (UNEP 1998c), whereas in Mauritius between 800 000 and 900 000 tonnes of sand are mined annually. This has resulted in beach erosion in the vicinity of mining sites, as well as backshore erosion due to construction on beaches (UNEP 1998b). Although erosion is sometimes due to natural causes, a survey in Seychelles in 1987 found that in 75 per cent of coastal sites surveyed, erosion was mainly attributable to human activities and ill-conceived development.

The pressure on coastal resources from urbanization and development has increased considerably in all the countries of the region, leading to the types of conflicts and impacts already mentioned. Problems linked with growing urban populations and development – including solid and liquid waste disposal, limited drinking water, coastal pollution, deterioration in the quality of life and coastal landscapes, and economic impacts – are becoming more widespread. In general, most countries suffer from a lack of urban, rural and tourist planning, sometimes resulting in unplanned informal settlements such as in Comoros (UNEP 1998c). About 41 per cent of Mauritius' coastal plain is taken up by housing, tourism, infrastructure and industrial development (UNEP 1998b). A proposal for urban planning has existed since 1994 but has not yet been implemented (PRE/COI 1998).

Tourism has increased pressures on land resources as well as water demand and has generated more waste. For example Mauritius, already one of the most densely populated countries in the world with 548 people per square kilometre, receives over half a million tourists per annum in addition to its own population of 1.1 million, most of whom are concentrated in coastal areas (FAO 1997a, Figure 1.2). Seychelles is expected to receive over 150 000 tourists in 1999, twice its population of 76 000, and this number is projected to reach 250,000 by the year 2007 (UNEP 1998a). Currently Seychelles treats only 19 per cent of the domestic wastewater produced daily, and only eight hotels have sewage treatment plants – the majority of which do not function properly (Shah 1995 and 1997; UNEP 1998a). In Mauritius, two-thirds of the coastal urban population discharge their waste into the sea, and treatment is limited to the removal of coarse

suspended material only (UNEP 1998b). Comoros currently has no system for the collection and treatment of wastewater.

Industrial development has produced more wastewater, and abstraction of water has resulted in less dilution of subsequent discharge (UNEP 1998a), as well as possible saltwater intrusion into groundwater resources. In Mauritius there is substantial evidence of pollution of lagoons around the capital, Port Louis (UNEP 1998b). Fertilizer use is also very high in Mauritius, at about 600 kg/ha particularly in horticulture and the sugar industry (Government of Mauritius 1991b). In Palmar, inorganic fertilizers used in onion plantations in the coastal strip rapidly seep into the bay causing high nutrient levels that have encouraged nuisance algae accumulation on the beach reaching up to one metre in thickness (GOM/ERM 1998b). Mortality of fish has also been reported (UNEP 1998b). Some factories treat their discharge at source, however only 6 out of 19 factories have zero discharge of waste water into rivers and the sea. The remaining factories discharge liquid waste directly into rivers which flow into lagoons, without undergoing any treatment. Twenty per cent of Madagascar's industrial enterprises are located on the coastal zone, including sugar refineries, tanneries, fish and shrimp processing plants as well as shrimp farms which discharge untreated waste into the sea. Pollution from hydrocarbons also occurs in the coastal waters, either through accidental spills or intentional discharges; most countries do not have any system for the collection

and disposal of oily wastes from marine transport (Shah 1995 and 1996; UNEP 1998a; République de Madagascar-PNUE 1998).

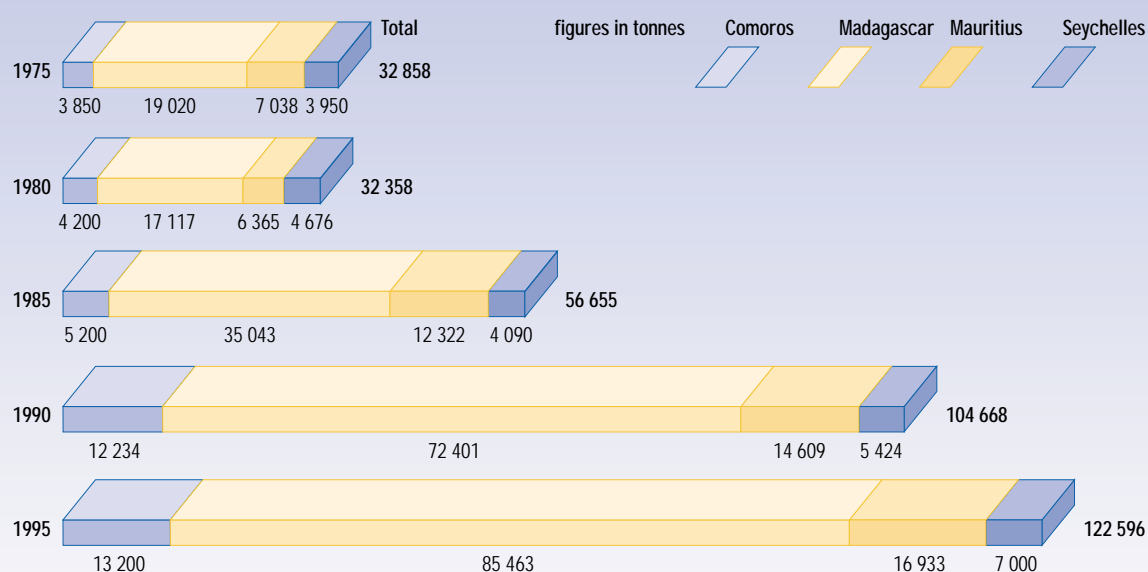
Marine resources

The waters of the Western Indian Ocean are home to a fascinating range of marine life including:

- whales, dolphins and the rare and protected coelacanth and dugong species found in shallow waters around reefs;
- turtles, including the loggerhead, leatherback, hawksbill and green turtle, endangered by human exploitation for their eggs, shell and edible flesh, as well as by pollution;
- fish, several thousand species, ranging from the tiny diamond fish (the smallest backboned animal) to huge whale sharks, and the economically important tuna;
- crustaceans, including hard shelled crabs, a large variety of shrimps, prawns and lobsters;
- coelenterates, including both hard and soft corals, jellyfish and anemones;
- sponges, echinoderms (starfish, sea urchins, sea cucumbers, starfish, brittle stars, feather stars, etc.), molluscs – bivalves (oysters, scallops and clams) and cephalopods (octopus and squids).

These marine resources are of significant economic importance to all the countries of the region, and are protected through the designation of Exclusive

Figure 1.6: Marine fish catch



Source: Fishstat 97, FAO 1997

Economic Zones (EEZs) covering almost five million square kilometres. Industrial fishing, especially of tuna, is an important economic activity for all countries except Comoros (UNEP 1998c).

The level of industrial fishing is highly variable between the countries of the region (Figure 1.6), and also involves European and Asian fishing fleets, which dominate this sector (UNEP 1998d). The tuna catch, ranked second in the world, has increased considerably with a market value estimated at US\$1 billion (ORSTOM 1996). Between 1979 and 1988, the tuna catch in the Indian Ocean trebled in size (Shah 1995; UNEP 1998a), and reported catches by foreign fishing nations have increased dramatically throughout the 1990s (FAO 1997a).

Tuna processing and canning is carried out in Seychelles, Mauritius and Madagascar. Tuna purse seine fishery accounts for about 60 per cent of the total Mauritian annual fish catch, and canned tuna represents more than 90 per cent of the total export of fish. In addition to the earnings from fish landings and processing, these countries earn revenue from the sale of licences for fishing and trans-shipping, as well as from maintaining the foreign fleets, which make a significant contribution to the economies of the region (UNEP 1998d).

Fishing for shark has been practised in Madagascar and Seychelles where it is mainly bycatch, but there is little information about this fairly recent development. In 1995, 55 tonnes of shark fins were exported by Seychelles and 17 tonnes by Madagascar, mainly to markets in Asia (Republic of Seychelles 1997b; République de Madagascar-PNUE 1998). Seychelles recently made it illegal for artisanal fishermen to possess nets for shark fishing in order to protect certain species of shark.

Coastal degradation, marine pollution and over-harvesting are among the most prominent pressures that threaten the long-term viability and productivity of the marine fisheries. According to some sources, there is evidence that commercial as well as artisanal fisheries in some countries of the region have exceeded or are about to exceed the point of sustainability (Insull *et al.* in UNEP 1998d). However, the marine resources for some of these countries are considered to be over-exploited only close to the shores. The considerable gaps in information regarding the status of many species and the fishery resources of this region in general are a barrier to taking a precautionary approach to the sustainable use of this

important resource (Shah 1997a; UNEP 1998a). Industrial fishing may also affect other species directly or in other ways which are currently not well understood. Over the last decade sea bird mortalities in Seychelles, owing to insufficient food, have prompted questions regarding the interactions of tuna and sea birds, and indicated a need for further research (Shah 1997a; UNEP 1998a).

Protected and endangered marine species found in the Western Indian Ocean region include marine turtles, dugongs, whales and dolphins, especially in the waters off the coast of Madagascar. Turtles are captured for their meat and eggs, the young are prey to birds and other predators. Adults are vulnerable to fishing, death from ingestion of discarded plastic, and their nesting sites are being destroyed. Dugongs captured in fishing nets are reported to be occurring less and less frequently, possibly indicating a decline in numbers. They are rarely released since their meat is in demand. Several species of whale are seasonal visitors to the waters of the region. The main pressure is from whale watching by tourists, which is increasing, as the minimum distance of at least 500 m is often not respected by tour operators (République de Madagascar-PNUE 1998). Poaching of dolphins and other protected species is reportedly common in Seychelles. Some dolphins and whales may be caught as bycatch during industrial fishing, and although they should be released, they may be injured in the process (Republic of Seychelles 1997b and 1997c; UNEP 1998a).

Although marine pollution levels are relatively low by global standards, pollution hot spots associated with urban, industrial and agricultural locations such as the tuna canneries in Seychelles and sugar cane fields and factories in Mauritius cause concern. Sewage discharge, urban runoff and industrial processing wastes are major sources of pollution of inshore waters due to poor or non-existent facilities for processing of these wastes (Ferrari 1995). Measures for the treatment of domestic sewage and industrial effluent, monitoring of pollutant levels and their effects, and regulations regarding effluent and waste disposal are generally inadequate or sometimes totally absent in this region (Salm 1996). The threat of marine pollution in the region, especially of oil pollution, risks of oil spills, and ship-borne waste, has been increasingly recognized (World Bank 1996 and 1998c). The Indian Ocean is one of the busiest shipping lanes in the world. Oily waste from ships and discharge of ballast water which may harbour exotic species, pests,

Box 1.5: Marine ecotoxicology

The origin of the variable toxicity of marine animals (fish, corals, sharks, turtles etc.) is linked to the disturbance of marine ecosystems, but little is known about it in the Indian Ocean. Poisoning results from the occasional or permanent presence of biotoxins in marine products. These strong poisons constitute a health hazard to consumers, which is sometimes fatal and is therefore a great handicap to the development of artisanal fishing, and a potential constraint to the regional export and exchange of marine products. Cases of such poisoning are on the increase throughout the world, and only the collection of epidemiological and scientific data at a regional level will provide professional fishermen, consumers and the authorities with full guarantees regarding the marketing of marine products and public health.

At the national level, Seychelles and Comoros do not seem to be affected by this problem. However, there have been numerous cases of poisoning in Madagascar, some endemic with serious collective accidents in recent years (whole households poisoned, with some fatalities). This situation has become worse in recent years. Similarly, in Mauritius and Réunion cigatera poses a public health problem, but specialized regulations and laboratories already exist to deal with this phenomenon.

Through its Regional Environment Programme, the IOC has begun to develop a regional response to this multi-dimensional problem, in the form of a number of different instruments: a network of skills and human resources on the one hand and a regional action plan for marine ecotoxicology (PAREM) on the other. The network has brought together the different sectors concerned (fishing, environment, public health and food control). PAREM is expected to make a significant contribution by strengthening national response capacities in the countries concerned. National as well as a regional action plans must respond to the dual objectives of monitoring the quality of the coastal marine environment and protecting consumer's health on the one hand, and to functions of early warning, surveillance and control on the other.

Source: PRE/COI 1998.

pathogens or diseases, all contribute to marine pollution. Another problem with human health and economic impacts is that of ecotoxicology (Box 1.5).

In view of the environmental and socio-economic importance of coastal and marine resources to all the countries of the Western Indian Ocean region, and the complex interactions taking place between man and environment, resulting in increasing pressure on these resources, better management is a priority as various studies have already demonstrated (Box 1.3). The extent of their exclusive economic zone, the abundance of marine products and the migratory aspect of the main species makes fishing an important area for regional co-operation. A great deal has already been done on a regional basis through the IOC and a number of other initiatives, but greater co-operation in this area will continue to be a priority for the region.

Atmosphere

Atmospheric pollution has both a local and a global dimension. Island states such as those in the Western Indian Ocean are known to be well ventilated because of sea breezes and their distance from main continents. However, their emissions contribute to the global production of greenhouse gases and ozone depletion. And it is precisely these islands that are most vulnerable to the effects of global warming and sea-level rise. Atmospheric pollution in this region originates from emissions by industry, transport, burning of biomass and domestic sources (Table 1.8).

The energy sector is a principal emitter of greenhouse gases (GHG) and other pollutants, depending on the primary energy source. All countries import almost all of their commercial energy consumption needs (between 80 and 100 per cent) which are mainly used to generate electricity as well as for transport (UNDP 1998), although some is re-exported (e.g. as aviation fuel or bunker fuel for fishing vessels from Mauritius and Seychelles where this can account for as much as 25 and 39 per cent of total imports respectively) (Republic of Seychelles 1997a)). Some renewable energy sources are used, including hydroelectric power in Madagascar (ONE and INSTAT 1994), solar power in most countries, but particularly Mauritius and Seychelles (Republic of Seychelles 1997a) and *bagasse* (sugar waste) in Mauritius.

Carbon dioxide (CO₂) emissions, largely the by-product of energy production and use, are the largest sources of greenhouse gases. Per capita emissions of CO₂, of between 0.1 and 2.5 tonnes, are low compared to the world average of 3.9 tonnes (Figure 1.7) – or to the 19.9 tonnes for North America (WRI *et al.* 1998). Although Seychelles has the highest emissions of CO₂ per capita in the region, the national CO₂ removal capacity was 845 310 tonnes in 1995, or 4.4 times the amount emitted (Coopoosamy and Moustache 1998).

Between 1991 and 1995, total CO₂ emissions from industrial processes increased by 5 per cent in Madagascar and 23 per cent in Mauritius (UNCHS 1996). Comoros is the least industrialized country in the region, and one of the least industrialized in Africa, with industry contributing about 10 per cent of GDP compared to an average of 25 per cent in sub-Saharan Africa (UNDP 1998). Total CO₂ emissions were only 66 000 tonnes in 1995 compared with 1.1 million tonnes for Madagascar (down from 1.6 million tonnes in 1980) and 1.5 million tonnes for Mauritius (World Bank 1998).

Table 1.8: CO₂ emissions and energy use

	Comoros	Madagascar	Mauritius	Seychelles
Per capita CO ₂ emission from industrial processes (tonnes) 1991 ⁽¹⁾	n.a.	0.07	1.14	0.06 ⁽²⁾
Total commercial energy use ('000 tonnes)				
1980	15	391	339	70
1994	18	479	431	122
Net commercial energy imports (as % of energy consumption)	100	83	92	100
Commercial energy use per capita (kg)				
1980	45	45	351	1 110
1994	37	36	387	1 691
Electricity consumption per capita (kW hours)				
1980	26	48	482	794
1994	26	41	1 003	1 753

Sources: UNDP 1998, except (1) UNCHS 1996, and (2) Coopposamy and Moustache 1998. Note: n.a. = not available

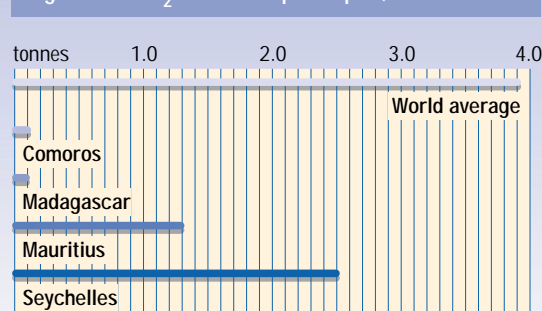
Overall, energy consumption in the region is low in comparison with other parts of the world, but is increasing, as indicated in Table 1.8. Commercial energy use increased by 1.6 per cent annually in Madagascar, and 2.6 per cent in Mauritius between 1980 and 1995 (World Bank 1998), while consumption of petroleum products increased by 15 per cent between 1993 and 1996 in Madagascar (ONE 1997a). However, commercial energy use per capita has shown a decline in Comoros and Madagascar, with per capita electricity consumption staying the same or also declining. By contrast, per capita electricity consumption has more than doubled in Mauritius and Seychelles, the more industrialized and higher income countries in the region with lower population growth (see Table 1.8).

The region does not have a heavy, power-intensive, industrial sector, although Mauritius has been subjected to rapid and accelerated industrialization over the last ten years, resulting in increasing industrial waste and road traffic (UNEP 1998b). Pressures on the environment arise from emissions

from boilers using coal in the industrial sectors, emissions of greenhouse gases from thermal power plants, manufacturing and mining activities, vehicle transport and burning of fields and grasslands. Some 30 000 tonnes of coal are used for raising steam in the textile and dyeing industries in Mauritius, with impacts on local air quality (GOM/ERM 1998a). Odours from industries such as tanning and tuna canning plants are a continuing local pollution issue in most countries.

Vehicle emissions from the rapid increase in vehicle numbers also contribute to overall levels of atmospheric pollution, although there has been no monitoring to determine the extent of the problem. Numbers of motor vehicles are low by international standards, at six per thousand people in Madagascar and 88 per thousand in Mauritius, compared with 559 per thousand in high income countries (World Bank 1998), but have been growing steadily (at least 8 per cent per annum in Mauritius (GOM/ERM 1998b) and around 7 per cent per annum in Madagascar) as has petrol consumption (ONE 1997a). Mauritius and, to a lesser extent, Seychelles already face problems of traffic congestion and poor air quality from vehicle emissions. Emissions from vehicles, many of which are diesel operated, are high in urban areas – a problem exacerbated by the age of most vehicles. For example, in Madagascar the average age of buses is 11 years and for taxis 7–8 years (ONE 1997a).

Air pollution tends to be more significant in urban areas due to greater emissions from industry and vehicles. In Madagascar, more than 70 per cent of industrial enterprises are located in and around the capital, Antananarivo, the principle ones being agro-processing, textiles and clothing, leather, wood, paper,

Figure 1.7: CO₂ emissions per capita, 1995

Sources: UNDP 1998 except (1) Coopposamy and Moustache 1998.

chemicals, mineral and metal products and industrial boilers (ONE 1997a). Air quality and pollution in Antananarivo is influenced by strong sunshine and an absence of wind, with impacts on human health – especially respiratory ailments (ONE 1997a). With prevailing south-easterly trade winds, the location of some of the industrial development around Port Louis, which is on the coast, has the advantage of minimizing the effects of atmospheric emissions on land, as these are rapidly dispersed offshore (UNEP 1998b).

Burning of biomass such as the use of wood and charcoal for energy, bush fires, and burning of sugar cane prior to harvesting, have an impact on air quality, causing severe air pollution through emissions of fly ash, ozone, carbon dioxide, carbon monoxide, methane and volatile organic compounds. These practices are widespread throughout Comoros, Madagascar and Mauritius. The use of wood and charcoal for energy has declined steadily over the past decade in Seychelles and also in Mauritius, where these only represent about 8 per cent and 1 per cent of energy supply respectively, having been replaced in both countries by liquid petroleum gas (LPG) in the domestic sector (GOM/ERM 1998b, Sinon personal comment 1999). Wood and charcoal are however still the most important source of energy in Madagascar and Comoros for up to 90 per cent of the population (see section above on forests). In Mauritius between 40 and 45 per cent of the land under sugar cane is burnt annually before harvesting (UNEP 1998b). Bush fires are a particular problem in Madagascar, where an average of 435 000 ha was burnt annually between 1991 and 1995, and over 3 million ha in 1995 alone (or 0.5 per cent of total land area) (ONE 1997a).

The impacts of air pollution range from the annoyance and health impacts of greenhouse gases, fumes, fly ash, dust, odours and noise, skin, eye, nose and throat irritation – thus increasing the incidence of respiratory diseases such as asthma, chronic bronchitis and emphysema – to the economic impacts of decreased productivity, increased health costs, and nuisance to residential areas, the tourist industry and traffic (UNEP 1998b). In Madagascar respiratory diseases are the cause of up to 23 per cent of cases of morbidity and mortality (ONE 1997a). Air pollution also impacts on ecosystems, causing acidification which affects soil, land and water quality, as well as contributing to global warming and climate change.

The countries of the Western Indian Ocean are all consumers of ozone-depleting substances (ODSs), but

no production takes place in the region, and all demand is met through imports. The most common ODSs are the chlorofluorocarbons (CFCs), used in all four countries. In 1997, Madagascar imported and consumed the greatest amount (104 tonnes), followed by Mauritius (27.3 tonnes). This compares with an average of 233 tonnes of CFCs for all the countries of the African region. In the industrialized countries, when the phase-out of CFCs began in 1989, the average consumption of CFCs per country was 23 744 tonnes compared with 225 985 tonnes in the European Community (EC) and 317 543 tonnes in the US (Ozone Secretariat data 1999, personal communication).

In general, consumption of CFCs has been falling in the region, for example Seychelles had a consumption of 2.5 tonnes of CFCs in 1997 (or 0.03 kg of CFCs per capita per annum), which has fallen from a peak of 10 tonnes in 1993. For Mauritius, the consumption of CFCs was 27.3 tonnes in 1997, (a per capita consumption of 0.02 kg per annum), compared with a maximum consumption of 76.0 tonnes in 1989. Despite being the largest importer in the region, with a reported consumption of 104 tonnes of CFCs in 1997, Madagascar's annual per capita consumption was only 0.01 kg of CFCs. Comoros imported 2.9 tonnes of CFCs in 1997, which corresponds to an annual per capita consumption of less than 0.01 kg. Compared to only 0.4 tonnes in 1986, it therefore seems that Comoros' small consumption may still be increasing (Ozone Secretariat data 1999, personal communication).

Atmospheric pollution appears to be increasing, particularly in urban and industrialized areas, and may be an emerging environmental issue in the region. However in the absence of systematic studies and a lack of baseline data it is difficult to identify the extent of the problem. With continuing deforestation, industrialization and urbanization this issue is likely to become an increasing problem if appropriate mitigating measures are not put in place.

Climate change and natural disasters

For more than a decade it has been recognized that islands such as those of the Western Indian Ocean are at high risk from the effects of global climate change and its associated impacts (sea-level rise and enhanced frequency of extreme weather events such as temperature and precipitation extremes, and natural disasters such as cyclones, storm surges, flooding and

landslides) and their adaptations are major concerns (IPCC 1995). Climate-related changes represent additional stresses on systems that are already under intense and growing pressure, and these pressures are expected to increase substantially in the coming decades (WCC'93 1994 in IPCC 1995).

Sea-level rise

Island states, particularly low lying islands such as the coralline Seychelles, are seen as particularly vulnerable to sea-level rise, both biogeophysically and socio-economically (IPCC 1995). These islands have certain common features such as areas of low lying flats, narrow coastal strips, atolls, reefs and sandy beaches. Because the population and economic activities are found primarily in the coastal zone, sea-level rise threatens industry, tourism, energy production, transportation, communication and governmental infrastructure (Leatherman 1997) as well as the natural ecosystems.

