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## Global Environment Facility

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GEF MSP Sub-Saharan Africa Project (GF/6010-0016):

“Development and Protection of the Coastal and  
Marine Environment in Sub-Saharan Africa”

# SEYCHELLES NATIONAL REPORT PHASE 1: INTEGRATED PROBLEM ANALYSIS

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March 2002

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The components of the GEF MSP Sub-Saharan Africa Project (GF/6010-0016) "Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa" have been supported, in cash and kind, by GEF, UNEP, IOC-UNESCO, the GPA Coordination Office and ACOPS. Support has also been received from the Governments of Canada, The Netherlands, Norway, United Kingdom and the USA, as well as the Governments of Côte d'Ivoire, the Gambia, Ghana, Kenya, Mauritius, Mozambique, Nigeria, Senegal, Seychelles, South Africa and Tanzania.

## Table of Contents

	Page
Executive Summary .....	i
Seychelles Country Profile .....	ixv
<b>Chapter 1</b>	
1. Introduction.....	1
1.1 Population and Economy .....	1
1.2 Geography and Climate .....	5
1.3 Coastal Habitats .....	5
1.3.1 Coral Reefs .....	5
1.3.2 Lagoons.....	6
1.3.3 Coastal Marshes (Freshwater Wetlands) .....	6
1.3.4 Sandy Foreshores.....	6
1.3.5 Mangroves .....	7
1.3.6 Seagrass Meadows.....	7
<b>Chapter 2</b>	
2. Scoping and Description of Methodology .....	8
2.1 Identification of Hot Spots, Sensitive Areas and Overriding Issues.....	8
2.1.1 Selected 6 Hot Spots .....	8
2.1.2 Selected 6 Sensitive Areas .....	9
2.2 Overriding Issues .....	10
2.2.1 Relevance of the GIWA List of Issues .....	10
2.3 Scaling: Prioritisation of Hot Spots and Sensitive Areas.....	11
2.3.1 Hot Spots .....	11
2.3.2 Sensitive Areas .....	11
2.4 Scoping: Prioritisation of Issues .....	11
<b>Chapter 3</b>	
3. Assessment of Environmental and Socio-Economic Impacts.....	15
3.1 Modification and/or Loss of Ecosystems or Ecotones.....	15
3.1.1 Environmental Impacts .....	16
3.1.1.1 Modification of Biodiversity .....	16
3.1.1.2 Modification in Storm Barriers.....	23
3.1.2 Socioeconomic Impacts .....	24
3.2 Global Change .....	28
3.2.1 Environmental Impacts .....	28
3.2.1.1 Saltwater Intrusion.....	29
3.2.1.2 Modification of Habitats (Coral Bleaching) .....	30
3.2.1.3 Loss of Habitat Due to Coastal Erosion .....	32
3.2.2 Socio-Economic Impacts .....	33
3.2.2.1 Sea-Level Rise .....	33
3.2.2.2 Coral Bleaching .....	35
3.3 Summary of Gaps/Problems .....	35
<b>Chapter 4</b>	
4. The Causal Chain Analysis.....	37
4.1 Modification and Loss of Ecosystems and/or Ecotones .....	38
4.1.1 Immediate Causes .....	38
4.1.1.1 Modification of Ecosystems and/or Ecotones .....	38
4.1.1.2 Loss of Ecosystems and/or Ecotones .....	41