The Intergovernmental Panel on Climate Change (IPCC) 'business-as-usual' high and low scenarios of 100cm and 30cm rise in sea-level by the year 2100 (IPCC 1990 Scientific Assessment in IPCC 1995) would have severe impacts on coastal areas and resources, although there would also be considerable variation with some countries more vulnerable than others. Seychelles estimates that a 1m rise will submerge most of its islands, with a loss of 70 per cent of its land area (Shah 1995 and 1996). On the other hand, a vulnerability assessment study for Mauritius concluded that it would lose five square kilometres of land, equal to 0.3 per cent of its area, and 3 000 people would be affected (Jogoo 1994 in IPCC 1995). The IPCC estimates also suggest that as much as 22 per cent of the population of the Indian Ocean small islands are at risk from sea-level rise if no protection is provided.

Many small island countries stand to lose a significant part of their land area at the predicted rates of sea-level rise, and even the less vulnerable small islands would suffer significant economic losses due, for instance, to the possible loss of beach and reef-based activities (IPCC 1995) such as tourism and fishing. Climate change and sea-level rise would affect tourism directly and indirectly. The loss of beaches to erosion and inundation, increasing stress on coastal ecosystems, damage to infrastructure and an overall loss of amenities would jeopardize the viability of the tourist industry in countries such as Seychelles and Mauritius (IPCC 1998).

Significant climate change would also adversely affect the ecosystems in the region. For example, a sea-level rise of about one metre could lead to increased coastal erosion and flooding, loss of wetlands and increased salinization of ground water. Coastal zones would also be negatively impacted by the accelerated erosion, dislocation of communities and damage to mangrove forests. All these changes would lead to disruptions of infrastructure and socio-economic activities (Mwangi 1995).

A noticeable change, over the past decades, has been the effect of wave action on beaches, causing erosion in all the countries of the region. In Madagascar the coasts are being eroded at a spectacular rate, for example at Mahajanga, Tomasina and Morondava (République de Madagascar-PNUE 1998). In Mauritius, an assessment of sea-level rise impacts carried out at St. Felix in 1992 and 1995 has shown that over the three-year period, the shoreline had receded by 12 metres as a result of erosion (Ragoonaden 1997). Beach loss has also been reported in Comoros and, although the assumption is that the loss has been due to coral and sand extraction, the country does not have the capacity to assess whether wave action and sea-level rise have also contributed.

Extreme weather events and natural disasters

The challenges of economic growth and environmental fragility of small islands are further compounded by their high level of vulnerability to extreme weather events and natural disasters as well as the likely impacts of sea-level rise. Island states are sensitive to changes in precipitation in terms of absolute amounts as well as spatial and temporal distribution. Similarly they are particularly vulnerable to any changes in the frequency and intensity of extreme events such as cyclones, floods, storm surges, landslides and droughts (IPCC 1998). These not only pose significant threats to the stability of national economies through damage to economic and social infrastructure, hydraulic installations, food stocks, and crop yields but also have harmful impacts on ecosystems and species diversity, as well as on the human population.

Comoros, Madagascar and Mauritius are frequently subjected to cyclones and floods causing severe damage in the coastal areas where most urban centres as well as tourism and agricultural developments are located. In 1997 torrential rain and flooding set a government housing development programme in Seychelles back by two to three years, this occurring in a country where natural

disasters are relatively rare (UNDHA 1997). On average, Madagascar suffers from cyclones about four times a year which cause significant damage due to the strong winds and flooding, soil erosion, contamination of fresh water, crop and livestock losses, loss of life and damage to the physical and human environment, as well as consequent socio-economic problems such as famine, increases in the cost of living, and theft (ONE and INSTAT 1994). For the past two decades, consistently after the passage of cyclones, Madagascar has had to seek international assistance to help in rehabilitation works, reconstruction and food security. (FAO 1984; UNDHA 1994).

Flooding of low-lying flats is already occurring in all the islands during cyclones and storm surges and due to sea-level rise, damaging roads, resort areas and settlements. On average, the region is visited by ten cyclones annually during the period of November to May. During the cool period of May to September, trade winds in the eastern part of the region cause anti-cyclonic conditions resulting often in heavy swells which in turn cause significant rises in sea-level, affecting coastal infrastructure such as roads and settlements. The damage to the natural environment can be quite marked,

Box 1.6: Extreme weather events in Seychelles

In 1997 and 1998, Seychelles experienced erratic and abnormal climatic conditions. In the middle of the dry season, between the 12th and 17th August 1997, a record 667mm of rainfall caused extensive damage to infrastructure (houses, roads, electricity distribution networks) and lives. The rainstorms over these six days were the worst ever recorded, with damage estimated at US\$6–7 million. Seychelles had little experience of natural disasters and no disaster management structure, legislation or plan (UNDHA 1997).

In 1998, during July–December, Seychelles experienced the most severe drought in 25 years, and the major industries were forced to close temporarily, including the Seychelles Breweries and the Indian Ocean Tuna Company. The losses have not yet been fully assessed, but preliminary estimates run into millions of US dollars.

Another alarming phenomenon during 1998 was the migration of tuna fish stocks further to the south-west of the Indian Ocean. The explanation given for this was the dramatic rise in sea temperature, which also resulted in extensive coral bleaching (NOAA 1998). A recent study showed that over 80 per cent of branching corals in Seychelles' reefs died as a result of this bleaching episode (see section above on coastal resources). Once again, the Indian Ocean Tuna Company canning factory and related industrial fisheries suffered considerable losses. The purse seiners were forced to operate outside the Seychelles EEZ and use other ports to unload their catches. The impact of sea temperature rise and coral die-off on the future artisanal fisheries of Seychelles has not yet been assessed but is expected to be serious.

Source: Martin and Sinon personal communications 1999; UNEP 1998a.

affecting beach stability and in certain places causing vertical scouring of up to two metres (Ragoonaden 1997). It has been predicted that a one to two degrees Celsius increase in sea surface temperature can cause a five-fold increase in cyclone intensity and also narrow the cyclone-free zone on both sides of the equator. This would make Seychelles, which is currently in the cyclone-free zone, more vulnerable by bringing it within the cyclone zone (Shah 1995 and 1996; UNEP 1998a).

In the tropical regions of the southern hemisphere, the El Niño/Southern Oscillation (ENSO) phenomenon is a major factor in year-to-year climate variability, with a marked effect on rainfall patterns. Possible climate changes associated with ENSO events could have serious consequences for water supplies and agriculture in many countries. As with sea-level rise, atoll communities dependent on rainfall for fresh water could be at risk from precipitation variability associated with anomalies such as the ENSO phenomenon (Meehl 1994 in IPCC 1998). Islands are most vulnerable to the El Niño phenomenon as they receive the higher maritime air temperatures as well as the effects of further environmental degradation through floods and droughts. The region experienced the impacts of ENSO when sea surface and air temperatures were abnormal during 1997 and 1998. Due to an increase in water temperatures, marine ecology was disturbed, as evidenced by the bleaching and death of coral reefs in the region in 1998 (NOAA 1998) (Box 1.6).

Drought and desertification occur in some Western Indian Ocean states. Mauritius, for example, is prone to droughts with consequent reduction in agricultural yields, and the whole country being subjected to a regime of water cuts. In the first half of 1999 the country faced such a drought, leading to severe water cuts in some regions of the island, and it is likely that sugar cane production will be significantly affected. Madagascar is the country most affected by desertification, particularly the semi-arid areas of the extreme south and all the south-west coast. Drought has become increasingly common over the last 40 years, occurring more and more frequently and lasting longer (République de Madagascar-PNUE 1998). This has resulted in greater particle loading of the south and south-westerly winds, the so-called '*vent de sable*', leading to increasing size and movement of sand dunes along the coast, which are gradually invading the interior, covering fields and habitation, with at least three villages being buried in the last eight years (République de Madagascar-PNUE 1998).

Other likely impacts of climate change include increased soil erosion, deposition and water turbidity in the Mozambique channel from Madagascar to Comoros, impacting on aquatic ecosystems and biodiversity. The resulting sedimentation is also affecting coastal currents, leading to increased severe coastal erosion, for example in regions of Madagascar such as Morondava and Mahajanga. This could have significant socio-economic consequences on fishing, tourism, etc. (République de Madagascar-PNUE 1998).

The transmission of many infectious diseases is affected by climatic factors. Vector-borne diseases such as malaria, yellow fever and dengue fever are sensitive to factors such as changes in temperature, rainfall and humidity, which could increase the spread of the vector. The mosquito that is the vector for dengue fever is found in Seychelles in densities that far exceed those under which dengue epidemics have occurred in other parts of the world (Shah 1996; UNEP 1998a). A study of dengue in the South Pacific showed a strong link between the incidence of outbreaks of the disease and the ENSO phenomenon (Hales *et al.* 1996 in IPCC 1998). An increase in the incidence of water-borne and food-borne infectious diseases could also result, including cholera and biotoxin contamination of fish and shellfish (already a problem in the Western Indian Ocean (Box 1.5)).

Although not major contributors to global warming, there seems little doubt that the island states of the Western Indian Ocean will be severely affected by climate change and its associated impacts, through sea-level rise or an enhanced frequency of extreme weather events and natural disasters, or both. This is an environmental issue that the countries in this region have only recently begun to address.

Urbanization

Since the early 1970s Africa has had one of the highest annual urban growth rates in the world, of about 5 per cent per year (WRI *et al.* 1998). Urban population growth rates for the Western Indian Ocean region over the period 1970/75 to 1995/2000 range from 1 per cent (Mauritius) to 5–6 per cent (Comoros and Madagascar). Urban populations in the region have grown steadily since the 1950s, and now account for between 30 and 60 per cent of the total population in each country (Figure 1.8). Such high rates of change strain the capacity of local and national governments to provide the most basic services to urban residents such as

housing and infrastructure, potable water and sanitation services, and solid waste disposal.

By the year 2025 it is estimated that almost 60 per cent of the total population of the region will be urban. This may be as high as 74 per cent in Seychelles, which is already the most urbanized country in the region both in terms of the percentage of urban population (currently about 60 per cent), and urban area as a percentage of total land area (about 23 per cent (UNDP 1997b)). Madagascar is the least urbanized in terms of percentage of total population, but has experienced the most rapid urbanization, as demonstrated by the annual growth rates of about 5.8 per cent between 1970 and 2000. More than 25 per cent of its total urban population is found in the capital city Antananarivo where most of the industry is located (ONE 1997a, 1997b). Comoros has also experienced similarly high annual urban population growth rates. Mauritius has had the lowest urban growth rates, but these are projected to double up to the year 2025, in contrast to rates in all the other countries of the region where they are projected to fall. (Figure 1.8). The principal impacts of urbanization in the region include (COI 1996a, 1996b, 1996c):

- habitat and biodiversity degradation and loss;
- unplanned and haphazard development (informal settlements, land-use conflicts, development on sensitive areas and risk zones);
- pollution (air, water and solid waste); and
- social problems (resource-use conflicts, poverty and unemployment, public health problems).

Urbanization and industrial development are increasing pressure on the limited land resources, as the greatest concentrations of population and economic activity tend to be on the lowland coastal zones which, being flatter and more accessible than the interior, have been developed first. In the small island states (Comoros, Mauritius and Seychelles), urbanization is the activity with the highest impact on the coastal environment, where most urban areas are concentrated. Almost 90 per cent of the population and infrastructure in Seychelles is on the main island of Mahé (Republic of Seychelles 1997b), of which 61 per cent is concentrated in the north of the island, with 40 per cent living on a 7km x 1km coastal strip along the east coast between Victoria and the airport (Shah 1995).

Land speculation with occupation of marginal land with fragile ecosystems is increasing. Saturation of the coastal areas by urbanization in Seychelles is giving rise

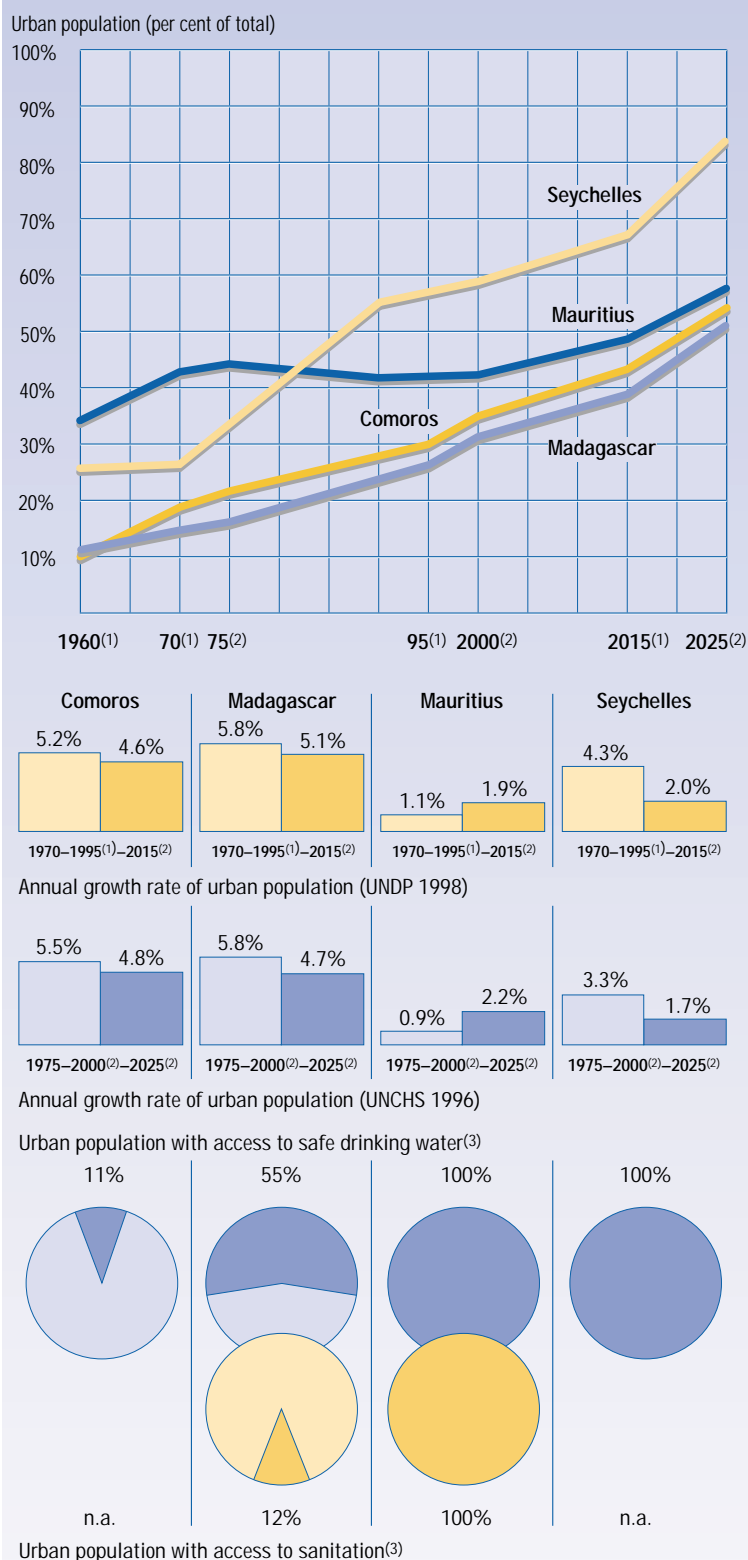
to construction on coastal sand dunes, on wetlands, in the buffer zone of 20 metres from the coastline and on granitic areas which act as refuges for endemic plants. Urbanization is moving into the highlands and is encouraging land reclamation (Shah 1995) which in turn can lead to further environmental problems (see section on land and food above).

Rapidly expanding urban populations make heavy demands on the environment as they generally consume more resources than rural dwellers and produce large quantities of solid and liquid waste. Uncontrolled urbanization is resulting in environmental degradation and accumulation of domestic wastes, particularly in Comoros (RFIC 1997b). Degradation of the quality of urban life is a major issue, for example in Mauritius where the main problems include air pollution, noise, congestion, waste management, over-crowding, deterioration of the landscape, and nuisance and pollution emanating from the close proximity of industry (GOM/ERM 1998b). Associated socio-economic problems include poverty and unemployment. In the Comorian capital of Moroni, the population is young, unemployment is around 20 per cent, and 40 per cent of the population lives below the poverty line (RFIC 1997b).

Not only do urban populations produce large quantities of solid waste, but there is often low efficiency in its collection, treatment and disposal (UNEP 1998d). Quantities of solid waste range from around 1 000 tonnes collected daily in Mauritius, to an estimated 80 tonnes of waste generated per day in Comoros (UNEP 1998c). Although solid waste collection occurs in many urban areas, this is often insufficient, for example in Antananarivo it is estimated that only 25 per cent of waste produced is collected. Disposal of solid waste poses problems due to scarcity of land on islands such as Mauritius and Seychelles. Although some solid waste is disposed of in various dumps and landfill sites (Mauritius and Seychelles) or incinerated (Comoros and Seychelles), burning by households is common, and uncontrolled dumping of waste can be a public health hazard and source of pollution for groundwater, as well as marine and coastal ecosystems (UNEP 1998c). Some recycling takes place in the region, such as of paper, textiles and metal in Madagascar and Mauritius, which also has companies recycling glass, precious metals and plastics (UNEP 1998c).

The exploitation of water resources by urban populations can lead to degradation of groundwater and fresh water resources through saline intrusion along coastal margins, and pollution from sewage and run-off.

Figure 1.8: Urban indicators and trends



Much of the coastal urban population in the region relies on septic tanks and pit latrines, resulting in faecal contamination of groundwater (UNEP 1998d). Untreated domestic sewage, together with storm-water run-off from impermeable urban surfaces, pose a threat to potable water supplies and to the clarity and quality of both fresh water and near-shore coastal waters (UNEP 1998d). Many of the towns and villages concentrated along the coast discharge their liquid and solid wastes directly into the sea (such as in Comoros where there is no waste management system) (UNEP 1998c). Contamination of groundwater by wastewater frequently occurs, for example in Anjouan and Mohéli where the water table is close to the surface (UNEP 1998c).

Throughout the region industrial development is growing, and is often concentrated in urban areas, which adds to the problems of pollution, saturation of infrastructure and congestion. For example 70 per cent of Madagascar's industry is found in and around Antananarivo (ONE 1997a). The structure of industry is also changing, for example in Mauritius initially away from agriculture towards industrial activities with major discharges and polluting practices (textiles, tanneries, dye houses). More recently there has been some diversification towards electronic goods and jewellery which are likely to lead to reduction in emissions and waste. However, diversification into other industrial sectors such as pharmaceuticals and light industry will require high quality resources (water, air) and generate pollution (GOM/ERM 1998b).

Conclusion

Ecological fragility and economic vulnerability are the two concepts that are commonly associated with the island states of the Western Indian Ocean. The economic development of all of these island states relies heavily on their natural resource capital. The land, forests, rivers, biodiversity, lagoons, beaches, reefs and marine areas are important ecological resources on which the economic prosperity of the islands depends. But these are very fragile ecosystems which can be easily degraded through mismanagement or natural calamities. For this reason the islands are highly vulnerable from all points of view – economic, environmental and social.

This overview of the state of the environment of these Western Indian Ocean islands indicates that the terrestrial, aquatic and marine environments are continuing to deteriorate due to this ecological fragility

combined with socio-economic driving forces and the unsustainable modes of resource utilization:

- Land, which is often limited, is under pressure from population growth, competing uses, and unsustainable land-use practices, as well as erosion, drought and desertification.
- Very little indigenous forest remains, and where it does remain deforestation is continuing, sometimes at an alarming rate.
- The region's rich and often unique biodiversity and ecosystems are increasingly threatened, particularly by habitat degradation and destruction.
- Fresh water quality and quantity are becoming critical issues for certain countries.
- Marine and coastal resources, on which most of the population of the region is highly dependent, are threatened by pollution, habitat degradation, infrastructure development and other land-based activities.
- Atmospheric pollution, although still low by international standards, appears to be increasing as energy use rises.
- Growing and rapid urbanization as well as industrialization are increasingly impacting on environmental systems and resources, putting strains on existing infrastructure and services, and leading to a deteriorating quality of life with associated environmental problems such as waste management, pollution of groundwater, coastal and marine areas, unplanned and informal settlements, and public health problems.
- Tourism, based on the countries' natural resources, makes an increasingly significant contribution to the economies and development of the region on the one hand, but is one of the factors that contributes to pollution and the degradation of the coastal ecosystems on the other.
- The island states are highly vulnerable to climate change and associated impacts such as sea-level rise and more frequent extreme weather events.
- The region is becoming more and more vulnerable to natural and man-made disasters (cyclones, flooding and tidal waves, drought and desertification, coastal and marine pollution from land-based activities and the discharge of hydrocarbons, etc.).

Due to the discernible ecological, socio-economic and developmental diversity found in the Western Indian Ocean region there will inevitably be differences in

terms of national and regional priorities for action. For regional priorities a major determining factor will be the commonality, regional or transboundary nature of specific environmental problems. The priority environmental issues for policy action listed below have been identified from two sources, firstly through the work of the IOC's five-year Regional Environment Programme (PRE/COI) (COI 1998b), and secondly through a Transboundary Diagnostic Analysis (TDA) for the coastal and island states of the Western Indian Ocean carried out in 1997–1998 at the request of the First Meeting of the Contracting Parties to the Nairobi Convention, with funds from the Global Environment Facility (GEF) (UNEP 1998d).

1. Climate change (PRE/COI).
2. Degradation of coral reefs (PRE/COI).
3. Loss of critical coastal habitats and biodiversity (TDA).
4. Decreasing harvests of marine and coastal living resources (TDA).
5. Coastal erosion (PRE/COI).
6. Coastal and marine protected areas (PRE/COI).
7. Coastal pollution including unsanitary conditions of beaches and coastal waters, as well as contamination of coastal living resources by major urban areas (TDA).
8. Ecotoxicology (PRE/COI).
9. Waste management and sanitation (PRE/COI).
10. Fresh water shortages and contamination (TDA).
11. Renewable energy (PRE/COI).

Inevitably, most of these priorities are concerned with coastal and marine issues, and there are considerable interlinkages between the issues, as well as the driving forces behind them. According to the Pressure-State-Response model often adopted in state of the environment reporting, human beings exert pressure on the environment and such pressures induce changes in the state or condition of the environment, to which society responds with policies and programmes to prevent, mitigate or repair environmental damage (Rump 1996). Chapter Two examines the third component of this model, the global, regional and national policy responses adopted by the countries of the Western Indian Ocean region individually and at the regional level, to deal with the environment and development challenges they are facing.

Policy Responses



‘Effective policy setting for sustainable development requires a blend of policy instruments that addresses the social fabric of life, ensures effective institutional arrangements, improves the economy, and protects the environment.’ (UNEP, 1997a, page 129).

Policy background

Prior to the colonial period the management of environmental resources was largely community-based in many traditional societies throughout Africa, including those of the Western Indian Ocean. Madagascar’s unique natural resources had been recognized from ancient times. The sovereign played a very important role in safeguarding ancestral land, soil and forests: all monarchs issued regulations protecting natural resources and limiting excessive exploitation of forest and mineral products, which were regarded as law and passed on through oral tradition. For example in 1881 Queen Andrianampoinimerina issued a code of 305 articles.

During the colonial period certain measures were put in place which further contributed to environmental conservation in all countries of the region, notably in the use of certain natural resources of economic importance, the creation of reserves, national parks, forest stations, regulation of shifting cultivation, and creation of institutions such as scientific and research bodies and sectoral governmental structures. For example, nature conservation and natural resource management in Seychelles can be traced back to 1778 (Republic of Seychelles 1997b).

Environmental awareness among decision-makers and the general population in the region has been increasing since the United Nations Conference on the Human Environment in Stockholm in 1972. The region’s development priorities currently have an environmental and sustainable development dimension which they lacked during the period following independence in the 1960s and early 1970s when economic development was the overriding consideration. The 1980s and 1990s brought about changes in national priorities, and most national environmental policies and laws were initiated in this period. Following the Brundtland Commission in 1987, the United Nations Conference on Environment and Development (UNCED) in Rio, 1992 and the UN Global Conference on the Sustainable Development of the Small Island Developing States in Barbados, 1994, the governments of the region have been very active in establishing the legislative and institutional framework for the integration of environmental concerns into their national development plans to ensure sustainable development.

At the regional level, all countries are members of the African Ministerial Conference on the Environment (AMCEN), and the Indian Ocean Commission (IOC), while Mauritius and Seychelles are members of the Southern African Development Community (SADC). AMCEN played a crucial role in creating a common position for Africa in the negotiations for, during and after UNCED in 1992 (UNECA 1991). The Indian Ocean Commission’s Regional Environment Programme

(IOC/REP), which formed the framework for regional co-operation with respect to shared marine and coastal resources, was established in 1989. Since 1995 the IOC/REP has been promoting a regional approach for sustainable development of natural resources and protection of the environment (COI 1998b). SADC is promoting environmentally sustainable development through the SADC Environment and Land Management Sector (ELMS), using a strategy of building the capacities of member states to address environmental concerns (SADC 1996a). SADC has developed a policy and strategy for environment and sustainable development which moves beyond *Agenda 21*, setting a new agenda for equity-led growth, self-reliance, and poverty-alleviation (SADC 1996b) (see Box 2.8 on sustainable development).

Multilateral Environmental and Non-binding Agreements

There has been a significant increase in policy decisions and actions regarding multilateral environmental agreements (MEAs) since UNCED when a number of MEAs relevant to the region were signed by most countries, most notably the Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC).

One of the most prominent non-binding global agreements (soft laws) in terms of its effectiveness is *Agenda 21*, adopted at UNCED, which has become the guiding document for environmental management in many countries. Governmental commitment to this agreement has been demonstrated by the preparation of national environmental strategies, policies or action plans, highlighting the state of the environment in most countries of the Western Indian Ocean sub-region, as well as setting out priorities and actions.

The implementation and impact of global MEAs

The political commitment of the Western Indian Ocean island states to most global MEAs is indicated by the level of signature, ratification and accession (Table 2.1), as well as countries' participation in the Conferences of the Parties and in the submission of national reports when required. Some MEAs are obviously of greater importance to the region than others and this influences the degree of commitment to each. Commitment to the implementation of global MEAs is often given in countries' national environmental

Table 2.1: Parties to major global MEAs (as at 1 March 1999)

	Comoros	Madagascar	Mauritius	Seychelles
Global Conventions				
CBD	●	●	●	●
CITES	●	●	●	●
CMS		●		
Basel	●		●	●
Ozone	●	●	●	●
UNFCCC	●	●	●	●
CCD	●	●	●	●
Ramsar	●	●	●	
World Heritage		●	●	●
UNCLOS	●	●	●	●
MARPOL			●	●
London				●
Regional Conventions				
Algiers		●	●	●
Nairobi	●	●		●
Bamako			●	
Lusaka Agreement				

- Parties to a convention are states that have ratified, acceded to or accepted the convention.
- A signatory is not a party to a convention.

policies, such as the *Environmental Management Plan of the Seychelles 1990-2000* (Republic of Seychelles 1990). Implementation also requires the incorporation of various international obligations into national legislation. Some countries in the region, such as Mauritius, have made this a priority while others have not as they consider that it might constrain economic activity. With the exception of Mauritius, very little national legislation for the implementation of any environmental convention ratified by the Western Indian Ocean island states has been enacted.

The unique biodiversity found in the sub-region, particularly the high numbers of endemic species, make it globally important in terms of biodiversity conservation. The objectives of the Convention on Biological Diversity (CBD) are the conservation of biological diversity, the sustainable use of biodiversity components, and the equitable sharing of benefits derived from genetic resources, and therefore the Convention's provisions are fully applicable and relevant to the region.

All four countries have ratified the Convention, and are therefore eligible to receive financial assistance for biodiversity projects and programmes under the Global

Environment Facility (GEF) (Box 2.1) which operates the funding mechanism of the CBD. Comoros, Madagascar and Seychelles have all produced national biodiversity strategies and action plans, which set out strategies for implementing the Convention, while that for Mauritius is in preparation (RFIC 1998; République de Madagascar

1997b; Republic of Seychelles 1997b). The Seychelles Biodiversity Strategy and Action Plan comprises a list of 41 projects, with a total budget of US\$12 257 million over a five-year period, equivalent to 6 per cent of the Seychelles total Public Sector Investment Programme (PSIP) 1997–99 (Republic of Seychelles 1997b).

Box 2.1: The Global Environment Facility (GEF) in the Western Indian Ocean

All the countries of the Western Indian Ocean are benefiting from GEF funding for projects focusing on biodiversity, climate change and international waters. By June 1998 a total of US\$33 million or 1.7 per cent of all GEF funding for approved projects had been allocated to the region, and considerable co-financing generated. These figures include enabling activities to meet the reporting requirements of the CBD and UNFCCC, for which the GEF operates the financial mechanisms. Examples of GEF projects in the Western Indian Ocean are listed below:

Comoros – Biodiversity – Approved projects

- Island biodiversity and participatory conservation in the Federal Islamic Republic of Comoros
- Biodiversity enabling activity

Madagascar – Biodiversity – Approved projects

- Environment Programme support
- Biodiversity Country Study (enabling activity)
- Biodiversity enabling activity
- Clearinghouse mechanism

Mauritius – Approved projects

- Development of best practices and dissemination of lessons learned for dealing with global problem of alien species that threaten biological diversity (Global project).
- Biodiversity restoration
- Restoration of highly degraded and threatened native forests in Mauritius
- Biodiversity enabling activity
- Biodiversity: Clearinghouse mechanism
- Sugar bio-energy technology
- Economics of GHG limitation – Phase I (Global project, enabling activity)
- Climate change enabling activity

Seychelles – Approved projects

- Biodiversity conservation and marine pollution abatement
- Management of avian ecosystems
- Biodiversity enabling activity
- Biodiversity: Clearinghouse mechanism
- Climate change enabling activity

Regional Projects – International Waters – Project Development Facility (PDF) Funds

- Western Indian Ocean marine biodiversity conservation programme
- Preparation of a Transboundary Diagnostic Analysis and a Strategic Action Programme for the Marine and Coastal Environment of the Western Indian Ocean
- Western Indian Ocean Oil Spill contingency planning project

GEF Funds allocated for Approved Projects as of June 1998 (US\$ million):

<i>GEF Focal Area:</i>	<i>Biodiversity</i>	<i>Climate Change</i>	<i>Int. Waters</i>	<i>Total</i>
Comoros	2.574	-	-	2.574
Madagascar	21.585	-	-	21.585
Mauritius	1.741	3.773	-	5.514
Seychelles	2.736	0.250	-	2.986
Regional (PDF)	0.025	-	0.330	0.355
Total	28.661	4.023	0.330	33.014

Source: GEF Operational Report on Programmes June 1998.

Note: Where global or regional projects indicated countries of the region, the budgets have been included pro rata. Multiple Focal Areas projects (e.g. the Small Grants Programme) and some Global projects do not specify countries or regions (e.g. the Global International Waters Assessment (GIWA)) but may benefit countries of the Western Indian Ocean; however, these have not been included in the funding table above.

Closely related to the CBD is the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which seeks to protect certain endangered species from over-exploitation by controlling international trade in such species and/or their products through a system of import/export permits. All countries in the region have ratified this Convention, which requires governments to designate Management Authorities and Scientific Authorities for the purpose of granting import/export permits and certificates. Madagascar, Mauritius and Seychelles have fulfilled this requirement. For example, the National Parks and Conservation Service in Mauritius acts as both the Management Authority and the Scientific Authority, as does the Conservation and National Parks Section of the Ministry of Environment and Transport in Seychelles. In Madagascar the situation is more complex. The lead institution is the Ministère du Développement et de la Reforme Agraire, the Management Authority is the Direction Générale des Eaux et Forêts, and in addition there are two Scientific Authorities (Ministère de l'Enseignement Supérieur and the Ministère de la Recherche Scientifique et Technologique) (CITES 1999).

National programmes have been set up to help in the sustainable utilization and trade in wildlife, which nevertheless sometimes suffers from abuse and lack of proper enforcement, as existing legislation is often inadequate and fragmented. In Seychelles, legislation to regulate the trade in shells, turtle products, seabirds, their eggs and young, and certain plants such as the *coco de mer* nut, exists but enforcement is variable because the government lacks sufficient data and capacity for implementation (Republic of Seychelles 1997b and 1997c). In Mauritius, although the import and export of wild flora and fauna is regulated primarily by the Wildlife and National Parks Act 1993, the prohibition of the import and export of species of wildlife only applies to 'prescribed wildlife', and since none have yet been prescribed, implementing regulations need to be promulgated. Regulations to incorporate the CITES list of prescribed species have been drafted but they have yet to be approved. Other legislation that regulates various aspects of the implementation of CITES includes the Fisheries Act 1980 and the Plants Act 1976.

The United Nations Framework Convention on Climate Change (UNFCCC) is of special relevance to the Western Indian Ocean region because of these countries' high level of vulnerability to the impacts of climate change. The particular needs and concerns of developing countries, including 'small island countries', 'countries

with low low-lying coastal areas', 'countries with areas prone to natural disasters' and 'countries with areas with fragile ecosystems', have been given special attention in Article 4.8 of the Convention. Specific mention is made that full consideration will be given to what actions are necessary under the convention to address the specific needs and concerns of the developing country parties 'arising from the adverse effects of climate change and/or the impact of the implementation of response measures'.

The UNFCCC is of high priority for the region because, although not major contributors to climate change themselves, the countries will be severely affected, particularly their ecosystems, water resources, coastal zones, forests, range lands, agricultural production, etc. Unlike the industrialized countries that are required to reduce their emissions of greenhouse gases (GHG) by the year 2000 to 1990 levels, the countries in the African region are not obliged to reduce their emissions to a specific target and deadline as their contribution is still low.

Mauritius was the first country to ratify the UNFCCC with Seychelles second. The Convention has also been ratified by Comoros, while Madagascar, which is a signatory, completed procedures to ratify in December 1998. Comoros, Mauritius and Seychelles are preparing Climate Change National Communications as required under the convention, which include a GHG inventory (sources and sinks), mitigation measures, and vulnerability and adaptation assessments, which would lead to relevant policy options and frameworks for response strategies to climate change.

Some countries are establishing structures and are implementing actions to comply with the obligations of the UNFCCC. For example Seychelles and Mauritius have both established National Climate Change Committees, operating under the Prime Minister's Office (Mauritius), or under the Vice President's Office (Seychelles). The Mauritius National Climate Change Committee is chaired by the Prime Minister and co-chaired by the Meteorological Service. The Seychelles National Climate Change Committee, under the joint aegis of the Ministry of Environment and the Meteorological Service, is currently drafting the National Climate Change Action Plan.

Under the UNFCCC and the Montreal Protocol, a number of projects have been or are being developed such as energy efficiency studies, alternative energy programmes, and inventories of greenhouse gases. Studies of the impact of climate change on various economic and social sectors have been carried out in

Mauritius and Seychelles. In addition, Mauritius has improved its network of observing stations on the mainland and its outer islands; has finalized an inventory of GHG emissions; and has carried out some detailed studies on the Vulnerability and Adaptation Assessment of the impact of climate change on certain economic sectors. Mauritius is also one of eight countries in the world participating in a pilot study on the economics of GHG limitations, which should lead to better use of energy, and improved environmental quality. The country also has plans for a number of further activities including the incorporation of a National Climate Action Plan into the National Socio-Economic Development Plan, greater promotion of alternative sources of energy, systematic monitoring of the atmosphere and ecosystems, greater participation in the Global Climate Observing System (GCOS), intensive public awareness campaigns, and research.

The countries of the Western Indian Ocean are all consumers of ozone-depleting substances (ODSs), which are imported since no production takes place in the region, although in general, levels of consumption have been falling (see section on atmosphere in Chapter One). All four are considered Article 5 countries under the Montreal Protocol, which means that they are eligible for assistance to reduce consumption of ODSs under the Multilateral Fund of the Montreal Protocol. Country programmes have been approved in Comoros, Mauritius and Seychelles, and one is being negotiated in Madagascar (Ozone Secretariat, personal communication 1999).

Under its country programme, Mauritius has established an ozone desk in the Department of Environment, which carries out monitoring and enforcement in collaboration with customs officials and importers. The ODS phase-out programme is expected to be completed by the year 2010 (GOM/ERM 1998c), and the country is also considering banning the import of CFCs. Seychelles has established an ozone focal point in the Ministry of Industry, while other actions include public education initiatives through the media, an ozone workshop for children in August 1998, a children's ozone competition and the ongoing development of a training programme for refrigeration technicians. Although they have ratified both the Vienna Convention and the Montreal Protocol, Comoros and Madagascar have taken fewer measures to implement them.

Existing legislation governing the production, movement, distribution, import and export of ODSs is often fragmented and inadequate. For example, in

Mauritius the relevant legislation includes the Supplies Control Act 1974, the Customs Act 1988, the Fair Trading Act 1980 and the Environment Protection Act 1991, but the mechanisms to properly implement the requirements of the convention are insufficient, and do not include all controlled substances under the Montreal Protocol. Other problems include lack of proper data, and discrepancies between data provided by customs and importers.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is also of direct relevance to the region as the African continent has been a destination of hazardous waste exports from industrialized countries. The Convention prohibits the export of hazardous wastes into countries that have not consented in writing to a particular consignment, or that have prohibited the import of hazardous wastes altogether. It requires parties to prevent the import of such wastes where they have 'reason to believe that the wastes in question will not be managed in an environmentally sound manner' (Article 4.2 (g)). The Convention has been ratified by Comoros, Mauritius and Seychelles, while Madagascar is yet to become a party.

Various measures to implement the Basel Convention are being taken. For example, Mauritius has nominated a focal point in the Department of Environment, drafted national legislation (under Section 37 of the EPA 1991 (Government of Mauritius 1991b)), ensured the availability of adequate disposal facilities for both hazardous and other waste, compiled statistics on the import and export of hazardous waste, and is taking steps to promote adoption of cleaner production or green productivity by the private sector.

The United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (CCD) has received a high degree of political commitment in Africa, and in the Western Indian Ocean where it has been ratified by all four countries. Implementation of the CCD is through national action programmes (NAPs), and sub-regional action programmes (SRAPs) a main element of which are early warning systems tied to food security and environmental monitoring. Raising public awareness, broadening the scope of consultation by opening it up to stakeholders, including civil society and NGOs, and the formation of new types of partnerships are features of the NAP.

It is not surprising that Madagascar, the country most affected by desertification, has been the most active

in this area. It organized a National Awareness Seminar on the Convention in 1997, has set up a national institutional co-ordinating body, and nominated a focal point with a view to facilitating the elaboration of a national action programme (CCD 1997 and 1998). However, in common with most countries in Africa, the NAP process has not yet been completed by any country in the region. The SADC sub-regional action programme is the one most relevant to the Western Indian Ocean, and has received support from the Convention Secretariat to strengthen the existing early warning system in the southern Africa region (CCD 1998).

The Convention on Wetlands of International Importance especially as Waterfowl Habitat, (the Ramsar Convention) requires that parties designate at least one national wetland for inclusion in the List of Wetlands of International Importance (UNEP 1997b). Only Comoros and Madagascar have ratified the Convention and designated Ramsar sites (Lac Dziani Boudouni in Comoros; Lac Tsimanampetsotsa and Complexe des Lacs de Manambolomaty in Madagascar) (Ramsar 1999). Mauritius has signed the Convention and is considering designating a bird sanctuary at Mer Rouge in Port Louis as a reserve under the existing Wildlife and National Parks Act 1993, after which it would become a Ramsar site.

The objective of the Convention Concerning the Protection of the World Cultural and Natural Heritage (1972) is to establish an effective system of collective protection of the cultural and natural heritage of outstanding universal value, organized on a permanent basis and in accordance with modern scientific methods. Madagascar, Mauritius and Seychelles have all ratified the Convention; Madagascar has one World Heritage site (Tsingy de Bemaraha) (ONE and INSTAT 1994) and Seychelles is home to two (Aldabra Atoll and the Valée de Mai Nature Reserve, home of the rare *coco de mer* (Republic of Seychelles 1997b, UNEP 1997b).

The United Nations Convention on the Law of the Sea (UNCLOS) (1982), which places upon parties the obligation to enact legislation for the prevention, reduction, and control of pollution of the marine environment, has been ratified by Comoros, Mauritius and Seychelles, while Madagascar is a signatory. Nearly every aspect of UNCLOS is relevant to countries of the Western Indian Ocean region. For these island states the living and non-living resources of the ocean are critical not only for subsistence but also for economic activities at local and international levels. Some of the provisions of the Convention such as those dealing with Exclusive

Economic Zones (EEZs) are particularly important for these island states, creating potentials for their further economic development, and more importantly providing them with the means to take an active role in the conservation and management of marine resources which are critical for the sustainability of their development efforts.

All four countries have designated EEZs, which give them sovereign rights over the resources in these areas, and the exclusive rights to explore and exploit all natural resources found therein. The Convention also requires states to manage the EEZs to prevent over-exploitation. It is essential that parties put in place the necessary laws, institutions and procedures to give effect to the convention. Although Mauritius has not passed any law giving effect to the whole Convention, provisions on marine pollution have been brought into national law through regulations, and the conservation and management of living resources is covered under existing legislation such as the Maritime Zones Act 1977. However, co-operation among the states is one of the most important factors for effective implementation. Further research is needed to establish what other measures should be introduced to fulfil the requirements of the convention, possibly at the sub-regional level through the Indian Ocean Commission.

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (The London Convention) (1972) aims to prevent the indiscriminate disposal at sea of wastes liable to create hazards to human health, harm living resources and marine life, damage amenities, or interfere with other legitimate uses of the sea. This has only been signed and ratified by Seychelles although both Seychelles and Mauritius have ratified the Convention on the Prevention of Pollution from Ships, 1973 (MARPOL), as modified by the Protocol of 1978. Mauritius has drafted regulations to implement MARPOL under Section 199 of the Merchant Shipping Act 1986 to cover all five annexes of the convention dealing with oil, noxious liquid substances in bulk, harmful substances carried in packaged form, sewage and garbage. It is also complying with the requirement to provide adequate facilities for the reception of wastes from ships, which is also being investigated by Seychelles.

All the 14 issues outlined in the Barbados Programme of Action (POA) are of relevance and importance to the region. Some countries made these issues the basis for their environmental policies and actions at national level, and most of these issues are or

were already being addressed by various national policy instruments, such as Mauritius' and Madagascar's National Environmental Action Plans (NEAPs) which were formulated in the late 1980s, the Environmental Management Plan of the Seychelles 1990–2000, and other more recent instruments and government programmes (see section on Laws and Institutions). The activities of the Nairobi Convention and the Indian Ocean Commission's Regional Environment Programme are also addressing the priority issues of the Barbados POA. However, a recognized weakness has been the lack of a regional body for the implementation of the POA in Africa, which is only now being addressed (CSD 1999c).

Although not an environmental agreement, the Fourth Lomé Convention is of considerable significance to the countries of the Western Indian Ocean, because this provides the framework for co-operation between the European Union (EU) and these countries in the areas of aid and preferential trade. Environment is one of the areas of co-operation (Articles 33–41). The key instruments of co-operation are development finance, and co-operation in the fields of trade and commodities, and the EU is the world's fifth-largest donor, with an aid budget of US\$5.3 billion (see section on financing environmental action, and Boxes 2.5 and 2.6 for more information).

Regional MEAs

Most regional MEAs seek to reinforce international conventions by filling gaps, and facilitating joint action and mutual understanding by regions in environmental policy and management. This approach allows environmental issues to be treated as 'regional commons' rather than national issues. The most important MEAs for the Western Indian Ocean are given in Box 2.2.

The principal impact of the Algiers Convention has been in the establishment of national parks, nature reserves, bird sanctuaries, game management areas and forest reserves (IUCN ROSA 1995). Madagascar is the only party to the Algiers Convention in the sub-region, while Mauritius and Seychelles are signatories. Madagascar has established over 40 protected areas, with the Ministère Rural et de la Reforme Agraire as the lead institution, and the Direction des Eaux et Forêts (DEF) and the Association Nationale pour la Gestion des Aires Protégées (ANGAP) as the management authorities.

The Bamako Convention was designed for the special social, economic and political conditions of Africa, which had not been fully incorporated into the

Box 2.2: Major regional MEAs adopted by countries of the Western Indian Ocean

- The 1968 African Convention on the Conservation of Nature and Natural Resources (the Algiers Convention) encourages action for the conservation, utilization and development of soil, water, flora and fauna.
- The 1985 Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Sub-region (Nairobi Convention) and its Protocols are designed to enable the countries of the Eastern African region to conserve and develop their marine and coastal resources, and to manage their environment in a sustainable manner.
- The 1991 Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes Within Africa is designed to create a framework for the control of hazardous waste through preventing transboundary movement or importation of hazardous wastes, and reducing their generation to a minimum in terms of quantity and/or hazard potential.
- The 1994 Lusaka Agreement on Co-operative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora aims to reduce and ultimately eliminate the illegal trade in wild fauna and flora.

operation of the Basel Convention. The opening which the Basel Convention had left for states to make their own bilateral negotiated arrangements for the export and import of hazardous wastes, if certain conditions were fulfilled, could have exposed the African environment to disturbing cases of waste importation. This convention, which entered into force on 22 April 1998, has instituted a reasonably strong structure for moral dissuasion against bilateral undertakings to introduce hazardous wastes into Africa, but lacks a separate secretariat, the interim secretariat being provided by the Organization for African Unity (OAU). Only Mauritius has ratified the Bamako Convention in the sub-region, and has drafted regulations to ban the import of hazardous waste, under Section 37 of the EPA. These regulations, which will satisfy the obligations of both the Basel and Bamako conventions, are awaiting promulgation. However, the country only imports a minimal quantity of hazardous waste, mainly in the form of heavy metals, scrap cast iron or steel.

The Nairobi Convention, whose major objective is to achieve the sustainable management of the East African environment, is directly relevant to environmental conservation and management as well as the socio-economic development of all the island states of the Western Indian Ocean. Although adopted in 1985, with

two Protocols (on protected areas, fauna and flora, and on combating marine pollution) and an Action Plan, ratification of the Nairobi Convention has been slow, and it only entered into force in 1996. The Convention, which has been ratified by Comoros and Seychelles and signed by Madagascar, is currently being revised to take into account developments since it was adopted.

Under the Convention, an Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region has been adopted. In order to support the implementation of this Action Plan, a regional co-ordinating unit was established in Seychelles in 1997, and a number of projects are under implementation, including protection and management of marine and coastal areas,

and development of a database and atlas. A transboundary diagnostic analysis (TDA) has been undertaken and a strategic action programme prepared, as well as a list of regional priority actions to combat marine pollution from land-based activities.