4.1.2	Sectoral Pressures (for Modification and/or Loss of Ecosystems and/or Ecotones).....	43
4.1.3	Responses .....	46
4.1.3.1	Environmental Management Policies and Tools Designed to Address Environmental Problems .....	46
4.1.4	Sectoral Policies (that Directly Increase the Pressure) .....	49
4.1.4.1	Urbanisation.....	49
4.1.4.2	Tourism.....	49
4.1.4.3	Fisheries.....	50
4.1.5	Community Response (Initiatives from Community or Social groups, which may Alleviate Pressure on the Issue .....	52
4.1.5.1	Market Responses .....	52
4.1.6	Root Causes .....	54
4.1.6.1	Social Change .....	54
4.1.6.2	Institutional Drivers .....	56
4.1.6.3	Economic Structure.....	57
4.2	Global Change (Coral Bleaching and Coastal erosion) .....	58
4.2.1	Immediate Causes .....	58
4.2.1.1	Coral Bleaching .....	58
4.2.1.2	Coastal Erosion .....	59
4.2.2	Sectoral Pressures (Coral Bleaching and Coastal Erosion) .....	60
4.2.2.1	Sectoral Pressures (Coral Bleaching).....	60
4.2.2.2	Sectoral Pressures (Coastal Erosion) .....	61
4.2.3	Responses .....	63
4.2.3.1	Environmental Management Policies and Tools Designed to Address Environmental Problems .....	63
4.2.4	Sectoral Policies (that Directly Increase the Pressure) .....	64
4.2.4.1	Urbanisation.....	64
4.2.4.2	Industry .....	64
4.2.4.3	Tourism.....	65
4.2.5	Community Response (Initiatives from Community or Social Groups which may Alleviate Pressure on the Issue .....	65
4.2.5.1	Market Responses .....	66
4.2.6	Root Causes .....	66
<b>Chapter 5</b>		
5.	Gaps and Commonalities .....	68
5.1	Gaps .....	68
5.2	Commonalities.....	68
5.2.1	Impacts Associated with Socio-Economic Development .....	68
5.2.2	Specificities and Vulnerabilities as a Small Island Developing State.....	68
5.2.3	Commonalities in the Causal Chain.....	69
5.2.4	Transboundary Issues .....	69
<b>Chapter 6</b>		
6.	Conclusions and Recommendations .....	70
6.1	Main Conclusions .....	70
6.2	Recommendations.....	72
6.2.1	General Recommendations .....	72
6.2.1.1	Environmental Management Plan for Seychelles (EMPS, 2000-2010).....	73
6.2.1.2	VISION 21 - Tourism Development in Seychelles 2001-2010.....	74
6.2.2	Specific Recommendations.....	76
<b>References</b>		79

Annex I	Identification Sheets for Hot Spots, Sensitive Areas and Overriding Issues .....	83
Annex II	Summary tables for hot spots, sensitive areas and overriding issues .....	97
Annex III	Reporting and calculation tables for Scoping Exercises.....	101
Annex IV	Habitats and communities suffering significant loss .....	105
Annex V	Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change .....	107
Annex VI	Socioeconomic exposure and summary tables .....	111
Annex VII	Detailed environmental assessment .....	127

## **List of Maps**

Map 1	Seychelles showing Hot Spots and Sensitive Areas .....	2
Map 2	Seychelles Major Island Groups .....	3
Map 3	Location of Main Island Groups in Relation to Africa .....	4

## **List of Tables, Figures and Charts**

Table 1	Threatened Endemic Bird Species .....	21
Table 2	Area of Reclamation 1973-2002 .....	42
Table 3	Major export items, 1995 – 2000.....	44
Table 4	Tourism Arrivals and Income 1995-2000.....	50
Table 5	Exports by the Fisheries Sector 1993-99 .....	50
Table 6	Tuna Catch Statistics (by Main Species) 1994-99 .....	51
Table 7	Total Artisanal Catch (1994-99) .....	51
Table 8	Percentage Contributions of the affected sectors to GDP.....	57
Figures 1-3	Threats to Seychelles' Biodiversity .....	19
Figure 4	Present Status of threatened endemic plants .....	20
Figure 5	Present Status of threatened Land Molluscs .....	20
Figure 6	Present Status of threatened endemic Insect Species.....	20
Figure 7	Present Status of threatened endemic reptiles.....	21
Figure 8	Value of Seychelles' Biological Resources .....	27
Figure 9	Economic Instruments for biodiversity conservation .....	28
Figure 10	Semi Industrial Fisheries Total Catch 1995-99 .....	51
Chart 1	Immediate Causes of Modification of Habitats or Ecotones .....	40
Chart 2	Immediate Causes of Loss of Habitats or Ecotones.....	41
Chart 3	Root Causes of Loss of Ecosystems & Ecotones .....	56
Chart 4	Coral Bleaching Causal Chain .....	62
Chart 5	Coastal Erosion Causal Chain.....	63
Chart 6	Root Causes of Coral Bleaching & Coastal Erosion.....	67
Box 1	Impact of the 1997/98 ENSO Event on the Tuna Industry .....	35
1.		