The importance and relevance of the Nairobi Convention to the region was recognized at the Conference on Integrated Coastal Zone Management in Eastern Africa including the Island States, held in Arusha in April 1993. As stated in the Arusha Resolution (to which Madagascar, Mauritius and Seychelles are signatories), the conference encouraged governments that had not done so to decide upon their ratification and accession of the Nairobi Convention in the shortest possible time.

Table 2.2: Reasons for the lack of implementation of MEAs

Obstacle to implementation:	Policy action required:
<ul style="list-style-type: none"> Inadequate policy framework. 	<ul style="list-style-type: none"> Harmonize national institutions and legislation that implement MEAs. Conduct a strategic impact assessment of conventions, to evaluate their social and economic as well as environmental implications and results, and to guide follow-up action. Streamline, rationalize and harmonize MEAs. Develop national and intra-regional mechanisms for implementation of MEAs. Strengthen co-operating and networking mechanisms between agencies and donors.
<ul style="list-style-type: none"> Inadequate financial resources (new and additional) – many conventions have no funding mechanism. 	<ul style="list-style-type: none"> Reallocation of national funds. Use of new and innovative funding mechanisms. Involvement of the private sector.
<ul style="list-style-type: none"> Failure of some MEAs to reflect national or regional priorities. 	<ul style="list-style-type: none"> Ensure active participation of appropriate national experts and stakeholders in negotiation and implementation of MEAs.
<ul style="list-style-type: none"> Sometimes the requirements of conventions conflict with national legislation, or are contrary to national traditions and customs, which also makes them difficult to implement. 	<ul style="list-style-type: none"> Conduct a strategic impact assessment of conventions, to evaluate their social and economic as well as environmental implications and results, and to guide follow-up action. Mobilize and enable greater involvement of national experts, NGOs and civil society in both the development and application of MEAs.
<ul style="list-style-type: none"> Lack of appropriate technical and scientific capacity, including trained and experienced personnel in various disciplines, particularly in environmental law, environmental economics and the physical sciences. 	<ul style="list-style-type: none"> Capacity building and institutional strengthening. Need for human resource development. Technology development and transfer.
<ul style="list-style-type: none"> Poverty makes enforcement difficult in the poorest countries (Madagascar and Comoros) and sometimes open to abuse e.g. in the case of CITES. 	<ul style="list-style-type: none"> Achieve sustainable human development. The sustainable management of environmental resources must include property rights and incentives as well as aim at improving the socio-economic status of the poor.
<ul style="list-style-type: none"> Duplication and overlap – a number of global and regional MEAs are concerned with similar issues, and therefore have common or overlapping activities. 	<ul style="list-style-type: none"> Conduct a strategic impact assessment of conventions, to evaluate their social and economic as well as environmental implications and results, and to guide follow-up action. Streamline, rationalize and harmonize MEAs. Need for a more systematic approach to the application of MEAs, which would be most beneficial if carried out at the regional level, while at the same time distinguishing between regional and national aspects. Strengthen co-operating and networking mechanisms between agencies and donors.
<ul style="list-style-type: none"> Lack of awareness, understanding and information among those institutions mandated to implement these agreements. 	<ul style="list-style-type: none"> Ensure active participation of appropriate national experts and stakeholders in negotiation and implementation of MEAs. Awareness raising of decision-makers and the general public. Strengthen co-operating and networking mechanisms between agencies and donors.
<ul style="list-style-type: none"> Lack of political will, and political instability both impede implementation. 	<ul style="list-style-type: none"> Ensure active participation of appropriate national experts and stakeholders in negotiation and implementation of MEAs. Awareness raising of decision-makers and the general public. Need for political and social stability.

The main objective of the Lusaka Agreement is to reduce and ultimately eliminate illegal trade in wild fauna and flora, which has given rise to large-scale poaching and the depletion of the continent's biological diversity to a level that is prejudicial to sustainable development. The Agreement has not been signed by any of the countries of the Western Indian Ocean region.

Overall trends and level of development of MEAs

MEAs are supposed to facilitate international co-operation on the management of the environment as a global resource. In view of the lack of quantitative indicators for assessing the impact of MEAs, any assessment has to be qualitative. There has been an increase in the ratification of global MEAs in recent years, which can be interpreted either as a greater awareness of environmental problems by the countries of the Western Indian Ocean, or as a response to deteriorating environmental resources. The overall trends in ratification and level of implementation of regional MEAs have been somewhat less successful. Nevertheless, the increase in activities related to MEAs, particularly the global conventions, suggest that they are having a positive impact. Although the review of the state of environmental resources in Chapter One indicated that they continue to deteriorate, it could be concluded that the level of deterioration might be much greater had actions related to the implementation of MEAs not been undertaken. Overall, the net effect is that foundations have been laid for the implementation of MEAs in the

countries of the Western Indian Ocean, but these require further development and co-ordination as significant barriers to implementation exist.

Obstacles to implementation of MEAs

Upon signature and ratification/accession to MEAs, institutions are usually designated or created to administer or co-ordinate activities generated by the Conventions, and are then supposed to proceed to enact or review legislation to create the necessary framework to implement those MEAs. However, considerable obstacles to the implementation of MEAs exist. Reasons for the lack of implementation of MEAs can be financial, institutional or technical, and are summarized in Table 2.2.

Laws and institutions

A country's constitution is the highest level of judicial norms, underlining national priorities and determining the direction and nature of future legislative policies and executive actions (Ogolla 1995). Environmental rights and responsibilities are explicitly incorporated into the constitutions of some countries in the region, such as Comoros and Seychelles. The latter has enshrined in its Constitutional Charter the protection of the environment as a human right: *'The State recognizes the right of every person to live in and enjoy a clean, healthy and ecologically balanced environment'* (Republic of Seychelles 1993, Article 38).

Table 2.3: Institutional and legal frameworks

	Principal institution dealing with environment	Principal policy instruments and legislation
Comoros	● Ministère de la Production Agricole, des Ressources Marines, de l'Environnement et de l'Artisanat	● National Environmental Action Plan (NEAP) 1994. ● La Loi-Cadre Relative à l'Environnement (Decree No.94/100/PR).
Madagascar	● Ministère de l'Environnement	● National Environmental Action Plan (NEAP) (1991–2007). ● La Charte de l'Environnement Malagache (Law No. 90.033 of 21 December 1990).
Mauritius	● Ministry of Local Government and Environment	● National Environmental Action Plan (NEAP1 and NEAP2). ● Environmental Protection Act 1991.
Seychelles	● Ministry of Environment (formerly in the Ministry of Foreign Affairs, Planning and Environment)	● Environmental Management Plan of the Seychelles 1990–2000. ● Environment Protection Act 1994. ● National Development Plan.
Regional	● Indian Ocean Commission, Regional Environment Programme (IOC/REP)	● General Co-operation Agreement Among the States of the Indian Ocean Commission, signed at Victoria, on January 10, 1984. ● Plan of Action for Regional Co-operation between the States of the Indian Ocean, adopted in Seychelles in January 1989. ● Proposed Framework Agreement for a Co-operative Regional Policy for the Sustainable Development of the Member States of the IOC (Accord Cadre pour une Politique Régionale concourant au Développement Durable des Etats Membres de la COI) to be submitted to the Heads of State of the IOC for signature in November 1999.

All the Western Indian Ocean island states have established institutional structures, passed appropriate legislation, and developed national environment policies stating the goals and objectives of, and directions and guidance for, government action for protecting the environment and for making development sustainable (Table 2.3). Some, such as Mauritius, have adopted an integrated approach to environmental management, as recommended by *Agenda 21* (Government of Mauritius 1997a).

Various legislation concerning environment and natural resource use has existed and been enacted in all countries of the region since before independence. However, such legislation was predominantly sectoral in scope, and largely use, rather than management, oriented. Because of this, each aspect of the environment – protected areas, sustainable use, regulation of hazardous processes and so on – was covered by a variety of acts and regulations. As a consequence, institutional responsibilities may be fragmented, overlap or conflict; technologies and regulatory approaches may vary. For example in Mauritius there used to be 25 distinct Acts concerning various aspects of environmental protection and natural resource management, administered by more than a dozen different government institutions. Seychelles' legislation is extremely fragmented and each aspect of environmental management may be dealt with by a variety of Acts, regulations, orders and decrees. For example, there are at least 100 pieces of legislation of relevance to biodiversity (Republic of Seychelles 1997b).

To address the *ad hoc* and fragmented nature of previous legislation governing environment and natural resources many countries have passed framework laws ('*loi-cadres*') which provide the institutional and legislative framework for the management and protection of the environment. Mauritius passed the Environmental Protection Act (EPA) in 1991, under which five ministries (referred to as the enforcement agencies) retain responsibility for enforcing environmental law (GOM/ERM 1998c). Environmental legislation was passed by the Malagasy government in 1990 through the promulgation of the *Charte de l'Environnement Malagache* (CEM). The framework environmental law of Comoros promulgated in 1994 took into account new concepts such as sustainable development, environmental impact assessment (EIA), biological diversity, protection of the terrestrial and marine environment and protected areas (RFIC 1998). Comoros also recognized the need to overhaul

legislation in a number of economic sectors in order to integrate environmental issues such as forests, flora and fauna, coastal issues, land use, pollution, and impact assessment (RFIC 1998).

While most countries in the region have suffered from a lack of co-ordinated and harmonized legislation for implementation of international environmental conventions, some such as Mauritius have made more progress in this respect (see section above on MEAs). However, enforcement of legislation is a major issue as this has historically been weak in many countries, with violations often not being prosecuted. Some of the reasons for lack of enforcement include (Republic of Seychelles 1997b):

- complicated and/or unclear legislation;
- weakness of institutions responsible for enforcement;
- low and inconsistent penalties and fines as provided in the laws;
- sanctions provided by the law are often criminal, rather than civil or administrative as in some other countries;
- kinship patterns on small islands present inherent enforcement difficulties.

One of the most important legislative instruments reinforcing the integration of the environmental dimension in development is Environmental Impact Assessment (EIA). In Madagascar, the *Etudes d'Impact d'Environnement* (EIE) is a component of both of the country's environment programmes (EPs) (Box 2.3). The MECIE Decree (*Mise en Compatibilité de l'Investissement avec l'Environnement*) sets out the general contents of an EIA, administrative procedures, modalities for public consultation, and the environmental priorities, most notably the requirement for EIAs for new practices (République de Madagascar 1997a and 1997b). Comoros' framework law anticipated EIAs for all private and public development affecting the environment, and a decree is being formulated (RFIC 1998). Seychelles has an established structure and administrative procedure for identifying and assessing the likely environmental impact of development policies and projects, but at times lacks the information base, expertise and technical and financial capacity to do so effectively. In addition, a weakness is that EIAs are legally required for all private development projects but not for all public sector projects.

In recognition of the importance of environmental issues environment ministries have been created in all the Western Indian Ocean states, usually combined with

Box 2.3: Environmental policy and management in Madagascar

The rich and unique nature of Madagascar's biological and natural resources has long been recognized, and although measures to safeguard and manage those resources can be traced back to pre-colonial times, these and more recent measures have not prevented continued degradation of the environment. Madagascar's NEAP estimated that environmental degradation drained the country by as much as US\$290 million or 15 per cent of GDP (World Bank *et al.* 1988).

Madagascar's awareness of the environment as an issue of national importance dates back to pre-colonial times, and is reflected in a number of significant actions and policies undertaken:

- 1960s: participation in UNESCO's Man and the Biosphere (MAB) programme.
- 1970: hosting of an international conference on the utilization and conservation of natural resources.
- 1984: adoption of the Malagasy Strategy for Conservation and Sustainable Development as defined in the National Conservation Strategy, and at the same time the creation of a National Council for Conservation through Development.
- 1990: promulgation of the Charte de l'Environnement Malagache (La CEM), which defined the National Environmental Policy (NEP), accompanied by a National Environmental Action Plan (NEAP) implementing priority projects through environment programmes (EPs).

An institutional framework was established, which comprises:

- a decision making body: Inter-Ministerial Committee for Environment;
- a consultative body: National Council for Environment;
- an executive agency: the Ministry of Environment;
- a management and coordination body: the Office Nationale pour l'Environnement (ONE); and
- executing agencies: (eg l'Association Nationale pour les Actions Environnementales (ANAE), l'Association Nationale pour la Gestion des Aires Protégées (ANGAP), le Centre de Formation en Sciences des informations Géographiques et Environnementales (CFSIGE), le Ministère des Eaux et Forêts, etc.).

Madagascar's NEAP, one of the first in Africa and in the world, is being implemented over 15 years (1991–2007) and is divided into five-year programmes. The first programme (EP1) had an implementation rate of about 40–45 per cent of funds received, for a number of reasons including the limited absorption capacities of the executing agencies (République de Madagascar 1997b). The second programme (EP2 1997–2001), being implemented with approximately US\$156 million of multi-donor funding, has the following components:

- | | |
|----------------|---|
| Strategic: | - Investment impact studies/legislation (Mecie/Législation) |
| | - Policies, strategies and instruments (PSI) |
| Specialized: | - Multiple use of forest ecosystems (ESFUM) |
| | - Protected areas and ecotourism (CAPE) |
| | - Soil and water conservation management (GCES) |
| | - Marine and coastal environment (EMC) |
| Cross-cutting: | - Local management of renewable resources (GELOSE) |
| | - Support to regional management using a spatial approach (AGERAS) |
| | - Regional funds for the support and management of the environment (FORAGE) |
| Support: | - Communication |
| | - Education and training (EF) |
| | - Geographic information (IG) |
| | - Environmental research (REF) |
| | - Support to programme co-ordination and management |

Although more qualitative than quantitative, the following statement illustrates the impact of these policies:

'In the late 80s, Madagascar's government and the international community became weary of the accelerated loss of its natural heritage. This once lovely island had been called Green Island (Nosy Manga); but, with the primary forest disappearing and soils rapidly eroding, sub-Saharan Africa's largest island had become the Red Island (Nosy Mena). In response, the Malagasy Government created a National Environmental Action Plan (NEAP) and put in place the right institutions to manage environmental matters, protect ecologically sensitive areas and support local initiatives. Large tracts of land have now been reforested and many reserves are now properly managed. Although a lot more needs to be done, the government and civil society have created a structure to channel assistance to the local stakeholders, where these resources matter most.' (World Bank 1997).

Sources: ONE and INSTAT 1994; République de Madagascar 1997a and 1997b; World Bank *et al.* 1988, World Bank 1997.

existing ministries such as agriculture or transport. In addition, a number of other new and subsidiary institutional structures have been created to support the operation of these key institutions, such as:

- high-level inter-ministerial committees or commissions (Comoros, Madagascar and Mauritius) made up of key ministers and often

chaired by the prime minister to provide high-level policy co-ordination;

- a co-ordinating body such as an environment co-ordination or steering committee which co-ordinates all public departments engaged in the protection of the environment to ensure maximum co-operation between enforcing agencies and other public departments (Seychelles);

- an advisory board made up of representatives from industry, NGOs, unions, educational institutions, civil society, the media and political parties, which provides advice to the Minister of Environment in order to strengthen the process of democratic decision-making and environmental accountability such as the Environment Advisory Council of Mauritius;
- environmental appeals tribunals which give proponents and complainants a chance to voice their opinions regarding decisions (Mauritius);
- regional consultative committees, environmental services and programming committees (Comoros and Madagascar).

Attempts have also been made to decentralize or regionalize environmental management, for example in Madagascar and Comoros through regional environmental services and consultative committees. Decentralization is playing a prominent role in Madagascar's second environment programme (EP2), with the decision that all executing agencies should decentralize decision-making. Seychelles plans to transfer some environmental responsibilities from the central government to 22 District Authorities, which will each establish an Environmental Management Unit (Republic of Seychelles 1997a). In Mauritius, where decentralization is less developed, collaborative arrangements are often made between the Department of Environment and local government in areas of shared responsibility such as conservation and preservation of cultural and architectural heritage, landfill sites, transportation of solid wastes, construction of sewer lines, and natural and industrial disasters.

All the countries in the region have produced and are implementing National Environmental Action Plans (NEAPs), which provide the framework for environmental management in the context of a country's overall economic and social development. Madagascar was one of the first countries in Africa to do so, in 1988, and is currently implementing its second five-year environment programme (EP2) under the NEAP (Box 2.3). Mauritius concluded its first ten-year NEAP in 1998, and is preparing its National Environment Strategy for the next decade (1999–2008) which includes a new NEAP (NEAP2) and Environment Investment Programme (EIP2) (GOM/ERM 1998c) (see also section on financing environmental action). The Seychelles National Development Plan (1990–94) was the starting point in an attempt to integrate environmental and

natural resource management issues into all the relevant economic sector strategies, policies and programmes (Republic of Seychelles 1990). This was complemented by the Environmental Management Plan of Seychelles (EMPS) 1990–2000, which constitutes the framework for action, assesses the state of the environment and sets priorities for the most effective use of limited funds, facilities and staff. The Government of Seychelles has started the process to assess the EMPS as well as designing a new management tool for 2001–2010, which will include significant stakeholder participation. Comoros formulated a NEAP in 1994 (RFIC 1994) with the objective of adding to the country's knowledge of its natural heritage, decentralizing the public sector, training technical specialists and ensuring concerted management of its heritage (RFIC 1998).

Economic instruments

Economic instruments (taxes, subsidies, charges, fees, deposits and bonds) aim to overcome market failures by internalizing externalities, and provide incentives that steer behaviour towards environmentally desirable actions. Although they have not been widely used so far, there are a number of examples of their application in the Western Indian Ocean countries. The considerable scope for proper pricing of scarce environmental resources, moving away from command-and-control mechanisms towards the use of taxes, charges and incentives to change behaviour, has been recognized by most governments in the region (Figure 2.1) (Republic of Seychelles 1997b; COI 1998b).

Charge and fee systems can be used to generate revenues for further investment. In Seychelles, government revenues, taxes and fees associated with natural resources such as biodiversity represent one-third of current government revenues from domestic sources such as airport taxes, bed-night levies, protected area revenues, fish licences, forest produce sales, giant tortoise revenues, tree felling permit revenues, and port expenditures (Republic of Seychelles 1997c). Airport taxes and park entry fees are already paid by tourists and visitors to Seychelles, while hotels have to pay a bed-night levy to the government. In many cases, however, these revenues do not flow to the institutions responsible for environmental management, but go directly to the Treasury.

Since 1992, within the framework of the implementation of Madagascar's first environment programme, the sustainable development of biodiversity

through ecotourism has been an important component, and has yielded benefits to communities bordering the protected areas concerned (Ranomafana, Isalo, Andasibe, Mantadia, Masoala and Nosy Mangabe). Fifty per cent of receipts from entry fees to these protected areas is used for micro-projects identified by the communities themselves – amounting to Fmg 972 million over the period 1992–97 (République de Madagascar 1997a and 1997b). In addition, certain user rights have been established for the local populations in about one-third of the protected area network (République de Madagascar 1997b). The Ulanga village associations in Comoros collect entry charges to turtle nesting sites and beaches which the associations monitor and protect.

In Mauritius, a proposal for the introduction of a green tax was made in 1996 but this was not implemented. Nevertheless, there are indirect incentives in the form of tax credits for importation of pollution abatement facilities to encourage industry to invest in new production equipment and machinery and in anti-pollution and protection. Mauritius has also adopted the ‘polluter pays principle’ (PPP) in the form of fines and recovery of expenses for the clean-up or removal of a pollutant, which should act as a disincentive if properly implemented. Seychelles has implemented a refundable deposit scheme levied on

organizers of public events for waste disposal and clean-up; this could be extended to other activities, for example to cover beach waste deposits, or as refundable mooring fees to minimize reef damage (Republic of Seychelles 1997b).

In its effort to sustain its pristine environment, the Seychelles government had planned to introduce a ‘Gold Card Strategy’ in November 1999. The Gold Card would give visitors entry to national parks and nature reserves. It was to be obligatory for all first-time visitors to Seychelles, was to cost US\$100 and be valid for life. The Gold Card was Seychelles’ way of applying the precautionary principle and the polluter pays principle, as the funds generated were to go directly towards the maintenance of parks and the airport. However, due to negative reaction from tour operators and those in tourism related businesses, the Gold Card is now to be introduced as an option rather than as a compulsory strategy (Republic of Seychelles 1999).

Madagascar is the only country in the region to have attempted green or environmental accounting, with the objective of incorporating the real value of environmental resources, as well as their depletion and degradation, into the system of national accounts (SNA). Water and forest resources were examined in an initial analysis. Because this is a relatively new concept requiring further

Figure 2.1: Economic instruments for biodiversity conservation

	Market creation	Fiscal instruments	Charge systems	Financial instruments	Liability systems	Bonds and deposits
Tourist activities	Increased enterprise and sales		Entry, landing, use fees			Beach waste deposits, refundable mooring fee
Fisheries activities	Fishing quotas	Differential activity and equipment taxes	Variable license fee scale			
Industrial pollution	Tradeable pollution permits, netting	Effluent charges, pollution taxes, technology subsidies	Waste collection and disposal charges, wastewater treatment charges	Loans to clean technologies	Environmental liability	Refundable waste deposits, hazardous chemical bonds
Urban and construction	Transferable development rights	Differential property and land-use taxes, subsidies to revegetation	Waste collection and disposal fees	landscaping loans, sewerage loans		Reafforestation and restoration bonds
Biodiversity utilisation	Farming, new product uses and value-added	Product taxes, subsidies to alternative enterprises	User charges	Loans, compensation for alternative enterprises		

Source: Republic of Seychelles 1997b

development, the difficulties of valuing certain environmental goods and services, and the need for more precise data and systems of management and analysis, further work is required (ONE 1997). The need for environmental accounting and appropriate tax laws, penalizing polluters and financing environmental protection, has also been recognized by the Government of Seychelles (Republic of Seychelles 1997a).

Direct and indirect subsidies lead to distortions in resource use, and are not consistent with *Agenda 21*. Little has been done to ensure proper resource pricing through the removal of subsidies, although such concerns have been recognized, for example in Mauritius over the subsidizing of water for consumption and irrigation, as well as sale of land in the coastal zone below market price (GOM/ERM 1998c).

Industry and new technologies

The countries of the Western Indian Ocean are not highly industrialized, and there are no power-intensive industrial sectors. Comoros is one of the least industrialized countries, with industry (mainly agro-processing and energy generation) accounting for only 10 per cent of GDP (UNDP 1998; RFIC/PNUD 1997). This compares with an average contribution to GDP of 25 per cent for sub-Saharan Africa. Industry only contributes 13 per cent to GDP in Madagascar (12 per cent being manufacturing), (ONE 1997a). The contribution of industry to GDP in Seychelles is 21.5 per cent, with the sector dominated by light industry for import substitution, the processing of natural resources such as fish for the export market, and energy which is generated entirely from imported petroleum (UNDP 1997b). Mauritius is the most industrialized country of the sub-region, with industry contributing 33 per cent of GDP. Manufacturing, which accounts for 23 per cent, is dominated by sugar processing, clothing and textiles (World Bank 1998a UNDP 1997a).

Although no country has adopted a comprehensive approach to the introduction of cleaner production technologies and processes, some measures are being implemented in Madagascar, Seychelles and mostly by Mauritius in industrial processes, energy generation, renewable energy, and vehicle pollution. In 1996, the Seychelles Ministry of Industry introduced its Industrial Policy and Strategy for Local Industries, one of the principal aims of which is maintaining Seychelles free of heavy industries which may destroy the fragile and pristine environment. The policy sets out to promote

industrial investments that are not environmental and/or health hazards, and EIAs are required to ensure that future manufacturing activities are environment friendly. Madagascar has recently developed a policy for Environmentally Sustainable Industrial Development (ESID) which, if properly applied, would assist the country to avoid many of the problems associated with industrialization (Box 2.4).