## **Executive Summary**

This Integrated Problem Analysis for Seychelles was conducted between December 2000 and August 2001. The exercise comprised of three phases. Phase 1 commenced with identification of hot spots, sensitive areas and overriding issues. A *scaling exercise* then prioritised 3 hot spots and 3 sensitive areas, and a *scoping exercise* that prioritised the relevant issues. Phase 2 focused on an assessment of environmental and social impacts, and Phase 3 on the analysis of causal chains for the three selected issues.

### **Phase 1: Scaling and Scoping**

In Phase 1, a preliminary *identification of hot spots and sensitive areas* resulted in an agreed list of 6 hot spots and 6 sensitive areas (see Annex I and II). The identified hot spots included three from the main island of Mahe, two from the second island of Praslin, and one from the third island of La Digue. For the identified sensitive areas, three sites were situated on Mahe, one on Praslin, the Curieuse Marine Park and Ste. Pierre, and the Cosmoledo Atoll. The main overriding issues that were identified were: (i) pollution; (ii) habitat and community modification; and (iii) global change.

In the *scaling exercise*, 3 hot spots (the Coastal Plateau of La Digue; East Coast, Mahe; and Anse Volbert, Praslin) and 3 sensitive areas (Port Launay and Baie Ternay Marine Parks and adjacent areas; Cosmoledo Atoll; and Mahe Wetlands) were prioritised (see Annex II). The habitats and communities identified as suffering significant loss were, in order of priority: coral reef lagoons, coastal marshes, sandy foreshores, mangroves, sea grass meadows, fast flowing stony bottom rivers, and ocean fisheries.

In the *scoping exercise*, the issues affecting hot spots, sensitive areas and overriding issues were ranked in order according to *perceived future changes* (see Annex III, IV and V). The most critical issues identified were (i) modification of ecosystems or ecotones; (ii) sea level rise; (iii) loss of ecosystems or ecotones; (iv) coral bleaching; and (v) coastal erosion. Although pollution was initially identified as a major overriding issue, when considering *perceived changes* this was seen as an issue that is to a large extent being addressed at the national level, and therefore manageable. On the other hand, issues such as modification and/or loss of habitat, and those associated with global change (e.g. sea-level rise, coral bleaching and coastal erosion) were considered as posing more of a long-term threat.

### **Phase 2: Impact Analysis**

In Phase 2 the focus of the impact analysis was on the major concerns of (i) habitat and community modification and loss; and (ii) global change. The nature of the impacts on the prioritised hot spots and sensitive areas identified in the scoping exercise differed quite significantly. In the prioritised hot spots, environmental and social impacts are mostly associated with issues related directly to social and economic development, including land reclamation, housing and tourism development. In the three prioritised sensitive areas impacts are typically associated with a greater range of issues, including poaching and over exploitation of resources, upriver water extraction, agriculture and global change, as well as the clearing of land for development purposes (see also Annexes VI and VII).

In the detailed environmental assessment of habitat and community modification, the most important impacts identified were (i) modification of biodiversity, including the loss of species and genetic diversity; and (ii) modification in natural storm barriers. In addition to ecosystem modification directly associated with development related activities, ecosystem modification associated with invasive species was also noted as an important issue.

In the last 25 years the modification and loss of coastal ecosystems on the main granitic islands has accelerated as a result of rapid social and economic development. This is clearly evident in each of the prioritised hot spots, all of which are situated on the coastal plateau where extensive development has occurred since independence in 1976. In the case of the three prioritised sensitive areas, two are located on the main island of Mahe, and are subject to similar impacts from social and economic development, while on Cosmoledo Atoll, impacts are different due to the lack of human settlement, and are related mainly to the exploitation of fisheries and other resources, including illegal fishing and the poaching of birds and turtles.

The major ***threats to endemic species and vegetation*** on the main granitic islands are related to the rapid rate of development, which has led to the conversion of land for infrastructure. While many species of plants are naturally rare, due to the small size of the islands and range restrictions of suitable habitats, habitat destruction has resulted in a further fragmentation of these habitats, particularly at low altitudes and on the coastal plateau. While the introduction of animal species has been the major cause for the rarity of invertebrates, the major threat to vertebrates has been human predation, although this has declined in recent years for most threatened species. Habitat loss as a result of housing and tourism development is a major factor, particularly in the main granitic islands, especially for those species that are range restricted. Introduced plant species, where they are invasive, are also a major threat in the granitic islands, and several endemic species of tree are currently under threat as a result of diseases thought to have been introduced. The introduction of species such as rats and cats has also been a significant factor on many islands, particularly for a number of rare bird species.

Historically, the extensive areas of wetland marshes and mangroves have played an important role as ***flood and storm barriers***, by breaking the force and impact of wave action. During the nineteenth and twentieth centuries these habitats were gradually removed. The pressures on these ecosystems have been further intensified by deforestation and construction on hillsides as the demand for land has increased. The consequent erosion and leaching of Seychelles red earth has led to the over-siltation of wetlands. Another contributing factor has been the invasion of many freshwater wetlands by alien species. Finally, diversion of water from rivers for use by human settlements and for agricultural irrigation has resulted in insufficient throughput of water to wetlands.

Rapid social and economic development has intensified the pressure on the coastal environment as the scarcity of flat land has led to land reclamation over the reef flats. As coral rubble is used as fill, there is consequent loss of all shallow marine habitats in the vicinity, and some modification of surrounding habitats. Another contributing factor to the modification of storm barriers is the increase in beachfront developments, for housing, hotels and roads, which has resulted in the removal of coastal vegetation from dune land, thus increasing the vulnerability of beaches to sand erosion.

The ***modification of ecosystems and/or ecotones*** has always been significant in the socio-economic development of the country, as upland areas are mostly unsuitable for either agriculture or other types of development. On the coastal areas, where land is at a premium, reclamation has been practiced extensively ever since the islands were first settled. Under such circumstances, it is difficult to identify immediate negative socio-economic impacts, as much of the development that has led to modification and/or loss of habitats have been associated with improvement to infrastructure for tourism, housing and recreation, which has benefited local populations. On the other hand, the costs of management of such “modified habitats” has increased, particularly on the large reclamation areas on the East Coast of Mahe, and the threat of sea-level change will greatly add to such costs as additional coastal protection measures will be required.

Nevertheless, the loss and modification of ecosystems, and consequent impacts on biodiversity, are not purely ecological issues, as the major economic sectors, particularly fisheries and tourism, are directly dependent on biological resources. In addition, ecosystems/biological resources provide many indirect

values, including acting as a sink for wastes and residues and in the protection they afford to beaches and watersheds. Such resources also have the potential for future economic returns, including possible pharmaceutical, industrial and agricultural applications. Finally, there is also an intrinsic value to Seychelles' biological resources in terms of their cultural and aesthetic significance. If the country's biodiversity resources are lost or significantly diminished, the benefits that can be accrued from biological goods and services will diminish progressively, and will have a major impact on Seychelles' economy and society in general. However, biodiversity conservation also has cost implications, both in terms of direct expenditures and in terms of limiting certain production and consumption activities. For example, the cost of mitigating and protecting Seychelles' ecosystems includes (i) the cost of foregoing or diminishing unsustainable activities; (ii) the costs of replacing and/or adapting technologies that impact negatively on biodiversity; and (iii) the direct physical costs of biodiversity management and protection. The challenge facing Seychelles is to identify ways and means for apportioning the costs of conservation in the most efficient and equitable manner and, taking account of the financial constraints of Government, how to generate revenues to finance biodiversity conservation.