Modernization of the industrial sectors is being promoted using incentives, financial assistance, and provision of support services. Various incentives exist for investment in anti-pollution and environmental protection technology, and fiscal incentives in the form of pioneer status certificates and Strategic Local Enterprises under Mauritius' Industrial Expansion Act of 1993. To achieve its policy objectives, the Government of Seychelles is providing support to industry through tax and social security concessions, various forms of financial assistance, and assistance with appropriate science and technology (Republic of Seychelles 1997a). Mauritius is also promoting state-of-the-art technology through a number of new institutions dealing with research, information and technology development. In Madagascar a number of measures have been taken to reduce pollution by government and industry, including installation of ventilation systems and environmental protection equipment to deal with pollution within the factories, installation of incinerators for industrial waste, and also using waste for fertilizer. Preliminary measures have been taken by some industrial enterprises to purify their industrial waste water, including treatment by decantation in settling pools: however, these are still likely to be insufficient (ONE 1997b).

One of the main cleaner production initiatives has been the ILO/UNEP Technology Development Project in Mauritius, implemented by the Mauritius Employers Federation (MEF). Four enterprises in tourism, textiles, sugar production and food processing have been participating, and the results demonstrate that cleaner production is a cheap and easily adaptable method of achieving good industrial environmental management, available to any size of enterprise. Mauritius is also applying the use of preventative measures such as linking the rationalization and modernization of the sugar industry to the development of cleaner technology, and the adoption of an integrated environmental management strategy.

Standards, certification and accreditation schemes also provide incentives for enterprises to adopt newer, cleaner technologies and processes. The Government of

Mauritius is providing facilities to assist enterprises to become 'greener' through local accreditation and certifying bodies. The Seychelles Investment Promotion Act allows new investment activities in the industrial sector to qualify for Certificates of Approval (COAs), with benefits including zero rate taxes on importation of machinery, equipment and raw materials. Both Mauritius and Seychelles are promoting the adoption of the International Standards Organization (ISO) standards. The Seychelles Bureau of Standards (SBS) was established to assist industries achieve the levels of quality assurance and quality control necessary to obtain ISO 9000 certification. Mauritius has been promoting ISO 9000 and ISO 14000 series through the Ministry of Local Government and Environment (MLGE), the Mauritius Export Processing Zone Authority (MEPZA) and other organizations. So far, many enterprises have adopted the ISO 9000 series standards but only two have adopted the ISO 14000 series. As a precursor to the eventual adoption of the ISO 14000 series the MLGE is planning the introduction of industrial waste audit regulations to encourage industries to self-regulate and adopt cleaner technologies.

One of the main areas of industrial activity and sources of pollution is energy generation and use, and various measures are being taken to encourage the use of cleaner technologies and renewable energy. The Seychelles Energy Affairs Bureau has examined renewable energy sources and energy saving because of the high cost of imported energy and insufficient generating capacity. All possible sources of renewable energy (biomass technology, biogas, solar crop drying, solar water heating, photovoltaics, wind, ocean thermal energy conversion, wave/tidal power, mini-hydro and activated charcoal) have been assessed. The Bureau concluded that only solar water heating has good potential for further development, and it is encouraging households to use solar power through the dissemination of information on the available equipment and technology. In addition, the considerable scope for substantial energy savings by modifying energy consumption patterns has been recognized (Republic of Seychelles 1997a).

Schemes to encourage the general public to adopt cleaner technologies have been implemented; for example soft loans are provided for investment in domestic solar water heaters in Mauritius, and 7 000 applicants have benefited from the scheme. Switching from the use of kerosene to LPG has been promoted in Seychelles, including the distribution of free gas

Box 2.4: Environmentally sustainable industrial development in Madagascar

Industry in Madagascar is still undeveloped, with the main industries being textiles, mining, essential oils, construction and food processing. Industrial pollution currently only affects certain areas. Between 1995 and 1998, the United Nations Industrial Development Organization (UNIDO) assisted the government to implement a new policy for Environmentally Sustainable Industrial Development (ESID). The objective was to strengthen Madagascar's technical and institutional capacity to design and implement a strategy for ecologically sustainable industrial development. The programme worked on two levels:

1. formulation of environmental regulations and norms for industrial production, with special emphasis on industrial waste;
2. establishment of a unit in the Ministry of Industry and Craft specialized in monitoring and advising on environmental issues.

The programme has achieved a number of results:

- 50 professionals from government and industry have been trained in pollution prevention, waste minimization, and monitoring and controlling industrial waste.
- A specialized unit for controlling industrial pollution has been established in the Ministry of Industry and Craft and is fully operational.
- A law for the management and control of industrial pollution has been formulated and was submitted for government approval in 1997. This is the first legislation designed to curb industrial pollution in Madagascar.
- Two laboratories have been designated to monitor environmental indicators.
- An information network has been established, which provides data and information on industrial pollution abatement and cleaner technologies.

The ESID was a tangible result of the legislative component of EP1, which requires the systematization of EIA in all investments. With this policy and institutional measure, Madagascar has the foundation for environmentally sustainable industrial development which should help it avoid the environmental problems being experienced by more industrialized countries.

Sources: UNIDO 1999; République de Madagascar 1997a.

cookers to households, while energy efficient stoves are being promoted in Comoros. One aspect of Madagascar's energy policy relates to the sustainable development of new and renewable sources of energy, including reforestation, and self sufficiency in energy (République de Madagascar 1997a). The country is also planning to explore the conversion of waste into biogas (ONE 1997a).

A GEF-funded project was carried out in Mauritius from 1992 to 1997 to develop and test technologies for using sugar cane residues (bagasse) as fuel to expand power generation by existing sugar mills, and to harness the long-term potential of power generation from sugar cane waste. Results included 30 per cent increased efficiency of bagasse power production, and bagasse power exports to the electricity grid were nearly doubled. Overall the project achieved the global environmental objectives for which it was designed, as well as providing benefits at national level (GEF 1998).

Vehicle emissions are one of the principal sources of

atmospheric pollution, particularly in urban areas. In some countries, such as Madagascar, old used vehicles are imported for sale, and are often badly maintained due to the high cost of spare parts. Measures that could be taken to deal with this problem include financial incentives provided to owners to replace old, severely polluting vehicles with new less polluting ones, as was done in Mauritius. Madagascar has established better, high-performance equipment in vehicle inspection centres, enabling stricter inspections and control of public and commercial vehicles to be carried out. The levels of lead in the atmosphere throughout the capital are being monitored, particularly within the two road tunnels, to act as an early warning of when the levels of heavy metals exceed the World Health Organization (WHO) recommended levels (ONE 1997a).

Financing environmental action

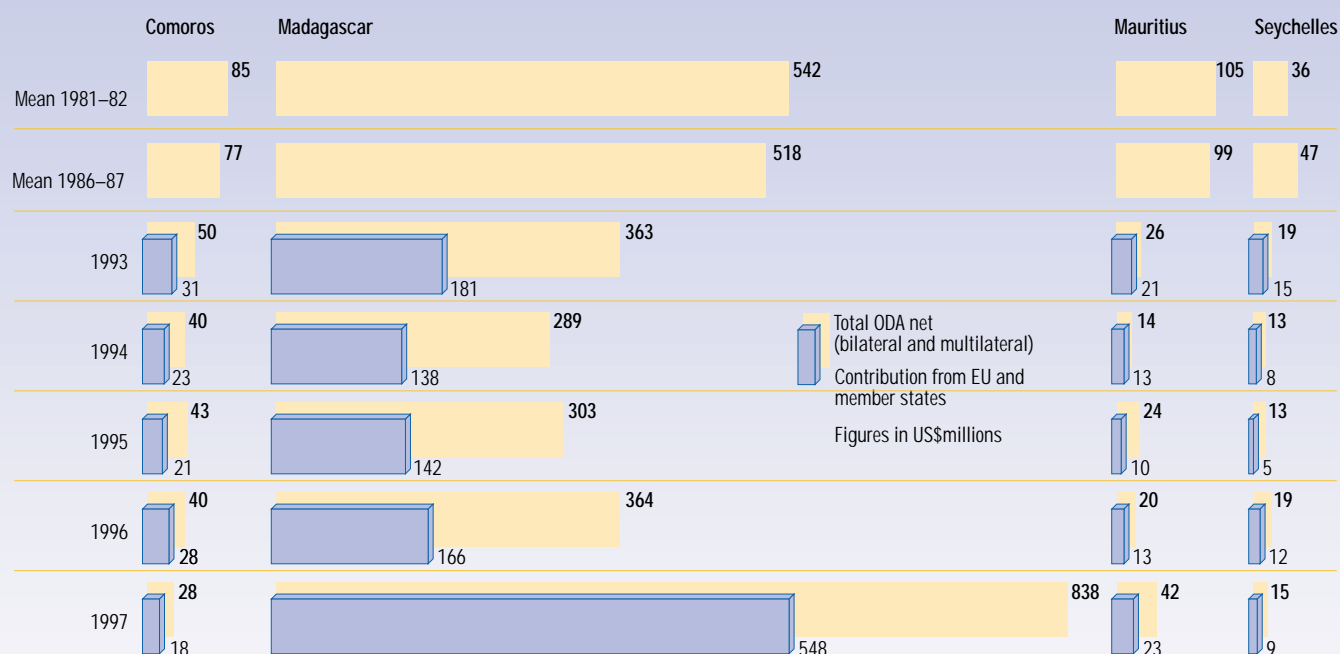
Agenda 21 recognized that developing countries, especially the least developed such as Comoros and Madagascar, would need substantial new and additional funds for the implementation of sustainable development, and that official development assistance (ODA) should be a main source of funds for these countries. Other sources include the public and private sectors, debt reduction and

innovative financial mechanisms such as economic instruments, joint implementation programmes, and national and international environment funds.

For the least developed countries, such as Comoros and Madagascar, ODA is a main source of external funding, and is essential for the effective implementation of *Agenda 21*, which cannot generally be replaced by private capital flows (Report of the UN Secretary General, in Osborne and Bigg 1998). Although globally ODA has been declining throughout the 1990s, both in real terms and as a percentage of GNP, the picture for countries of the region is somewhat mixed (Figure 2.2). ODA to Comoros declined steadily up to 1997. By far the biggest recipient of ODA in the region is Madagascar, and although ODA declined up to 1996, 1997 showed an increase of 230 per cent to US\$838 million. Similarly, total ODA to Mauritius declined to 1996, and then more than doubled in 1997. Seychelles receives the least ODA of all the countries in the region. The EU and its member states are by far the most important donors in the region, providing between 55 and 65 per cent of all ODA.

Overall, there have also been changes in the composition of ODA, with a reallocation of aid towards those sectors with a greater share of public goods, and increasing aid to countries with good policies (World

Figure 2.2: Total ODA net (bilateral and multilateral) and EU contribution (US\$ millions)



Sources: OECD 1999a; OECD 1999b.

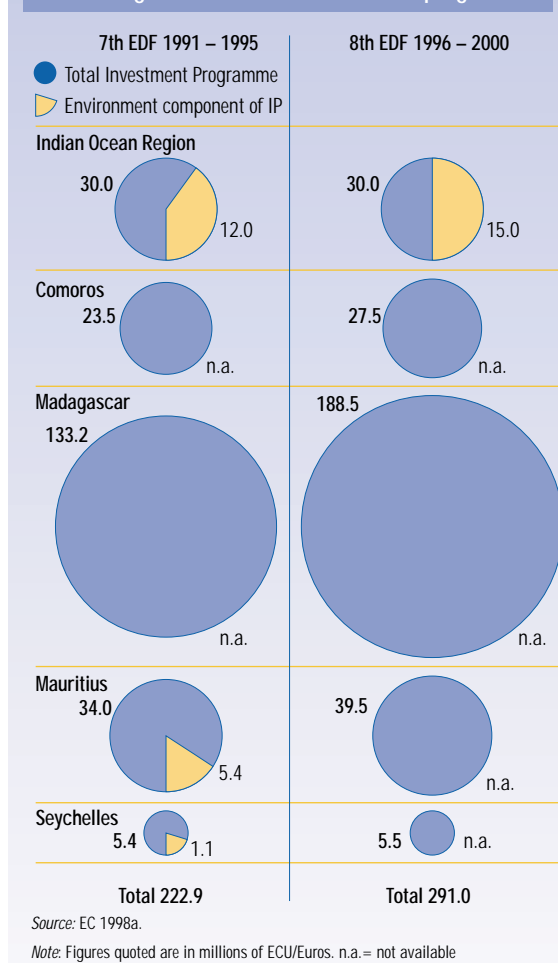
Bank 1999). The data available, which are fraught with shortcomings, indicate that globally the shares of bilateral ODA commitments for the conservation and management of resources have risen over the period 1990 to 1996 in total and percentage terms, while multilateral ODA commitments in this sector have fallen over the same period (CSD 1998).

EU development co-operation in the Indian Ocean is within the framework of the Lomé Convention (Lomé IV) and covers all four countries. The EU is the world's fifth-largest donor, with ODA of US\$5 261 million in 1997 (OECD 1999a), and environmental protection forms an important area of EU co-operation. The regional indicative programme (RIP) and two of the four national indicative programmes (NIPs) under the 7th European Development Fund (EDF), have environment as one of the priority focal area for support. The allocations for the Indian Ocean Regional and National Indicative Programmes for the period 1991–95 and 1996–2000 are given in the Figure 2.3.

Forty per cent of the RIP (7th EDF), or €11 million, is devoted to funding the Regional Environment Programme currently being implemented by the Indian Ocean Commission (REP/IOC) (Box 2.6). Under the 8th EDF, 50 per cent of the RIP, or €15 million, is going to fund the management and protection of natural and maritime resources. For Comoros and Madagascar, the poorest countries in the sub-region, the priorities under the NIPs are support to rural development and transport infrastructure. Environmental protection is a priority in the EU's development co-operation with Comoros, Mauritius and Seychelles, under the 8th EDF (1996–2000) (EC 1998a).

There have recently been unexpectedly large increases in private capital flows to developing countries, including foreign direct investment (FDI). In the region, private sector flows are most significant in Mauritius, where they totalled US\$261 million in 1997. In Madagascar they were very low or even negative between 1991 and 1996, indicating capital flight, but then jumped to US\$192 million in 1997. The picture in Seychelles has been very variable, from a high of US\$72.6 million in 1994 to a low of US\$-9.6 million in 1995, rising to US\$30 million in 1997. In Comoros private sector flows have fallen from a high of US\$2.8 million in 1991 to a low of US\$-1 million in 1995, recovered slightly in 1996 at US\$0.7 million but fell again to US\$-0.1 in 1997 (OECD 1999b). A country such as Comoros is unlikely to benefit significantly because of its high level of indebtedness, which has a negative

Figure 2.3: EU co-operation in the Western Indian Ocean: regional and national indicative programmes



effect on domestic investment, including the investment necessary to attract private capital (CSD 1997). Although it is impossible to say how much if any of these private capital flows might be financing environmental action, directly or indirectly, for countries where they are significant, private capital flows are an important source of finance to be harnessed in the future.

Despite their high level of indebtedness, neither Comoros nor Madagascar have been participating in the Heavily Indebted Poor Countries (HIPC) Debt Initiative, which focuses resources on countries with a solid track record of performance (World Bank 1999). In 1996, Comoros' medium and long-term debt was 98 per cent of GDP, therefore efforts to reduce indebtedness are still badly needed (PNUD 1998).

With regard to financing from countries' own public resources, one indicator of the importance being placed by governments on the environment could be the amount and proportion of a government's budget being devoted

to this sector. Under Seychelles' Public Sector Investment Programme (PSIP), the environment sector moved from 20th to 10th position on the list of public sector capital expenditure between 1993 and 1994. Expenditure rose from SR225 million in 1993 to SR4686 million in 1994; an increase from 0.08 per cent of total public sector capital expenditure to 2.5 per cent, at a time when overall public sector capital expenditure fell by 32 per cent (Republic of Seychelles 1997a).

There has been a significant increase in the number of national institutions established and actions being implemented to deal with environmental issues in all countries of the sub-region, demonstrating increased political and financial commitment to this sector. All the

countries have prepared, and are implementing, NEAPs and national investment programmes which list priority environmental projects, funded from public and donor sources. Seychelles' Environment Management Plan 1990–2000 includes 60 projects dealing with environment and natural resource priorities, 24 of which were to be implemented by the Ministry of Environment. Mauritius' first Environment Investment Programme (EIP1) which ended in 1998, comprised about 30 projects geared towards the protection and sustainable use of resources, including projects dealing with land use planning, solid waste management, control of industrial pollution, and protection of the aquatic environment. The indicative total cost of the first five

Box 2.5: Small Island Developing States (SIDS) and the Lomé Convention

Lomé Convention

The Lomé Convention, which for the past 25 years has been the framework for the European Community and its African Caribbean and Pacific (ACP) development co-operation partners, has from the very beginning taken into consideration the obstacles particularly hampering the SIDS¹. Out of the 71 ACP countries 26 are independent island states² and 17 of them³ fall under the category of least-developed ACP States, which entitles them to special treatment under the Convention⁴. When compared with other ACP regions the island states have derived considerable benefits *per capita* from the European Development Fund (EDF) allocations⁵. In addition, for several island ACP countries the trade protocols of the Lomé Convention on sugar, bananas and rum have provided privileged access to the European market, and also indirect price support for these products. In order to assist some SIDS to diversify their mono-producer economies, the EU is supporting some banana and mineral producers with EDF and budget line assistance. Good examples of this are Jamaica and the Windward Islands.

Lomé and Environment

Lomé IV embodied for the first time in 1991 environmental objectives stating that 'development shall be based on a sustainable balance between its economic objectives, the rational management of the environment and the enhancement of natural and human resources' (Art. 4) and a new Title I on Environment spelled out the principles, priorities and procedures for integrating 'environmental aspects' into all other Lomé operations. It did not however set any quantitative targets and as EDF 7 was programmed just prior to the Rio Conference, it is unreasonable to expect the Rio commitments to be fully reflected in the EDF national indicative programmes for 1990–95. The integration of the environment dimension into EC development co-operation takes place at three different levels: direct financing of projects and programmes with specific environmental objectives; environmental concerns in the overall dialogue with the partner countries; and through efforts to ensure that overall development and economic co-operation activities integrate environmental issues, in particular by using Environmental Assessment tools.

In 1996, the EC initiated a comprehensive independent evaluation of the environmental performance of its programmes in the developing countries. It was concluded that, in the period of 1990–1995, the overall environmental performance of EC programmes was relatively

low compared to the extensive policy objectives. Only a few ACP countries included environment into their National and Regional Indicative Programmes as a cross-sectoral issue at the strategic level, although almost all rural development programmes incorporated natural resource management. However, it was also indicated that improvements have been set in motion since 1990 through the design of specific strategies and through a more systematic use of Environmental Assessment tools and the integrated Project Cycle Management. In late 1993 the Commission introduced formal procedures, which became mandatory in 1996, for assessing the environmental implications of project proposals and for integrating environmental factors during the project cycle. Over the period 1990–1995, Environment Impact Assessment (EIA) procedures were rarely applied, although those actually undertaken being of a high quality. In 1998, the various departments of the Commission involved in economic and development co-operation started a comprehensive review to update and harmonise the EIA procedures and guidance. Strategic environment assessments will be introduced during policy formulation and country programming. However, since Lomé Convention is a partnership agreement, the success of environmental policies depends only in part on incorporation of priority objectives into the design of EC programmes. More importantly, it depends on the commitment of ACP governments to these objectives in their respective national and regional indicative programmes.

Post-Lomé

The current Lomé IV Convention expires 29 February 2000 and negotiations with a view to concluding a new development partnership agreement were started in September 1998. In 1996 the European Commission published its Green Paper on the future ACP-EU relations launching the debate on the thorough review of the present Convention. The Paper observes that the relationship between the EU and the ACP countries will enter a new phase, that this renewed relationship will have to be based in the new global reality and that the innovations introduced will have to increase the efficiency of the co-operation programme. It also identifies some special aspects of importance to the SIDS: the challenges of further regional integration and transition to a competitive economic environment; problems such as political transitions, heterogeneous economies within the region, lack of human resources, migration and drugs⁶; and stresses the attention to be given

years of NEAP2 has been estimated in the region of US\$10–11 million, small compared to the estimated cost of environmental damage in Mauritius, which has been estimated to be at least US\$120 million per year (GOM/ERM 1998c).

Probably the clearest picture regarding the financing of environmental action at national level is given by Madagascar, but it is also the least typical. Environmental activities have been implemented in a highly co-ordinated manner since 1991 under the NEAP's two environmental programmes (EP1 and EP2). The budget for EP1 was approximately US\$150 million, and for EP2 is US\$155 million, from government and multi-donor sources (bilateral and multilateral). Under EP1 the government

contribution was in the region of 20 per cent, with the balance from donors and other sources. However, the rate of implementation of investments for EP1 was only about 42 per cent, or US\$71.5 million over seven years (1990–96), making an average of US\$10 million spent per year (Republic of Madagascar 1997b). The main reasons for this low rate of implementation are linked to the time taken to establish the executing agencies, and develop their capacities, as well as political events in 1991 (République de Madagascar 1997a and 1997b).

Environment funds are innovative financing mechanisms that can pool revenues from various types of resources (earmarked taxes and charges, concessional grants or loans, debt-for-nature swaps, interest on

to problems relating to transport, communications, environment and preservation of natural resources.

On the surface the EU and ACP agree on the principles and objectives of future co-operation: strengthened partnership through deeper political dialogue – a partnership geared towards poverty reduction, sustainable development and further integration of the ACP into the international economy. Both mandates recognise the need for 'differentiation' between ACP countries (e.g. by providing special treatment to least-developed countries and vulnerable land-locked and island countries).

However, the aspirations of designing a simple, leaner and user-friendly agreement, are not necessarily focused on same priorities. The Commission's mandate translates the commitment of radical review of the existing Convention into four main priorities. First, to rationalise and simplify existing instruments by grouping all resources for long-term development into a single facility (including structural adjustment, Stabex, Sysmin, decentralised co-operation etc.). Second, to restore the centrality of programming while linking resource allocation to performance. Third, to move away from projects towards support for sectoral reforms and, if conditions allow, direct budget aid. Fourth, to introduce the concept of differentiation in resource management. The ACP reform agenda looks quite different. There is much insistence on reducing delays; improving transparency; simplifying aid instruments; clarifying the division of roles and reducing the adverse effects of aid on local institutions and capacities. The focus is on improving day-to-day management, less on changing the rules of the game. The three main proposals of the ACP group differing from the EU mandate are: more time before making changes; retain as much as possible of the current agreement; and a fairer deal – the ACP call for existing access for agricultural goods to be improved, whereas EU is not prepared to settle the case before negotiations on the future trade arrangements (REPAs), maintaining the current access provisions until the new agreement.

Generally, the ACP seem more 'conservative' than EU. The principles that the ACP promote are: local ownership of reforms; Predictability and security of resources; Partnership with more explicit allocation of responsibilities; Simplification and rationalisation of instruments and Flexibility in programming. As for the actors in partnership, in its negotiating mandate the ACP Group is rather vague about the nature and modalities of the private sector involvement

whereas for EU extending partnership to a wide range of actor seems to be a political priority.