In common with other small island developing states, Seychelles is vulnerable to ***global climate change***. The country is threatened both environmentally and economically from the effects of such global change, including sea-level rise (with impacts on coastal erosion), the increasing incidences of extreme weather conditions, and climate-induced changes to ecosystems (such as coral bleaching and an increasing incidence of invasive species). Such impacts will undoubtedly have adverse effects on efforts to achieve sustainable development. In the detailed environmental assessment of global change three issues were identified as being of particular importance, namely (i) saltwater intrusion into freshwater aquifers; (ii) coral bleaching; and (iii) loss of habitats and damage to coastal zones as a result of coastal erosion.

While the nature and extent of the threat to Seychelles' endemic habitats and biodiversity remains an issue that needs to be researched, it is clear that most habitats are at risk and will be severely modified by climate change, with some being more vulnerable than others. First of all, any increase in sea level will flood the remaining areas of mangroves, since most mangroves areas on the granitic islands are typically situated behind dunes and are often below sea level. Climate change will also have a variety of impacts on coral reefs. The modification and loss of mangrove and coral reef habitats will in turn have major impacts on a range of coastal and marine organisms, as well as fish species, with far reaching socio-economic consequences.

On the main populated granitic islands (Mahe, Praslin) water supply is derived mainly from water catchments (dams), and directly from rivers and streams. Nevertheless, ***saltwater intrusion to freshwater aquifers*** is increasingly becoming a problem on both the smaller granitic islands and coralline islands. Moreover, while it is only on the granitic islands of La Digue and Fregate, and most of the coralline islands, that groundwater is extracted for use, coastal habitats and biodiversity are also dependent upon the integrity of groundwater aquifers and freshwater lens.

Over the past 200 million years, ***coral reefs*** have adapted to numerous changes, although over most of this period there was no pressure from human activities. However, reefs are now faced with a combination of threats, including over exploitation, pollution and especially global climate change. All of these threats are increasing, and in particular human activities are leading to the acceleration of global climate change that may make it difficult for coral reefs to adapt and survive. Global change is likely to impact on coral reefs as a result of sea level rise, temperature increase, reduced calcification rates, altered ocean circulation patterns, and increased frequency of severe weather events. Another likely impact of global climate change is a greater frequency and intensity of coastal flooding, particularly during severe storms or during abnormal high tides. The typical topography of the main granitic islands, which is characterized by steep mountain slopes means that the narrow coastal zones are particularly vulnerable. The coral reefs and coastal vegetation protect the coast against storms and

beach erosion, while the wetland and mangrove areas around the coast act as flood and storm buffer zones. Any degradation of these environments therefore makes beaches and coastal areas generally more vulnerable to erosion, with serious economic impacts, notably on the tourism industry. The range of complex sensitivities associated with shoreline change and erosion also indicates the influence of human-derived impacts on coastal systems, which increases the sensitivity of systems to climate change.

### Phase 3 - Causal Chain Analysis

The immediate causes of ***modification of ecosystems*** in Seychelles are mainly the result of land development (land use changes), associated especially with urbanisation and tourism development. Changed freshwater and sediment supply is also an important contributing factor, again linked especially to urbanisation and tourism development. It is estimated that land development as a result of urbanisation and tourism and leisure development each account for around 30% of the immediate causes of modification of ecosystems. Transport developments in the form of new road construction and port development, and changed freshwater and sediment supply each contributing to around 20% of the immediate causes. Global change is also a significant immediate cause of modification of marine habitats, particularly evident on coral reefs (***coral bleaching***), as well as the increasing likelihood of global climate change induced weather anomalies and sea level rise that will affect many coastal habitats.

The immediate cause of ***loss of ecosystems and ecotones*** is overwhelmingly associated with land use conversion, associated principally with urbanisation. This is particularly true on the main island of Mahe, where large-scale land reclamation projects have taken place on the East Coast over the past 30 years. Closely related are losses of marine ecosystems as a result of dredging/dredge-spoil activities (including losses as a result of deposition of sediment). Another cause of loss of habitat is the reclamation of land from the sea for the purpose of waste disposal. The loss of habitat associated with land use conversion has however not been limited to the East Coast of Mahe. Throughout the main populated islands of Mahe, Praslin and La Digue, significant loss of freshwater marshes (and some mangroves) has occurred, though data on the total area is not available. On the third island of La Digue, there has been significant loss of lowland forest, principally for housing and tourism and leisure developments.

The main ***sectoral pressures*** are ***urbanization*** and ***tourism development***, both of which have led to significant land use changes/conversion. Urbanisation is estimated to contribute as much as 60% of the pressure, as land use conversion/land reclamation is driven by the need for suitable land for social and economic development in a situation where there are high expectations and strong political pressures to maintain recent levels of growth and social development. The total area of land reclaimed on the East Coastal of Mahe during the past 30 amounts to around 629 hectares and represents just over 4% of the total land area of Mahe. Elsewhere, the development of hotels and other tourism establishment on coastal areas has contributed to loss of ecosystems. There has also been extensive land-use conversion resulting in loss of habitats on the upland areas, especially for housing development.

The ***root causes*** of land use conversion/land reclamation is the need for land suitable for social and economic development. Although Seychelles is a developing country, it has experienced very rapid social and economic development over the past 20 to 30 years, with GDP per capita has increasing from US\$ 3,600 in 1975 to US\$ 7,192 in 1998. The increase in population and demographic change has been a significant factor in the increased demand for flat land suitable for housing and associated infrastructure development. Increasing numbers of tourist arrivals, which have grown from 54,490 in 1971 to 130,046 in 2000 is also a significant factor. Finally, rapidly changing lifestyles, including increased and changing consumption patterns and rising expectations are a major root cause of the pressure on ecosystems.

### ***Global Change (Coral Bleaching and Coastal Erosion)***

The dominant **immediate causes** of coral bleaching are large-scale “global threats” that have resulted in an increase of sea temperatures, which is estimated to contribute to the coral bleaching in Seychelles waters on a scale of at least 70%. These global threats are the result of natural causes and global pollution, and are transboundary issues that are beyond the control of any national government. Although the major cause of coral bleaching is a global phenomenon, there are local, particularly around the main islands of Mahe, Praslin and La Digue, that can be identified as contributing factors and/or factors that inhibit full recovery. These include sediment discharge, sedimentation from reclamation activities, and local increase in seawater temperature. However, these factors only account for around an estimated 25% of the pressure.

While the threat of sea-level rise to reefs (as opposed to reef islands) is negligible on a global scale, sea-level rise poses more of a threat to reef systems around small island states where reef structures are under stress from human activities. In addition, on the main granitic islands of Seychelles, which are mountainous and surrounded by coral reefs, the increasing frequency of heavy rainfall patterns and flood conditions have resulted in increased sediment flows that contribute to the deterioration of fringing reefs already under stress as a result of rising sea temperatures, and other human activities.

The local contributing sectoral pressures on coral reefs emanate from a range of sources, including industry (23%), urbanisation (22%), tourism (15%), transport (14%), agriculture (13%), and fisheries (8%). The impact of industries on coral reefs is almost exclusively localized along the east coast of Mahe. Although the Seychelles has a policy favouring light industries, certain rather large manufacturing industries all have localized impacts on the health of coral reefs. Urbanisation also generates sources of both point source (sewage systems) and non-point (runoff) sources of pollution, which will have a direct impact on coral reefs in terms of coastal water enrichment as well as sediment deposition. Tourism infrastructure located close to many coral reef areas may cause bleaching in reefs through the increase in discharge of laundry water and sewage into the sea. However, their contribution to coral bleaching is far less than from urbanization. Both agriculture and fisheries have little impact on coral reefs with regards to bleaching.