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- ¹ Art. 335 Lomé IV Convention
- ² Western Coast of Africa: Cape Verde and Sao Tomé & Príncipe; the Caribbean: Antigua and Barbuda, Bahamas, Barbados, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, St. Christopher & Nevis, St. Vincent & the Grenadines, St. Lucia and Trinidad & Tobago; Indian Ocean: Comoros, Madagascar, Mauritius and Seychelles; South Pacific: Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu
- ³ Antigua and Barbuda, Cape Verde, Comoros, Dominica, Grenada, Haiti, Kiribati, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sao Tome and Principe, Seychelles, Solomon Islands, Tonga, Tuvalu, Vanuatu and Samoa
- ⁴ Art. 329 Lomé IV bis
- ⁵ The total funds provided by the EC to island developing states for the period 1976–1995 were 4447 MEURO. For the period 1996–2000 (Lomé IV bis) the package foreseen for the National and Regional Programmes amounted to 1024 MEURO.
- ⁶ Green Paper p. 21

endowment funds, and so on) to provide long-term funding for environmental programmes. The success of environment funds is reflected in their growing number (CSD 1997). Environment funds based on contributions by government, GEF, industry and other private sector sources, have been created in Madagascar, Mauritius and Seychelles, (Miktin 1995; GOM/ERM 1998c) and one is planned in Comoros under its NEAP (RFIC 1994) but the operational modalities need to be established under a government decree.

The Seychelles Environment Trust Fund has been established under the GEF-funded Biodiversity Conservation and Marine Pollution Abatement Project. The fund is operated by the Seychelles Island Foundation which manages the two World Heritage sites (Aldabra, the world's largest coral atoll, and the Vallée de Mai National Park) (Republic of Seychelles 1997b; Miktin 1995). The Trust Fund brings together all those who have a stake in environmental protection, as its Board comprises representatives from the government and the private sector (Republic of Seychelles 1997b).

Madagascar has used a number of innovative measures to generate new additional resources for environmental conservation and management. One mechanism is debt-for-nature swaps used to convert some of the country's external debt into a domestic obligation to support environmental activities and programmes. The first such agreement was between the Government of Madagascar and WWF-US in 1989, when US\$2.1 million of debt was exchanged. Since then a number of such debt-for-nature swaps have been concluded with international conservation groups including WWF-US and Conservation International, under the country's Debt-for-Nature programme which was part of the NEAP (République de Madagascar 1997a). The funds generated have been used to support environmental education, sustainable development, conservation and ecosystem management of protected areas, inventories of endangered species etc. They have also been used to establish endowment funds, with the interest earned used to finance conservation activities (Dogsé and Droste 1990, quoted in WCMC *et al.* 1992). Under the FORAGE

Box 2.6: The Western Indian Ocean and the Lomé Convention

Regional co-operation

Regional co-operation under the Lomé Conventions shall promote long term collective and self-reliant, self-sustained and integrated social, cultural and economic development and greater regional self-sufficiency. In recognition of regional co-operation as a special feature of the four Lomé Conventions, over 10% of the Lomé funds have been set aside for projects dealing with issues of interest to groups of ACP states on a regional basis. This funding is additional to national allocations.

Since Lomé III, regional co-operation programmes have been signed between the European Community and the Indian Ocean Commission (IOC). Under Lomé I and II, Community aid (€30 million) was mainly concentrating on alleviating problems resulting from the huge distances between the eight ACP countries by implementing projects in the field of transport (air and sea) and contributed to enhancing regional assets: fishing and trade. Lomé III Regional Indicative Programme funds (€29 million) were earmarked for maritime and natural resources management, meteorology, external trade and tourism.

The Lomé IV Regional Indicative Programme, which is supported with €30 million from the 7th European Development Fund (EDF), concentrates on the environment and external trade. An €11 million project is under way in the environment sector and external trade will receive a boost with an €9.3 million project for the promotion of trade exchanges. In non-focal sectors, four other projects have been approved in the fields of telecommunications, technical co-operation and applied agricultural research, and inter-university co-operation.

The focal sectors of the Regional Indicative Programme (€30 million) of the 8th EDF are the management and protection of natural and maritime resources (50%) and the development of exchange (35%).

To date, the EDF has financed over 20 projects in the Indian Ocean region. The regional programmes have been recognised to improve intra-

regional understanding. Yet co-operation with the EC has not met the expectations and most EDF regional programmes have not had the expected impact. The EC has recognised following difficulties: limited commitment, absence of sectoral strategy in regional co-operation, absence of real regional approach and lack of capacity to manage EDF projects at the IOC level. On the other hand, the main IOC actors have expressed their frustration over regional programmes and claim that the priorities and the regionality criteria have been imposed by the EC in contradiction to the partnership spirit of the Lomé Convention. Because of the very heterogeneous nature of the region these criteria (Article 162 of the Convention) cannot be applied as strictly as in other regional blocks where the geographical entity is more homogeneous. IOC has identified as further obstacles the over-centralised bureaucracy of EDF procedures causing delays in decision-making, the new cross-sectoral objectives (e.g. environment and gender issues) which are seen to complicate the management of projects and the shortage of EC's field staff combined with their frequent rotations. One of the most common and strongly voiced criticisms towards European aid has been the strong reliance on outside technical assistance, which in the long term is seen as counter-productive to region's own capacity and programme ownership.

In order to improve the limited human resources situation at the IOC, a Programming Unit will be financed from the 8th EDF in order to support the IOC secretariat in managing the EC-supported programmes.

Post-Lomé and Trade

In various degrees individual Indian Ocean Island States have benefited from unilateral trade preferences, trade protocols and the guarantee mechanism offered to ACP countries through the system of Stabilisation of Export Earnings (Stabex). Madagascar has been allocated €70 million in Stabex transfers for loss of export receipts, notably for coffee, vanilla and cloves, since Lomé I. The country is also one of the traditional banana

component of EP2 (Box 2.3), US\$3 million is being used to establish regional funds for the support and management of the environment, to respond to the priorities identified by Regional Programming Committees (République de Madagascar 1997a).

International financial mechanisms such as the GEF have transferred financial resources to developing countries for investments related to protection of the global environment. By mid-1998, the states of the Western Indian Ocean had been allocated about 1.7 percent of GEF funds, totalling US\$33 million for projects mainly covering biodiversity, but also climate change and international waters (GEF 1998; Box 2.1).

Finance is one of the major barriers towards implementation of all types of MEAs, and international funding has played a major role in supporting national and regional environmental management initiatives. Support from the GEF in particular for activities related to the UNFCCC, CBD and international waters has been important and is likely to increase. Lack of finance is a greater problem for regional MEAs than global

MEAs, as parties to regional MEAs are expected to meet certain financial costs such as those of the secretariats, as well as fund activities to implement the agreement.

Overall, some progress has been made in increased financing for environmental action in the Western Indian Ocean, although it is not easy to determine the magnitude from the information available. However, much more still needs to be done by increasing public and private capital flows to this sector. With regard to external sources of finance, unresolved issues of particular relevance, especially to the least developed such as Comoros and Madagascar, include the unfulfilled UNCED commitments to increasing ODA to the level considered necessary to implement *Agenda 21* (and the overall fall in real terms) and reducing the debt burden. At the domestic level a wider range of instruments and mechanisms, reforms in public expenditure, greater private-sector participation and more innovative mechanisms need to be considered and further developed (CSD 1997).

producers to benefit from the EU's special assistance system set up in 1994 to improve productivity and quality. In addition, a fisheries agreement with the EU provides Madagascar an annual compensation of €725 000. For Comoros, the Stabex transfers (vanilla, cloves, essential oils) for 1990–93 and 1996 came to a total of €6.9 million. Mauritius has received almost €100 million a year in form of guaranteed sugar export prices. Consequently, it has benefited more than any other ACP country from the Sugar Protocol annexed to the Lomé Conventions. Seychelles negotiated a new three-year Fisheries Agreement with the EU in 1998 involving €10.4 million.

In November 1998, the European Commission released studies on the impact of its proposed Regional Economic Partnership Agreements (REPA) on ACP countries. The six impact studies looked at possible agreements between the EU and CARICOM/Dominican Republic, EAC, the Pacific, SADC, UDEAC-CEMAC, and UEMOA. It should be noted that groupings such as IOC were not considered, thus Mauritius and Seychelles appear under the SADC group while Comoros and Madagascar were not included.

The general conclusions of the studies were: 1) In most cases, LDCs have little to gain from REPAs in terms of market access to the EU¹. They can keep non-reciprocal trade preferences in any case; 2) The loss of non-reciprocal preferences would hardly affect the export performance of many ACP countries; 3) By contrast, the direct or indirect effects of not renewing the protocols could dramatically affect the exports of some ACP countries. However, the studies did not estimate these effects as this would have required separate studies; 4) The negative impact on customs revenues varies considerably, but could be substantial for some.

The main conclusions for Mauritius and Seychelles were:

The consumers and buyers of intermediate products and machinery imported from the EU could face lower prices, and thus higher real

income, so there could be consumer gains. Within SADC, the REPA would have the greatest proportional revenue loss impact on Seychelles (30%) and there would also be significant impacts for Mauritius (9%). These figures are based on an estimate of 90% liberalisation which would not be necessary on the ACP side. However, there might be more insecurity to maintain the benefits of the sugar protocol without REPA, which would result in substantial export earnings losses and negative social consequences.

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¹ The LDCs may however lose out in terms of trade, investment and co-operation on trade-related matters if they do not join a REPA but their neighbours/competitors do.

Public participation

Increasing political stability, democracy and improved economic performance in most of the Western Indian Ocean region countries have promoted improved local governance and public participation in the development process. Areas where public participation in environmental management has increased significantly include the involvement of the general public, non-

governmental and community based organizations (NGOs and CBOs) in policy formulation and decision-making processes, in the management of resources, including sharing of benefits and harnessing local knowledge, and in voluntary actions including awareness raising and environmental education, lobbying and oversight.

Policy formulation is increasingly involving public participation. Throughout the development of its second NEAP, the Mauritius Department of Environment emphasized the importance of public consultation to ensure that key stakeholders had the opportunity to contribute. The National Consultative Group, which included representatives from NGOs, business, industry, fishermen and agricultural associations and national environmental practitioners, participated in all the seminars and activities that contributed to the formulation of NEAP2 (GOM/ERM 1998c). Public participation and NGOs play a very important role community action in Comoros, which has been harnessed by the government and donors, including participation in debates on development strategies and their consequences (RFIC/PNUD 1997).

Representatives of various sectors often take part in the decision-making processes in Mauritius through steering committees and task forces. Public participation is an important component of the EIA process, often provided for in legislation. Under the Mauritian Environmental Protection Act, EIAs are open to public scrutiny and comment, including the holding of public hearings. However, this is one area where the transparency and effectiveness of the EIA process can be improved, as participation is sometimes encouraged but then ignored, and often only through very strong media and public mobilization have public views been taken into consideration. In Mauritius the public may also comment on draft management plans for reserved lands, but these comments can then be ignored by the Director of the Environment: therefore there is a need to strengthen the legal foundation to ensure that this does not happen.

The status and effectiveness of NGOs and CBOs vary between the countries: however their role and contribution in natural resource management issues has become increasingly significant. The strong involvement of CBOs such as the Ulanga in local environment and development issues in Comoros has been particularly important (Box 2.5). Activities directly involving the participation of local communities and NGOs in the sustainable management of their coastal resources, including capacity building, have been initiated through the IOC's Regional Environmental Programme. Local

Box 2.7: Community participation in Comoros

Comoros has a long tradition of community participation, including the holding of public meetings for decision-making, which has also facilitated the development of numerous local, regional or national groups, village associations and NGOs who, in the absence of government action, play an important role by harnessing local potential to respond to society's needs. This dynamic, decentralized and totally autonomous approach has been harnessed by the government itself and donors.

The Ulanga associations (Ulanga means nature or environment in Comorian), were created in 1990 in order to undertake voluntary actions, most notably to raise awareness of the destruction of forests and beaches, the drying-up of water courses, the increase in uncontrolled dumping of rubbish in urban areas and the disappearance of threatened species such as the coelacanth, turtles and the Livingstone bat. They work in close collaboration with the government and engage in environmental activities such as reforestation, monitoring and protecting turtle nesting sites. They undertake voluntary actions such as cleaning of roads and beaches, demonstrate against environmental destruction of forests, sand and coral exploitation, and are active in non-formal environmental education. The Ulanga were created largely by youth without external assistance or support, with financing essentially from members' subscriptions, and expanded spontaneously. Through the dynamic participation of their members, the Ulanga associations are a powerful means of communicating with, and mobilizing the participation of the public in local environmental management (IOC/EU 1998).

More specialized NGOs and associations have also emerged, such as the Association for Intervention for Development and Environment (AIDE or Association d'Intervention pour le Développement et l'Environnement) which brings together different but complementary expertise. Its objective is to provide technical support to national capacity in environmental matters, to contribute to increasing knowledge of ecosystems, to actively participate in the protection and sustainable exploitation of the country's natural heritage, and to promote the exchange of ideas and experiences amongst development practitioners. AIDE benefits from technical assistance provided by international organizations such as CARE, Peace Corps and the Canadian Centre for International Studies and Cooperation (CECI).

From a strategic point of view such NGOs and their national co-ordination, regional federation and local groups play an important precursory role in advance of government action.

Sources: IOC/EU 1998; RFIC 1998; RFIC/PNUD 1997.

communities have formed various organizations to manage solid wastes (in Itsandra, Comoros), to monitor the protection of marine turtles (Mohéli, Comoros), to manage reef resources (Foulpointe, Madagascar), to manage water resources (Morondava, Madagascar) or to promote ecotourism in protected areas (Grand Anse, Mahé, Seychelles). These agreements were made directly at the village level or through the support of the local authorities such as District Councils. In some cases these administrations have benefited from support to follow-up activities and regional planning. Efforts have been made to maintain this local dynamism through the formulation and discussion of management plans (Grand Anse, Seychelles; Itsandra, Comoros).

In Mauritius, Ile aux Aigrettes has been leased to an NGO for restoration of its native flora and fauna and for ecotourism (National Parks & Conservation Service 1999, personal communication). Bird Island in Seychelles has been owned and successfully managed privately as a bird sanctuary for a number of years, and the protected islands of Aldabra, Aride and Cousin are also leased to and managed by NGOs. The Government of Seychelles also promotes community-based management to achieve greater efficiency and to address the problem of lack of qualified personnel (Republic of Seychelles 1997b and 1997c).

Madagascar has passed a law providing for local community management of renewable natural resources, and its two environment programmes have included the whole spectrum of participation by the public and NGOs under several of their components, including the management of protected areas, the sustainable use of biodiversity and equitable sharing of benefits through ecotourism and bioprospecting, awareness raising and environmental education in schools and local communities, and fundamental research in association with the universities, especially through the CAPE and GELOSE components of EP2 (Box 2.3). These communities have also benefited by sharing revenues from protected areas, and through the granting of user rights, as mentioned earlier.

Environmental information and education

Lack of public access to information hampers understanding, participation and transparency in environmental management. Legislation often does not adequately provide for public access to information and access to justice, although in some cases amendments could overcome this problem, for example in the

Mauritius Environmental Protection Act. Countries in the region are addressing the issue of the availability of, and accessibility to, environmental information for decision-making, action planning and public awareness, through the systematic collection, analysis, dissemination and exchange of environmental information. For example, environmental information, education, and communication are important components of both Madagascar's EPs, and a communications strategy has been adopted under EP2.

Specialized information units have been created within several government environmental institutions, for example Madagascar has established the Environmental Information Systems Unit in the National Environment Office, and in Mauritius the Department of Environment has an Information, Education and Research Division dealing with provision and dissemination of information, information networking, environmental reporting, and non-formal environmental education. However, environmental databases and information are also widely dispersed in other institutions including government departments, NGOs, business and professional associations, universities and the private sector. For example, the principal institution dealing with biodiversity information in Madagascar is ANGAP, which has developed a Biodiversity Information System (SIBIO). In addition, there are at least 13 other national or international organizations with biodiversity databases and information, and at least 11 organizations dealing with environmental communication, education, training and awareness raising (République de Madagascar 1997b).

All countries have produced State of the Environment Reports (SOERs) and various sectoral or environmental issue-based reports, strategies and action plans. Madagascar has been developing its Environmental Information System and Network (EIS and EIN), which includes the collection, analysis and dissemination of environmental information and statistics in various ways, such as through a pilot on-line information service (Tableau de Bord Environnemental or TBE) and the internet. Mauritius is in the early stages of developing an EIS, while Comoros has only recently begun to address this issue (RFIC 1998).

Environmental awareness in the region is still low as dissemination of information on environmental issues is inadequate at all levels of society. A survey carried out on environmental awareness in Seychelles showed that half the population has little understanding of the complexity of environmental interactions, or causal problems, and that the decrease in biodiversity was

not considered an important issue for them. Education and communication efforts are therefore essential to improve the understanding of the average citizen about the environment.

To address these shortcomings, most countries are actively promoting environmental education and information, as well as organizing on-going programmes and information campaigns to mark significant events such as 'World Environment', 'Clean-up the World' and 'Ozone' days. These include talks, exhibitions, use of mixed media (journals, films, radio, television) to educate the population on subjects such as anti-littering, waste minimization and global environmental issues, carried out in schools, business and grassroots community organizations. Comoros, which developed a communication plan in 1997, is using traditional methods such as songs and theatre, as well as modern means of communication. National and international organizations, NGOs and village associations, play a crucial role, as do interpersonal interventions through extension services, and village associations (women, youth, etc.) especially in countries such as Comoros and Madagascar (RFIC 1998). Conservation International (CI) Madagascar and International Communications (InterCom) have carried out various communication activities including a workshop on the Communications Strategy, in which 30 Malagasy professionals (conservationists and journalists) participated, and a media campaign (TV, press and radio) (République de Madagascar 1997a).

Formal and non-formal environmental education is being provided at all levels from primary to tertiary education as well as to the general public, and through various channels such as partnerships between government and NGOs and local associations. It is included as part of the school curriculum in all countries, and is a priority for Seychelles not only in schools but also for teacher training. NGOs such as the Wildlife Clubs of Seychelles, Birdlife International and Nature Protection Trust of Seychelles work in partnership with the Ministry of Education and Department of Environment to promote environmental education of school children and the general public. Since 1992, World Wide Fund for Nature (WWF) has been working in Madagascar to raise awareness, and to train and introduce schools, local NGOs, clubs and associations to biodiversity issues, including conservation information, education, scientific and economic aspects (République de Madagascar 1997a). Various educational materials are being produced and

used, including educational manuals and modules on environmental subjects, audiovisual materials (films, posters, TV and radio programmes) and magazines such as *Canal Environnement* and *Revue VINTSY* in Madagascar (République de Madagascar 1997a).

At the sub-regional level there are two new initiatives being implemented by the IOC, which are just beginning, but which will provide valuable support and reinforce the activities going on at national level. A two million Euro environmental education programme – ARPEGE (Appui Régional à la Promotion d'une Education pour l'Environnement) is being formulated, to support the educational systems of the IOC member states through teacher training, and through the production and use of educational modules and materials, which will become an integral part of educational policy. The programme has a target of educating 70 000 students about environmental protection.

The second initiative is the University of the Indian Ocean (UIO), established in 1998 by the IOC with EU funding to provide knowledge and expertise in the region through a network of existing institutions of higher learning and research. The UIO has been providing training in the areas of environment, new technologies, and enterprise management since April 1999, through its partner institutions, including EIA (in Madagascar), management of waste water (in Mauritius), and energy planning (in Réunion).

A number of environmental education and awareness-raising initiatives are going on outside of formal education. Seychelles has set itself the goal of upgrading the technical knowledge and skills of all those with an impact on the environment, as well as educating all workers, employers, technicians, professionals, government cadres and decision-makers in the elements of environmental management by the year 2000. In Madagascar initiatives are under way to raise the awareness of factory workers to the risks of air pollution in factories (ONE 1997a). There is a pilot reforestation project with the Tzimbazaza Botanical and Zoological Park (PBZT) and villagers in Madagascar, in which the PBZT provides seeds and technical assistance regarding soil conservation. PBZT staff are also constantly receiving on-going education so that they can provide information, educate and raise awareness of the general population during their field-trips. Other activities include reforestation by schools and the formation of school reserves in rural areas (République de Madagascar 1997a).

Social policies

It has long been recognized that poverty is both a cause and consequence of environmental degradation, and that the poor suffer most from environmental damage (UNECA 1991; UNDP 1998). Therefore poverty alleviation through sustainable human development is a priority imperative for greater economic and environmental sustainability in the region, which can only be achieved if the appropriate policies are put in place to address the root causes. Poverty exists in all the countries of the Western Indian Ocean. Seychelles and Mauritius have been particularly successful in alleviating poverty and improving human development through the reduction of population growth rates, improvements in health, provision of free education, social security benefits and services to improve the living standards of the needy, and

in the status of women, in addition to economic development (Box 3.1). Mauritius has also developed a 'Marshall Plan' for the Development of Deprived Regions, to upgrade water supply, sewage, schools and the provision of infrastructure to 53 deprived localities.

Poverty is, however, an overriding factor in Comoros, affecting about half the population, and in Madagascar where the figure is around 70 per cent (RFIC/PNUD 1997; UNDP 1998). The elements of a strategy for sustainable human development and the elimination of poverty in Comoros have been outlined, but need to be initiated (RFIC/PNUD 1997). Madagascar formulated a National Plan of Action for Social Redress (Plan National d'Action pour le Redressement Social or PNARS). This strategy aims to resolve the fundamental problems linked to poverty, human development and environmental improvement by addressing demographic issues,

Box 2.8: Sustainable development in the Western Indian Ocean: a regional perspective

Sustainable development has become the fundamental principle of environmental and development policy in the Western Indian Ocean, both at national and regional level. Madagascar, Mauritius and Seychelles had already taken significant steps towards sustainable development well before the UNCED Conference in 1992. All countries of the region have policies addressing sustainable human development, and some countries have been more successful in achieving it than others. These countries also have policies addressing various aspects of sustainable economic and environmental development. For example, Madagascar has introduced sustainable development policies for the energy, tourism, transport and industrial sectors.

In the last decade, political leaders of the Indian Ocean region have become increasingly aware of the fact that regional co-operation and integration are important instruments which can reinforce national efforts for sustainable development. The Indian Ocean Commission's Regional Environment Programme (IOC/REP) adopted in 1989 as part of the Plan of Action for the regional co-operation strategy between the islands of the Indian Ocean, forms the framework for regional co-operation with respect to shared marine and coastal resources. Since 1995 the IOC/REP has been promoting a regional approach for the sustainable development of natural resources and protection of the environment. The objective of the programme is to support the planning, implementation and monitoring of policies, strategies and diverse actions leading to a more sustainable development, with the aim of rationalizing the use of resources by all operators in the coastal zone (EC 1998).

In addition to environmental management, tourism, commercial fishing, and natural disasters are among the areas in which regional collaboration is considered essential and is being implemented. The governments of the region mandated the IOC to co-ordinate and promote regional tourism. However there have not been any in-depth studies and clear-cut regional tourism policies have yet to be developed. Under two EU-supported Regional Tuna Programmes¹, Madagascar, Seychelles and Mauritius have consolidated their research, surveys, marketing and organizational structures to manage and further expand commercial fishing, so as to take advantage of their geographical location, and the vast resources of their coastal and marine areas. In dealing with natural disasters, the capacities of the government agencies are often limited and necessitate the involvement of the international community especially in the areas of reconstruction and food security. Although there are mechanisms at the national level for early warning, and for assisting the populations affected, a regional approach is recognized to have a much greater potential in taking a precautionary approach and in alleviating the socio-economic impacts of natural disasters, as well as the impacts of climate change and sea-level rise.

The lack of a regional co-ordinating body to advise, guide and co-ordinate the activities of the island states of the African region in relation to the global and regional MEAs has been recognized as a weakness. This issue was also mentioned during the Sixth Session of the Commission on Sustainable Development (CSD VI), in relation to the implementation of the Barbados Programme of Action for the Sustainable Development of Small Island Developing States. In response, an initiative was launched in late 1998 to create an Indian Ocean, Mediterranean and Atlantic (IMA) SIDS centre to promote co-operation and co-ordinate the implementation of the Barbados POA for the Africa region (CSD 1999c).

One outcome of the IOC/REP has been the recognition of the need for a regional policy on sustainable development. The IOC has addressed this issue by defining a regional policy and strategy for sustainable development, and is establishing the legal and institutional instruments necessary for its implementation. The Regional Policy for Sustainable Development (RPSD) will include the establishment of a Regional Commission for Sustainable Development (RCSDD). A Framework Agreement, which has the status of an international convention, has been drafted, and will be submitted to the Heads of the IOC States for signature in November 1999. In this respect, the region could also benefit from closer ties with SADC, which has moved beyond *Agenda 21* and formulated an equity-led growth policy and strategy for environment and sustainable development which has poverty alleviation as the priority (SADC 1996).

¹ The European Union has supported two Regional Tuna Programmes (1987 and 1996) to assist the ACP member states of the IOC develop their capacities to manage and exploit their tuna resources, under the 5th FED (€6.3 million) and 6th Fed (€5 million). A new project covering fishing is being prepared.

provision of water and sanitation, improvements in nutrition, basic education, literacy, the environment and habitat, and the establishment of an emergency response capability (ONE and INSTAT 1994).

Consumption patterns have a direct impact on the environment by consuming natural resources, generating waste, and contributing to pollution. Critical areas of consumption include energy, education, water, transport, health care, and housing; and all have strong links to human development. Consumption increases as societies become richer, resulting in growing inequalities between rich and poor. New patterns of consumption need to be sustainable, more equitable and less environmentally damaging (UNDP 1998). Although countries in the Western Indian Ocean are not large consumers compared to developed countries, Mauritius and Seychelles have recognized that the issue of consumption patterns needs to be addressed. Both countries have recognized the need and potential to influence patterns of energy consumption through the use of renewable energy sources and energy conservation, and are promoting the use of solar energy in particular, through solar water heaters. In addition, Mauritius has been harnessing one of its waste problems, bagasse or sugar waste, to generate electricity in many sugar factories. Mauritius is also addressing consumption patterns through building awareness to change consumer attitudes and behaviour of the general population towards environmentally sound products and lifestyle choices, and by promoting recycling and green consumption. Recycling of household waste (paper, cartons, scrap metal, glass and textiles) is also being encouraged in Madagascar. Composting of household waste used to be carried out, but the only factory, which had a composting capacity of 10 000 tons per annum, stopped operating in 1994 (ONE 1997a). The size of the market in Mauritius limits economic viability of recycling, and this is something that could be explored on a regional basis.

Conclusion

A large number of new national and multilateral environmental policy initiatives have been approved, formulated, and are being implemented by the countries of the Western Indian Ocean. These policies are mainly based on regulatory mechanisms but some countries are beginning to use a broader mix, such as incentive-based economic instruments and cleaner production technologies. However, their use is still very limited, and considerable scope remains for adoption. Many of the

major global and regional MEAs have been ratified by most countries, but numerous obstacles to implementation exist. National institutional and legislative frameworks have been enacted, according to the specificities and needs of each country, however their effectiveness is often low due to lack of adequate staff, expertise, and finance for implementation and enforcement.

There has been growing recognition that environmental policies are more likely to be effectively implemented if they are supported by an informed and involved public. Environmental information and education currently constitute major axes in the implementation of environmental policy. Environmental education and awareness programmes are expanding almost everywhere, while environmental information systems and public access to environmental information are beginning to be addressed. Public participation, by NGOs and through the integration of the local population in decision-making and the management of natural resources, although still limited, is beginning to take on an important dimension in environmental management. These trends towards greater democracy and public participation are strong positive factors in strengthening environmental management in the region.

Although there are an increasing number of initiatives, such as environment funds and charges, diversification of financial resources to support environmental action remains very limited, and the reliance on bilateral and multilateral ODA is likely to continue. Regional co-operation has played an important role in supporting implementation of national environmental policies by addressing common problems with a regional dimension. Nevertheless, all these policies and experiences have not been enough to halt or reverse degradation of the environment. There has therefore been a growing recognition of the need for poverty alleviation and sustainable human development, as well as more integrated sustainable development policies at both national and regional level.

The following priority policy issues have been identified in order to implement a sustainable development policy at the regional level (COI 1998b), and many of these priorities are equally applicable at the national level:

- a) development and adoption of a regional system of sustainable development indicators;
- b) establishment of networks on measurements, expertise and actors in the region;

- c) development and adoption of common methodologies for monitoring and evaluation of resources, ecosystems and policies, including the development of manuals and guidelines for implementation;
- d) training of human resources;
- e) further development of existing standards, and the creation of regional standards depending on needs;
- f) international and regional labelling of production sites and processes;
- g) establishment of operational protocols concerning technical or organisational matters; and
- h) experimentation with economic instruments, notably the polluter-pays-principle and tradeable permits.

Any sustainable development policies and instruments must be flexible and comprehensive enough not only to address the present priority environmental issues and concerns in the region, but also the emerging issues of the future. Chapter three takes a look into the future, attempts to identify what these emerging issues might be, and suggests some alternative policies to address these issues.

Future Perspectives



The current state of the environment in the Western Indian Ocean is the result of the impacts of pressures exerted upon it, and of the policies implemented to respond to those pressures, stretching from the past to the present day. Likewise, the projected future impacts of present-day policies are playing an increasingly important role in current decisions and policy-making. Despite their inherent uncertainties, scenarios, projections and forecasts are becoming increasingly popular as a basis for decision-making (UNEP 1999). This chapter takes a look into the future, at the emerging environmental issues that may become priorities for the Western Indian Ocean region in the twenty-first century, as well as some of the alternative policies that are required to address these issues more effectively.

The challenge of sustainable development

The challenge of the future is sustainable development, i.e. 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland Commission, in Commonwealth Secretariat 1997). It is therefore about harmonizing human development with the environmental constraints of the planet, as well as about reconciling the needs of present generations with those of the future. A vision of sustainability for the twenty-first century might include the following

(Gallopín *et al.* 1997, quoted in SEI/UNEP 1998):

- eradication of absolute poverty, malnutrition and famine;
- universal entitlement to basic social services such as health care and education;
- improving quality of life and expanding possibilities for fulfilment;
- diminishing economic and social disparities;
- increasing environmental quality, with renewable resources recovering, pollution under control and a stable climate;
- infrequent violence and armed conflict;
- stable global population.

The challenge is how to move from international commitment to actual implementation of sustainable development, from vision to action (SEI/UNEP 1998). This requires the design, testing and implementation of appropriate, and alternative, policies to those that have been tried so far, and found to be inadequate or ineffective, and thus help make the shift from commitment to sustainability.

Scenarios for the future

A widely accepted technique for examining the future is through scenario development, in order to assess current and alternative policies. The baseline would be a 'business-as-usual' scenario, with a continuation of

Box 3.1: IIASA-UM's Population-Development-Environment model for Mauritius

A collaborative study between the International Institute for Applied Systems Analysis (IIASA) and the University of Mauritius (UM) in the early 1990s produced the Population-Development-Environment model for Mauritius funded by the United Nations Population Fund (UNFPA).

The model has five modules: population, economic, land use, water and policy. Using extensive data on each of these modules, taken from existing sources and extending back to 1962, and knowledge about specific linkages, a variety of scenarios was run, both of alternative histories and of the future.

The model was used to examine a number of future scenarios, the most interesting of which was a continuation of current policies, practices and trends. This pointed to an environmental crisis, with increasing water pollution and the prospect of coral damage and eutrophication of lagoons, resulting in the collapse of the tourism industry. The conclusions of the modelling exercise were that:

- the solution is early water treatment, which will protect the coastal and marine environment and the tourist industry which depends on it; and
- the costs would be high in the short term, but would decline to insignificance, from an estimated 21 per cent of GDP in 1990 to 4 per cent by 2020 and only 1 per cent by 2050.

Other findings relate to population, economy and environment:

- Fertility reduction in Mauritius was important, but less so than economic development in producing the current high quality of life that Mauritians enjoy.
- The relationship between development and environmental degradation: Mauritius's past economic development has increased water pollution. The modelling showed that past trends were unsustainable, and continuing current practices would produce high levels of pollution, probably with serious repercussions on the high-earning tourist industry.
- Sustainable development in Mauritius is a clear possibility, but requires adjustments to unsustainable practices, and the modelling helped to indicate where these adjustments need to be made. The alternative could be a crisis or collapse of activities based on an unprotected environment. This type of modelling is therefore a very important tool for promoting sustainable development.

The example of Mauritius may have limited application for sustainable development planning for more complex continental countries because it is a small island state with a relatively simple set of sociocultural, economic, development and environmental conditions, and fewer transboundary issues. However, it may be highly relevant to sustainable development planning for other SIDS. The IIASA-UM model has since been applied to more complex situations in Cape Verde and Mexico.

Source: Ness and Golay (1997)

current policies and their impacts on the environment. As a backdrop for the Western Indian Ocean region, a projected global 'business-as-usual' scenario for 2050 (SEI/UNEP 1998) has the following quantitative features:

- world population increases 65 per cent to 9.4 billion;
- economic output more than quadruples;
- income per capita, expressed as purchasing power parity, grows 2.6 times;
- energy requirements increase by a factor of 2.4;
- water requirements increase by a factor of 1.6;
- food requirements almost double, driven by population growth and rising incomes;
- about 72 per cent of the world's population is urban;

- inequalities between OECD and non-OECD countries, in terms of purchasing power parity, increase; and
- poverty increases slightly rather than decreases.

Such scenarios make a number of assumptions, some of which may be unrealistic, and therefore need to be interpreted with caution, but they do provide a framework for looking at the future and what is or is not possible (UNEP1999).

A number of scenarios have been developed for the African continent or for particular regions. Although the priority issues and policy responses for the Western Indian Ocean island states are different from those for Africa, there are some points in common, and a number of useful lessons can be learnt from looking at scenarios that have been developed for the continent, particularly those dealing with southern Africa. The 'business-as-usual' scenarios they present are driven by demographic change, particularly population growth, and poor economic growth. The analysis shows that they all paint a similar picture: slow or stagnant economic growth, shortages of agricultural land, ineffective governance and institutions, loss of biodiversity and susceptibility to natural disasters (UNEP 1999; SEI/UNEP 1998).

The alternative, sustainable scenarios for Africa project a future dependent on:

- integrated policies, e.g. regarding land and water;
- effective population growth strategies;
- reform of tenurial rights, especially for land;
- development of alternative employment opportunities;
- enabling factors, such as the development of legal, institutional and political will.

A number of additional success variables for sustainable scenarios were identified:

- human resource development (especially education);
- outreach programmes;
- public participation in the development process;
- a resurgence of African culture;
- the economic autonomy of African countries with respect to global markets: either requiring countries to 'delink' from global markets to build strong and self-reliant institutions; or to enter the global economy through macro-economic adjustment, trade liberalization and better governance;
- the level of intraregional cooperation.

No specific scenario studies have been carried out for the island states of the Western Indian Ocean region as a whole. However, the trends so far predicted for key variables are as follows.

- By 2050 the population of these Western Indian Ocean countries is projected to increase from about 17 million (1998) to 43.6 million. Most of this increase will be in the poorest countries, where the populations will more than double: Madagascar from 15 million to 40.4 million; and Comoros from 0.7 million to 1.6 million (UN Population Division 1998).
- Urban population in the region is predicted to almost double by 2025, from 41 per cent currently to 59 per cent; all countries are projected to have over half their population living in urban areas, with Seychelles the highest at 74 per cent. By 2050 this proportion is likely to be much higher.
- Tourism is likely to continue to increase, but will need to be carefully managed so as not to exceed the environmental or sociocultural carrying capacity. Mauritius, which currently receives more than half a million tourists a year, has set a 'Green Ceiling' of 750 000 per year under present constraints (GOM/ERM 1998b). Seychelles, the other major tourist destination, with over 100 000 visitors annually, is also considering a ceiling of 200 000 visitors per annum (Republic of Seychelles 1997a).
- Industrialization is unlikely to increase substantially. Light industry and services are becoming more important in Mauritius and Seychelles (tourism, financial, business and offshore services).
- Requirements for food, land, energy and water will all increase substantially as a result of population growth.
- Deforestation, loss of habitats/ecosystems and pressures on protected areas and other natural resources will continue, driven by the need for land, food and energy in the form of biomass.

The one scenario model that has been developed is the IIASA-UM Population-Development-Environment model for Mauritius (Box 3.1), which examined a continuation of current policies, practices and trends. This scenario pointed to an environmental crisis, primarily concerning water pollution, with subsequent severe impacts on tourism, as well as recommending adjustments necessary in order to achieve sustainable development.

Box 3.2: Environmental and economic vulnerability

Islands are vulnerable: environmentally, economically and politically. Vulnerability implies a particular susceptibility to risk or harm, and it is well established that this is a characteristic of island states, particularly small island states (Commonwealth Secretariat 1997). Indices to reflect this economic and environmental vulnerability, as called for in the Barbados Plan of Action, are currently being developed (Briguglio 1997; SOPAC 1999). According to the preliminary Economic Vulnerability Index, which takes account of trade openness, peripherality and dependence on imported commercial energy, Comoros is ranked 2nd, Seychelles 10th, Mauritius 31st and Madagascar 48th, out of a total of 105 states examined (Briguglio 1997).

Environmental vulnerability is made up of external risks or threats such as natural disasters, over which the countries concerned have little or no control, and internal risks or threats, often resulting from poorly controlled or managed socio-economic processes. In addition, island states are ecologically fragile, with high degree of species endemism, which has a low ability to compete with introduced exotic or alien species, or resilience or ability to adapt to changes, resulting in a high proportion of indigenous species under threat (Commonwealth Secretariat 1997). A preliminary Environmental Vulnerability Index has been developed, but so far only for a few countries (SOPAC 1999).

These two indices will contribute to the construction of a Composite Vulnerability Index (CVI) for developing countries, which will try to quantify the degree of vulnerability of states to exogenous factors. Such an index can be an operational tool to help determine development assistance to small developing states, as well to identify those most vulnerable to external shocks.

One of the latest initiatives that have been undertaken regarding the vulnerability of SIDS is the setting up of the Joint Commonwealth Secretariat/World Bank Task Force on Small States. The main objective of this Task Force is to study the vulnerability of small states to natural shocks and external economic events, and the adequacy of aid instruments to address the challenges they face. The CVI will help categorize small states according to their degree of vulnerability to various exogenous factors such as fluctuations in commodity prices, natural disasters and environmental degradation.

In other words, all the 'business-as-usual' scenarios available, at the global, continental, regional and national levels, present a picture of increasing resource use and pressure leading to environmental degradation. A continuation of present trends in population growth, economic development and consumption patterns will result in an increasingly stressed natural environment. For the poorest countries in particular, such as Comoros and Madagascar, it is therefore imperative that any future alternative policy measures for sustainable development continue to address poverty reduction and sustainable human development, as well as sustainable economic development.

Emerging issues and policy options for the 21st Century

The vulnerability discussed in Box 3.2, which gives most environmental issues a different dimension for island states because of their small size, isolation, ecological fragility, geographic dispersion and limited resources, was recognized at UNCED and subsequently in the Barbados Plan of Action. One of the challenges is

Table 3.1: Emerging issues in the Western Indian Ocean

Environmental issue	Comoros	Madagascar	Mauritius	Seychelles
Climate change and related events (sea-level rise, El Niño, cyclones, floods, droughts, etc.)	●	●	●	●
Marine pollution (hydrocarbons and ship-borne wastes)	●	●	●	●
Waste management	●	●		●
Atmospheric pollution /vehicle emissions	●		●	
Ecotoxicology		●	●	
Environment-related diseases	●			●
Lack of water	●			
Resource use conflicts/Environmentally sensitive areas			●	●
Declining fish resources				●
Sustainable use of threatened species				●
Locusts		●		

to identify which will be the emerging environmental issues of the next century. There are three types of environmental issue that may become priorities for the Western Indian Ocean region in the future:

- well-known problems to which the present response is inadequate, e.g. climate change, unsustainable use of renewable resources, loss of habitats and ecosystems, urbanization, oil spills and hydrocarbon pollution;
- sudden, unexpected transformations of old issues, e.g. natural disasters, coral bleaching;
- unforeseen events and scientific discoveries, e.g. CFC-induced ozone depletion, genetically modified organisms.

Table 3.1 lists the emerging environmental issues identified by countries through the GEO preparation process used in the region. Although it was not based on any quantitative analysis, it does give an indication of the common regional, as well as the national environmental, issues of the future.

Most of these emerging issues fall into the category of well-known problems receiving inadequate attention. Some can be regarded as external threats or risks, over which the countries concerned have little or no control or influence, such as climate change and marine pollution, whereas others, such as waste management, water and other resource use issues can be regarded as internal risks or threats (Commonwealth Secretariat 1997) and are the result of socio-economic processes that are not being properly controlled or managed.

However, care should be taken not to assume that

this list is exhaustive. Many environmental issues that have emerged to confront governments were only recognized as such in advance by a few individuals (UNEP 1999).

Climate change and related events

The vulnerability of the island states of the Western Indian Ocean to the impacts of global climate change and related phenomena (sea-level rise, more frequent and extreme weather events such as El Niño and La Niña, and natural disasters such as cyclones, floods and droughts etc.) is probably the most important emerging issue for the region. Climate change related issues are complex, poorly understood, and beyond the control of the countries most affected, but can have dramatic effects on their environments and economies.

The 1990s has been the warmest decade in the last 1 000 years. Evidence suggests that the atmosphere and oceans are warming, among other changes, and are having profound effects on the planet and its inhabitants. 1998 was the worst year on record for natural disasters, causing more damage than ever before, including hurricanes, droughts, floods, epidemics and the El Niño and La Niña weather events, resulting in predictions of more 'super disasters' (IFRC 1999b). El Niños appear to be intensifying as a result of this warming trend, with the most powerful ones ever recorded occurring in 1982–83 and 1997–98. Recent studies support computer models that not only predict the warming trend, but also increasingly turbulent and severe weather extremes, costing lives, billions of US dollars of damage, and enormous hardships for the people affected (IFRC 1999b).

The implications of these trends for the islands of the Western Indian Ocean is clearly of considerable concern. All the countries of the Indian Ocean will be affected and have completed or are in the process of ratifying and implementing the United Nations Framework Convention on Climate Change (UNFCCC), which aims to stabilize the emission of the greenhouse gases that are causing climate change. The principal impacts of climate change are:

Sea-level rise: The small islands of the Indian Ocean are in above average danger from sea-level rise, with an estimated 22 per cent of the population at risk. This could be reduced to 2 per cent at an estimated cost of 0.74 per cent of GNP per annum (IPCC 1992 quoted in Commonwealth Secretariat 1997). In the Western Indian Ocean, Seychelles is probably most at risk: an estimated 70 per cent of land area would be lost with a rise in sea level of 1 m (Shah 1996).

There are three broad types of strategies for coping with sea-level rise, and in most cases a mixture of the three is likely to be the most practical (Commonwealth Secretariat 1997):

- protect: build up sea defences to protect existing infrastructure and important areas of land (the Netherlands is a good example of this strategy);
- retreat: relocate activities away from the areas at risk and allow inundation to occur;
- accommodate: adapt to sea-level rise by raising buildings above the likely increased sea level.

Practical policy options that should be implemented include (CSD 1999d):

- integrate sea-level rise scenarios into national, regional and sectorial development plans;
- re-examine policies, plans and regulatory frameworks for land use to take into account the possible impacts of sea-level rise;
- detailed mapping of coastal zones and identification of areas vulnerable to sea-level rise;
- development of alternative sources of fresh water (rainwater harvesting, recycling and reuse);
- responses at the regional level, such as creation of monitoring networks, research, sharing of information and development of scientific and technical capacity;
- further measures to assist island states with the implementation of the UNFCCC, including technical assistance, technology transfer and capacity-building.

More frequent extreme weather events and natural disasters: The increase of the thermal capacity of the Indian Ocean through global warming may give rise to more frequent and more intense tropical cyclones. There is also the likelihood of the narrowing of the cyclone-free zone on both sides of the equator in the Western Indian Ocean. Islands like Seychelles that are free from cyclones would then become exposed to them (Shah 1996). Countries that are presently in the cyclone zone, such as Mauritius, already have some infrastructure, contingency planning and response capacities to minimize damage: fast recovery from cyclonic damage is essential for the tourist industry. However, other countries, such as Madagascar, are less well able to deal with cyclones and the resulting damage.

It has been predicted that the El Niño phenomenon could cause a change in the temporal pattern of rain distribution, and that cyclones could become more intense at the beginning of the year. Sugar extraction has also been found to be lower in El Niño years, which would severely effect the Mauritian economy. Increases in sea surface temperature will also have a (largely unknown) effect on the distribution of tuna in the Western Indian Ocean, which could have severe economic impacts for the countries of the region (ORSTOM 1996).

Dealing with increasingly frequent extreme weather events and natural disasters requires disaster mitigation, preparedness and emergency relief management. Such activities can be particularly effective if implemented at a regional level, and currently very little such capacity exists in the Western Indian Ocean. The development of national and regional programmes, however, requires significant levels of international support and assistance, and is often not regarded as a priority. Additional policy options that are important for reducing the impact of such weather extremes and natural disasters include:

- establishment of early warning systems;
- integration of environmental and natural disaster policies, including risk reduction, disaster management and emergency response, into national planning;
- improvements to information and communications systems;
- standardized legislation and regulations, such as a uniform building code to improve cyclone resistance;
- institutional development and community participation;

- human resource development for disaster management;
- establishment of systems and strategies, as well as the sharing of expertise at the regional level;
- improved access to training, technology and information;
- further research into the impacts on natural systems.

Marine pollution

The threat of marine pollution, especially of oil pollution, risks of oil spills and ship-borne waste, has been increasingly recognized in the region (World Bank 1996, 1998c). The Indian Ocean is one of the busiest shipping lanes in the world, carrying approximately 30 per cent of the world's annual crude oil output (World Bank 1998c), which passes through the region from the Middle East en route to Europe and America. Oily waste from ships and discharge of ballast water that may harbour exotic species, pests, pathogens or diseases all contribute to marine pollution. Another major hazard is the collection and subsequent disposal of ship wastes in landfill sites. In Seychelles, which has serious constraints of land and therefore of waste disposal, 14 000 tonnes of rubbish, fish wastes and oil are produced by commercial fishing fleets annually.

A World Bank (1998c) study of accident scenarios in the Western Indian Ocean indicated that an oil spill of 50 000 tonnes would:

- overwhelm the organization and response arrangements of the countries concerned, some of which have untested oil spill contingency plans. The region as a whole lacks legislation, equipment and a plan to deal with an oil spill emergency;
- have devastating impacts on the environment, damaging coral reefs, seagrass beds, mangroves, beaches and shorelines, populations of rare and endangered species such as dugongs, turtles, seabirds and other wildlife;
- severely harm the economies of the region, damaging fishing grounds, tourist resources such as beaches, diving and deep-sea fishing areas, disrupt shipping and affect activities relying on the intake of seawater.