By far the largest threat to coral reefs within the Seychelles is mass coral bleaching arising from global change effects, such as increased sea surface temperatures. Fine scale surveys undertaken in the granitic islands of the Seychelles following the 1997/98 coral bleaching event showed that in many parts live coral cover has been reduced to 10%. This is by far the largest extent of bleaching of several orders of magnitude higher than was ever recorded in Seychelles. The impact of such a natural catastrophe linked to climate change, more specifically global warming, is yet to be completely evaluated especially its relevance to fisheries stock, coastal stability and tourism.

As with coral bleaching, the issue of **coastal erosion** is identified primarily as a transboundary issue and a consequence of global change, probably contributing to more than 50% of the problem. These transboundary causes include sea level rise, increased wave intensity, and abnormal high tides. In addition, there are a number of more localized contributing immediate causes, including marine structures built along the coast, beach and sand mining, land use change, reclamation, changed freshwater and sediment supply due to dams, diversion, etc., and the clearance of channels and passages across reefs.

The local threats arise from a range of **sectoral** pressures, including urbanization, tourism and industry, which together account for an estimated 70% of the problem, while lesser pressures also originate from transport, fisheries and agriculture. Since there has always been an acute scarcity of coastal land to support urban development, coastline modification along the east coast of Mahe have been happening since colonization in the eighteenth century, and recently on a much larger scale. Tourism is also a primary cause of coastal erosion, mainly arising from attempts to cosmetically

improve the beach and swimming areas, as well as the provision of marine facilities such as marinas and piers. The impacts of sea level rise will have a significant impact on these stressed coastlines, and there is already evidence of severe degradation in areas not impacted by man. Climate Change is also predicted to cause an increase in weather and wave extremes.

While **root causes** can largely be identified as arising as a result of global change, at the local level the root causes of both coral bleaching and coastal erosion were very similar to those described for the modification and loss of ecosystems and ecotones, namely: (i) social factors associated with population and demographic change and changing values/life-styles, together with social and economic development; (ii) institutional drivers, notably the strong government commitment to social and economic development; and (iii) an economic structure that is small in size and which has the typical features of other small island developing states, and a development model that emphasizes growth.

### **Gaps and Commonalities**

While there is a strong awareness at government level of the need to promote sustainable development, there are many gaps and limitations in addressing environmental problems. The major constraint in addressing environmental problems in Seychelles is the critical lack of data. In most cases this includes a general lack of baseline studies. This lack of data was apparent in both the *impact analysis* and *causal chain analysis*. While it was possible to observe some critical examples of impacts on the marine and coastal environment, and to identify their causes, there is little hard data and few studies available that could form the basis for informed decisions to be taken on interventions to mitigate such impacts. This is in large part due to the absence of any institutions of higher learning or research in Seychelles. Nevertheless, some biodiversity studies are now being undertaken, notably relating to birds and invertebrates on some small islands, and on the impact of coral bleaching.

In the course of the causal chain analysis (and in the earlier parts of the exercise) a number of commonalities were clearly identified. In the first place, the issue of social and economic development was identified as a major cause of environmental problems throughout the causal chain. This is in marked contrast to many other countries in the region, where inequitable models of development and the existence of widespread poverty are probably more important issues. At the same time, the government has consistently given a relatively high priority to the management and protection of the environment, and is committed to promoting development that is economically, socially and environmentally sustainable.

The issue of land reclamation (for socio-economic development generally) and coastal developments associated the tourism industry were recurring themes throughout the causal chain analysis, particularly with respect to impacts on ecosystems (loss and modification). The issues were also among the local factors (as opposed to the impacts associated with global change) impacting on coral bleaching and coastal erosion.

In addition to social and economic vulnerability, many small island developing states, including Seychelles are faced with extreme environmental fragility, and are particularly vulnerable to the threats posed by global warming, notably sea-level rise. This is clearly an important issue in Seychelles, as global change was one of two issues identified during the causal chain analysis.