Mauritius and Seychelles have ratified some of the principal international conventions relevant to oil pollution control and compensation for spillage, such as MARPOL, the London Convention, the 1991 Fund

Convention and the 1990 Convention on Oil Preparedness, Response and Co-operation (OPRC90). Most countries in the region do not have port reception facilities for oily wastes from ships, as required under MARPOL (UNEP 1998e). Only Mauritius has a National Oil Spill Contingency Plan (CSD 1999a). The GEF-funded Oil Spill Contingency Planning project in preparation will help the countries of the region which have not yet done so to ratify and comply with OPRC90, which requires states to develop and maintain adequate capacity to respond to oil pollution emergencies. The project includes: establishing the legal and institutional frameworks; carrying out national and regional contingency planning; setting up national and regional oil spill response capacities; and developing sustainable financial institutional agreements (World Bank 1998c).

Other policy measures that need to be taken to combat the threat of marine pollution include (UNEP 1998e):

- all countries, including the East African coastal states, ratifying and implementing the relevant international conventions, and taking measures to supervise the operation of vessels using ports in the region, in accordance with the provisions of the conventions;
- provision of port reception facilities for oily and other waste, as required under MARPOL;
- provision of technical equipment, finance and support for mobilization of a rapid response in the event of a major oil disaster;
- consideration given to long-term measures for more effective traffic control, especially in the Mozambique Channel.

Fresh water quantity and quality

A water crisis is looming for a number of Western Indian Ocean states. The stress placed on fresh water resources is becoming a major issue for many countries in the region as populations, urbanization, per capita water consumption and pollution increase. Comoros is projected to become increasingly water short by 2025, and Mauritius will be under water stress (see Fresh water section in Chapter One). Despite abundant rainfall, Seychelles currently has a water deficit of about 8 000 kilolitres/day, which is predicted to rise to 10 060 kilolitres/day by the year 2010 because of high run-off and the seasonality of rainfall (Shah 1997).

Madagascar's abundant water resources are unevenly distributed, under-researched and underdeveloped.

Box 3.3: Integrated policies to control water pollution

The availability of clean water, water pollution and the associated degradation of the terrestrial and marine environments have been identified as increasingly important environmental issues for the Western Indian Ocean region. Causes of problems include increasing industrialization, urbanization and intensification of agriculture exerting pressure on surface and groundwater resources as well as coastal and lagoonal areas through greater consumption and discharge of untreated domestic and industrial wastewater. For example, in Mauritius, which is the most industrialized country in the region, the main sources of water pollution are from the sugar and textile industries as well as hotel and related tourist industries.

Any attempt to tackle water pollution in a comprehensive and integrated manner will need to include a combination of the following policy initiatives:

1. **Sewerage and drainage master plans** for each island ('end-of-pipe' approaches to deal with existing sources of water pollution).
2. **Development or adoption and implementation of environmental standards and regulations** to cover areas such as water quality for various types of water (drinking, industrial, irrigation, recreational, etc.), effluent limitations, pesticide residues, air, waste, noise, odours etc. These are important tools to control industrial pollution, which must be founded on legislation so that legal action can be taken against polluters, and have the appropriate institutional mechanisms for enforcement.
3. **Environmental Impact Assessment (EIA)** to take account of the impact of any type of development on the environment at the conceptual and planning stages, and minimize these impacts before they occur. In this way, developers are encouraged to adopt pollution prevention and control strategies, compare alternative technologies available, and in theory the best possible option should be retained if all mitigative environmental costs are included in the overall calculation of project costs.
4. **Land-use planning**, through a National Physical Development or similar Plan, can be used to control the siting of polluting activities, as well as to control and minimize land-use conflicts. For example, the pollution of watersheds or aquifers can be prohibited through land-use zoning; coastal zones can be protected through strategic development plans aimed at promoting sustainable development.
5. **Waste audits** are another important environmental management tool, especially if applied to the most polluting industrial sectors such as agro-processing and the hotel industry. Under such regulations industries would be requested to: (i) complete a checklist of their plant and processes, including the generation of waste (solid, liquid and gaseous); (ii) undertake a waste audit programme and submit an audit report; and (iii) submit a waste management plan, indicating the time-frame for implementation. Guidelines are necessary to facilitate waste audits, as well as appropriate standards, as the waste audits would in turn monitor the degree of compliance to those standards. Waste audits would also act as precursors to more comprehensive environmental audits, which in turn would facilitate the adoption of cleaner production options and/or environmental management systems such as ISO 14001.
6. **ISO 14000 standards** are the international standards for long-term environmental improvement which encourage business and industry to take a proactive approach to environmental management. If adopted, these standards complement regulatory structures and will decrease the need for regulation in some areas, but not replace the need for it entirely. These standards call on organizations to develop their own environmental management systems (EMS), complete with policies, plans and procedures, as well as monitoring implementation, thereby encouraging these organizations to take a broad view of environmental issues. So far, only two enterprises in Mauritius have adopted ISO 14000 standards, although a number of others have shown interest.
7. **Product stewardship** through life-cycle analysis and eco-labelling are tools within the ISO 14000 standards which are only just beginning to be adopted, particularly by some enterprises in Mauritius.
8. **Cleaner production processes and technologies** are pollution prevention approaches that reduce pollution generation at every stage of the production process, and minimize waste that needs to be treated. This can be achieved through improved operation and good housekeeping, process modification, changes in plant and equipment, substitution of raw or toxic materials, and redesign/reformulation of products. The advantage is that cleaner production addresses pollution problems at source, in contrast to the 'end-of-pipe' approach, which often simply moves pollutants from one environmental medium to another, and therefore needs to be encouraged within the region.

Some of these policy instruments, such as EIAs and land-use planning, are proactive in attempting to prevent pollution, but may not be very effective, particularly in the absence of baseline data, and only apply to new undertakings. Where sources of pollution already exist, the most appropriate policy instruments include regulation as well as the use of incentives to move towards cleaner production techniques and technology.

Traditional 'command-and-control' regulatory methods such as standards and regulations have serious shortcomings, and therefore new, alternative approaches that aim at prevention and complement or move away from these traditional methods need to be adopted. Such an alternative approach should include the following four principles:

- Pollution prevention and waste minimization, adopting a 'cradle-to-grave' approach to waste management that reduces pollution loads and environmental degradation, moving away from the 'end-of-pipe' approach.
- Integrated pollution control, which addresses cross-media (e.g. land to water) and multi-media impacts, and provides a more efficient administrative system for pollution control. This avoids the traditional approach of addressing environmental media separately as unrelated aspects of environmental management.
- The 'precautionary principle' – where there are threats of serious or irreversible environmental damage, lack of scientific data should not be used as a reason for postponing measures to prevent environmental degradation. This has particular relevance in relation to environmental risk assessment, for example where hazardous industrial chemicals are being assessed for their possible environmental impacts.
- Optimizing the regulatory mix by combining regulatory techniques with market-based mechanisms that provide incentives or disincentives (such as pricing, subsidies, taxes, 'polluter pays' principle), as well as the preventative approaches.

Despite their inherent weaknesses, regulatory instruments currently prevail as the main policy tool dealing with water pollution, and cannot be avoided. Some alternative options that should be considered in the future include:

- Choice of best environmental option (sometimes known as the best practicable environmental option), which takes into account the cost of disposal. This allows industries to adopt a multi-media approach, and to select the place and manner of disposing of waste that is the least damaging to the environment.
- Performance-based approach, where the focus is on giving industries environmental goals and the latitude to select the best ways of achieving them. This is an integrated approach that allows for technical and managerial innovation to achieve the best environmental outcome.
- Self-regulation and responsible care, which can be forced on industries by external factors such as trade agreements or the need for eco-labelling.

Source: Mauritius 1998.

Policy measures required to address the issue of water shortages include (UNEP 1998e; UNCHS and UNEP 1999a, 1999b; CSD 1999b):

- proper assessment and monitoring of water resources, as well as the supply and demand aspects of different sectors (domestic, agriculture and industry);
- promoting an integrated approach to use and allocation of water resources throughout river basins through integrated water basin management plans;
- introduction of water conservation measures and technologies for the efficient use of water resources, such as demand management, especially in agriculture and industry (the largest users of water), metering, differential pricing structures, recycling, recirculation or re-use of cooling, process or treated wastewater, conservation measures in irrigation, etc.;
- review of water and land-use policy to eliminate conflicts, e.g. subsidies and price distortions;
- fresh water valuation: use of proper pricing and tariff structures;
- promoting groundwater collectors, rainfall harvesting and storage, and technologies appropriate for SIDS;
- reducing unaccounted for water (leakages, illegal connections and unmetered connections);
- Environmental Impact Assessments (EIAs) for dams, developments, irrigation schemes and similar activities that have a major impact on water courses and water demand;
- promote public awareness on water issues, including the status of resources, use, conservation and pollution.
- control of surface water pollution either through fixed emission standards, water quality objectives, or a mixture of the two;
- protection of groundwater quality through protection zoning, based on the vulnerability of aquifers to contamination, to control potentially polluting activities in catchment areas;
- control of pollution from industrial wastewater through pretreatment of industrial effluents and/or effluent charges, and the adoption of clean technologies, especially in key industries (textiles, sugar factories, fish processing, breweries, chemicals, tanneries, etc.) and urban solid waste;
- establishment of quantitative standards and implementation of monitoring of the levels of key pollutants and/or indicators of environmental degradation;
- compulsory EIAs for all new investments and developments;
- monitoring and reporting of the impacts of all new investments/developments, with the costs borne by the investor/developer;
- financial instruments such as pollution charges or tradable permits for point sources of pollution, or product charges for non-point sources such as agricultural or industrially contaminated land;
- harmonization and enforcement of legislation and regulations concerning all of the above.

In addition to water shortages, contamination and pollution are other major and growing problems. The principal causes of contamination of fresh water, coastal and marine waters are urban waste, sewage and industrial pollution, with coastal cities causing pollution 'hotspots' in the region. Measures needed to control these include (and see Box 3.3):

- creation of 'sustainable' cities by addressing the socio-economic issues underlying urban growth, and urban planning;
- applying integrated solutions to the management of water supply, demand and wastewater disposal, particularly in city planning;

Solid waste management

The disposal of solid waste is a growing problem for the islands of the region as quantities increase because of rising populations, increasing standards of living and changing consumption patterns, and the development of industries such as manufacturing, tourism and marine-related activities. The nature of solid waste to be disposed of is also changing, from primarily organic by-products to increasing quantities of inorganic, toxic and hazardous wastes. The main problems regarding solid waste management for the island states are: pollution of groundwater, surface and marine waters from leakage or seepage; lack of sewage treatment facilities; lack of waste disposal sites; lack of facilities for the management, storage and disposal of toxic and hazardous substances (CSD 1999a), such as agrochemicals, heavy metals, oily wastes, synthetic organic chemicals and hospital waste; ineffective regulations; and inadequate institutional and human resource capacities.

Policy measures that need to be implemented to

address the issue of solid waste management include (CSD 1999a; UNEP 1998e):

- integrated waste management, including waste reduction and minimization strategies, cleaner production and environmentally sound technologies, recycling, re-use and composting;
- use of waste such as bagasse (sugar cane residue) for energy generation;
- development and improved management of sanitary landfills;
- harmonization and implementation of legal frameworks concerning waste management;
- implementation and monitoring of standards, regulations and guidelines for waste and pollutant disposal by industries;
- port reception and disposal facilities for ship-borne waste;
- development of long-term storage and disposal facilities for hazardous waste;
- use of economic instruments and incentives such as landfill taxes, recycling credits, liability deposits and deposit-refund systems;
- involvement of the private sector, NGOs and the general public;
- initiatives at the regional level, including implementation of environmental agreements such as the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities; training; waste management strategies; and initiatives such as establishment of regional waste disposal or recycling facilities;

Table 3.2: Options for sectoral policy

Sector	Environmental issue	Alternative policy instrument
Macroeconomy	● Sustainability	● Resource accounting and sustainability indicators ● Environmentally sensitive economy-wide measures
Coastal and marine resources	● Coastal pollution ● Overdevelopment ● Overfishing	● Effluent charges ● Tradeable development rights ● Tradeable fishing quotas
Water	● Scarcity ● Pollution ● Land sterilization through over-application	● Removal of subsidies ● Extraction charges ● Effluent charges ● Irrigation charges ● Tradable water rights
Solid waste	● Land scarcity ● Leachate run-off (from landfills) ● Air pollution (methane from incinerators) ● Nuisance (odours and vermin)	● Landfill taxes ● Recycling credits ● Deposit-refund systems ● Liability systems (for hazardous waste)
Biodiversity / Tourism	● Overuse ● User conflicts ● Pollution	● Entry charges to regulate pressure on resources and maximize revenue ● Community participation, management of resources and incentives ● Biodiversity prospecting (intellectual property rights) ● Resource franchising agreements (debt for nature swaps, etc.) ● Effluent charges ● Deposit-refund systems
Energy	● Air pollution ● Global climate change (Greenhouse gases)	● Fuel switching ● Economic incentives for renewable energy ● Cleaner production and technologies ● Proper energy pricing
Forestry	● Deforestation ● User conflicts	● Concession bidding ● Deforestation taxes/royalty taxes ● Resource franchise agreements (debt-for-nature swaps, etc.)
Agriculture	● Pollution runoff ● Soil erosion ● Agro-chemical abuse	● Removal of subsidies ● Property rights (soil conservation) ● Input charges (fertilizer, pesticides)

Source: Based on Commonwealth Secretariat 1997.

- innovative initiatives such as educating tourists about small island issues and encouraging them to collect their rubbish and take it home with them, as has been done in the Maldives.

Sectoral policy options

Policies for sustainable development require domestic reforms regarding resource and property rights, implementation of market-based instruments, elimination of price distortions to achieve full cost recovery, proper accounting and economic valuation of environmental assets, and the proper reflection of the global value of indigenous assets. A wide range of policy measures can be adopted to achieve these objectives and therefore contribute to the sustainable development of the Western Indian Ocean island states. Some examples are given in Table 3.2.

Alternative policies: Island Systems Management

Based on Nichols and Chase (1997)

Traditional coastal zone management recognizes the interdependence and interactions of terrestrial and marine ecosystems, and is one of the main current environmental and sustainable development management issues for island states. The coastal zone has traditionally been regarded as a band, with a defined width, which is the transition between land and sea. However, there is a lack of standardization of the concept of the 'coast', which leads to a variety of terms (integrated coastal zone/area management (ICZM/ICAM), coastal area or resources management, etc.) and presents a number of difficulties when applied to islands, especially small islands.

Islands must be viewed as complete units, characterized by a complex matrix of interactions between systems. It is impossible to manage the use of part or parts of the island system without considering the impacts on other parts of the system. There is therefore a need to revise the concept of the 'coast' in relation to island management. In practice, the entire land mass of small islands and its juridical marine area should be regarded as the 'coastal zone'. This is the 'Island System' concept, which has been developed into the 'Island Systems Management (ISM)' approach: 'a multidisciplinary, multisectoral, multifaceted mechanism aimed at rationalizing the use of island resources and the achievement of the goals of sustainable development'. It has been described as 'an adaptive

management strategy which addresses the issue of resource use conflicts, and which provides the necessary policy orientation to control the impacts of human interventions on the physical environment'. ISM, however, requires the necessary 'institutional and legal framework to co-ordinate the initiatives of all public and private sectors, while ensuring the common goals are attained through a unified approach' (Nichols and Chase, 1997).

Most management and regulatory regimes have adopted a sectoral approach, which is reflected in institutional arrangements and governmental planning. However, this approach has proved inadequate in addressing the sustainable development of island states such as those of the Western Indian Ocean, particularly their ecological sustainability, and tends to create resource use conflicts. The IOC/REP's five-year Integrated Coastal Zone Management programme is coming to an end and its results have still to be evaluated. However, it has been suggested that ICZM in general has not yet been successfully implemented anywhere because of institutional and human resource constraints (CSD 1999c). New definitions of the coastal areas of small islands are now being proposed which encompass the entire land mass and its judicial marine area (Briguglio 1997b), and not just coastal strips of a certain width. There is therefore growing recognition among planners and resource managers of the need for integrated planning and management, which is boundary less, and which will address not only the current environment and development pressures, but also the long-term restoration, protection, maintenance and sustainability of natural, cultural and economic resources of island states.

In response to the recognized need for a harmonized policy framework for the management of island states, the Organization of Eastern Caribbean States Natural Resources Management Unit (OECS-NRMU), has developed the Coastal Resources Management Initiative (CRMI) as an example of ISM for the region. CRMI is defined as a participatory, interactive, multi-stakeholder, multidisciplinary, multisectoral approach aimed at achieving the sustainable use(s) of resources at local, national and regional levels. Coastal resources management therefore becomes an integral part of a broader framework of integrated development planning and management (Nichols and Chase, 1997).

The successful management of island resources requires a mixture of science, policy, law and

administration, and is highly dependent on the social, economic, cultural and political circumstances of each island state. The concept of Island Systems Management has been endorsed by small island states as the strategy to be adopted in order to achieve sustainable development (Briguglio 1997b), and may therefore be the alternative policy of the future for the island states of the Western Indian Ocean, which could benefit from investigating the initiative underway in the Eastern Caribbean and its applicability to the region.

Conclusion

As they enter the twenty-first century, the island states of the Western Indian Ocean face a number of challenges linked to environmental and economic vulnerability, principally to achieve development that is environmentally, economically and socially sustainable. Current trends suggest that there are increasing socio-economic pressures on the natural resource base, on which all these states are highly dependent, leading to continuing environmental degradation.

Their environmental vulnerability is highlighted by both the current and emerging environmental issues that they will have to face. Over some of these they have little or no control, such as climate change and increasing weather extremes, while others are the result of poor or inadequate management processes, because these countries are constrained by lack of technical, financial or institutional capacities.

Policy responses so far have been inadequate, either in scope or in their application, and there is increasing recognition of the need for new, alternative policy options with the following characteristics:

- **Integrated policies:** moving away from the sectoral approach used in the past, which tends to create resource use conflicts that are also an emerging issue for some island states (see Table 3.1). The multi-disciplinary, multi-sectoral, multi-faceted Island System Management approach, which aims to rationalize the use of island resources and achieve the goal of sustainable development, is currently being applied in the Eastern Caribbean. The applicability of this alternative policy approach could be further investigated for the Western Indian Ocean region.
- **Use of market-based instruments:** these have an important complementary role to play, especially removal of subsidies, proper pricing of

environmental and natural resources, and incentive-based instruments.

- **Greater awareness** by policy-makers in all sectors of government, as well as at all levels of society, of the interactions between socio-economic factors and the environment, of the need for sustainable development, and their participation in decision-making and management processes to achieve it. In other words, the environment must be given equal priority with economic development planning, but issues such as poverty and sustainable human development must also be addressed.
- **Greater capacity** is needed to deal with these increasing challenges, requiring human, technical, institutional and financial development.

Countries of the Western Indian Ocean have begun responding to these challenges, at both the national and regional levels, with the development of sustainable policies and institutional structures. However, the challenge of their economic vulnerability remains and is illustrated by the importance and implications of the current negotiations for a new Agreement under the Lomé Convention. With its focus on poverty eradication, social policies and sustainable management of the environment and natural resources, this Agreement has the potential to provide powerful support at the national and regional level for the goal of achieving sustainable development. However, there is considerable uncertainty about the ending of well-established relationships and mechanisms that have operated for almost 25 years, as well as about some of the new ones being proposed. In addition, these proposals do not always appear to adequately reflect the handicap of vulnerability with which these island states exist. This is an additional challenge with which the Western Indian Ocean island states, in common with other ACP countries, enter the twenty-first century.

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Acronyms

Participants in the Regional Consultation

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Acronyms

ACP	African, Caribbean and Pacific	NEAP	National Environment Action Plan
AMCEN	African Ministerial Conference on the Environment	NGO	Non-governmental Organisation
ANGAP	Association Nationale pour la Gestion des Aires Protégées	NIP	National Indicative Programme
AOSIS	Alliance Of Small Island States	OAU	Organization for African Unity
CBD	Convention on Biological Diversity	ODA	Official Development Assistance
CBO	Community Based Organisation	ODSs	Ozone-Depleting Substances
CCD	Convention to Combat Desertification	OECD	Organisation for Economic Co-operation and Development
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna	OECS	Organization of Eastern Caribbean States
CMS	Convention on the Conservation of Migratory Species of Wild Animals	OPRC	Convention on Oil Preparedness, Response and Co-operation
COI	Commission de l'Océan Indien	PPP	Polluter-pays-principle
COMESA	Common Market for East and Southern Africa	PSIP	Public Sector Investment Programme
CSD	Commission for Sustainable Development	REPA	Regional Economic Partnership Agreement
CVI	Composite Vulnerability Index	RIP	Regional Indicative Programme
EC	European Community	SADC	Southern African Development Community
ENSO	El Niño/Southern Oscillation	SAF	Structural Adjustment Facility
EDF	European Development Fund	SIDS	Small Island Developing States
ESID	Environmentally Sustainable Industrial Development	SNA	System of National Accounts
FAO	United Nations Food and Agriculture Organization	SOPAC	South Pacific Applied Geoscience Commission
FDI	Foreign Direct Investment	SRAP	Sub-Regional Action Programme
FTAs	Free Trade Areas	Stabex	Stabilization of export earnings from agricultural commodities system
GCOS	Global Climate Observing System	UIO	University of the Indian Ocean
GEF	Global Environment Facility	UM	University of Mauritius
GSP	Generalized System of Preferences	UNCED	United Nations Conference on Environment and Development
HDI	Human Development Index	UNCHS	United Nations Centre for Human Settlements
HIPCs	Heavily Indebted Poor Countries	UNCLOS	United Nations Conference on the Law of the Sea
ICAM	Integrated Coastal Area Management	UNDHA	United Nations Division of Humanitarian Affairs
ICZM	Integrated Coastal Zone Management	UNDP	United Nations Development Programme
IIASA	International Institute for Applied Systems Analysis	UNECA	United Nations Economic Commission for Africa
IOC	Indian Ocean Commission	UNEP	United Nations Environment Programme
IOC/REP	Indian Ocean Commission Regional Environment Programme	UNFCCC	United Nations Framework Convention on Climate Change
IORARC	Indian Ocean Rim Association for Regional Co-operation	UNFPA	United Nations Population Fund
IPCC	Intergovernmental Panel on Climate Change	UNIDO	United Nations Industrial Development Organization
ISM	Island Systems Management	WCMC	World Conservation Monitoring Centre
ISO	International Standards Organisation	WTO	World Trade Organization
LDCs	Least Developed Countries		
MARPOL	International Convention for the Prevention of Pollution from Ships		
MEAs	Multilateral Environmental Agreements		
NAP	National Action Programme		

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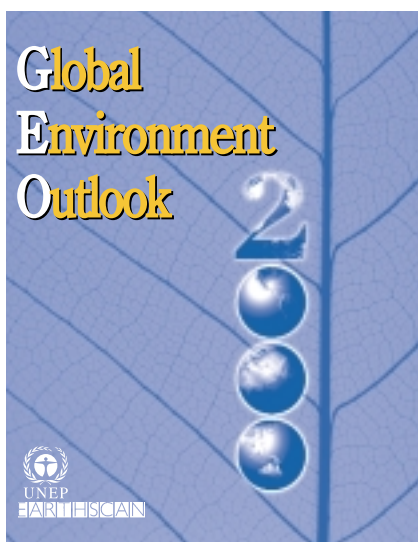
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