Among the recurring themes were the issues of enforcement, and limited resources (financial and human). Although Seychelles boasts a wide and comprehensive range of laws and other instruments aimed at the protection and conservation of the environment, monitoring and enforcement is often a major problem. This is particularly true of the marine environment, and specifically in relation to surveillance and enforcement within the country's large exclusive economic zone (EEZ), which covers

1.3 million square kilometres. One aspect of the weaknesses associated with effective implementation of existing policy tools and instruments is an inadequate degree of inter-sectoral coordination.

The major ***transboundary issues*** identified in the causal chain analysis were those associated with global change (i.e. global warming and sea level rise). In addition, the protection, conservation and management of Seychelles' endangered and endemic species may also be considered as a transboundary issue, from a number of perspectives. Finally, the Seychelles' unique granitic islands are important from a geological and evolutionary perspective.

In drawing conclusions and making recommendations based on the Integrated Problem Analysis as a whole, account must be taken of two important policy documents/plans that are to be launched this year, namely "*VISION 21 for Tourism Development 2001-2010*" and the "*Environmental Management Plan for Seychelles 2000-2010*", since these policy documents each propose actions and initiatives that if effectively implemented will address many of the issues identified in the Report.



## Seychelles Country Profile



### Geography and Environment

Surface area :	455 sq km
Coastline:	491 km
Maritime claims:	<p><i>contiguous zone</i>: 24 NM</p> <p><i>continental shelf</i>: 200 NM or to the edge of the continental margin</p> <p><i>exclusive economic zone (distance from shore)</i>: 200 NM</p> <p><i>territorial sea</i>: 12 NM</p>
EEZ:	1,300,000 km <sup>2</sup>
Natural resources:	Fish, copra, cinnamon trees
Land use:	<p>arable land: 2%</p> <p>permanent crops: 13%</p> <p>permanent pastures: 0%</p> <p>forests and woodland: 11%</p> <p>other: 74% (1993 est.)</p>
Environment - international agreements:	<p>party to:</p> <p>Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Nuclear Test Ban, Ozone Layer Protection, Ship Pollution</p> <p><i>signed, but not ratified</i>:</p> <p>Climate Change-Kyoto Protocol to be ratified in 2002.</p>

### Population

Population:	79,715 (July 2001 est.)
Population growth rate :	0.49% (2001 est.)
Life expectancy :	70.69 years (2001)
Urban population (% of total):	54.8 (1995)
% living on the coast	100%
Population density on the coast	176 hab/km <sup>2</sup>

<b>Economy</b>	
GDP: purchasing power parity	- \$610 million (2000 est.)
GDP - real growth rate:	- 1.5% (2000 est.)
GDP per capita: purchasing power parity	- \$7,700 (2000 est.)
GDP composition by sector:	
<i>agriculture, forestry and fisheries</i> :	3.2%
<i>manufacturing and construction sector</i>	
<i>(including industrial fishing)</i> :	28.8%
<i>Other transport and distribution</i> :	23.7%
<i>Government services</i> :	13.8%
<i>Finance and services</i> :	10.0%
<i>Other services</i> :	7.8%
<i>tourism related direct</i> :	12.7% (1999)
Labor force:	30,900 (1996)
Labor force - by occupation:	Industry 19%, services 71%, agriculture 10% (1989)
<b>Industries:</b>	fishery; tourism; processing of coconuts and vanilla, coir (coconut fiber) rope, boat building, printing, furniture; beverages
<b>Electricity</b> - production:	160 million kWh (1999)
Electricity - production by source:	Fossil fuel: 100%
Electricity - consumption:	148.8 million kWh (1999)
Electricity - exports:	0 million kWh (1999)
Electricity - imports:	0 kWh (1999)
<b>Agriculture</b> - products:	coconuts, cinnamon, vanilla, sweet potatoes, cassava (tapioca), bananas; broiler chickens; tuna fish
Exports:	\$111 million (f.o.b., 1999)
Exports - commodities:	fish, cinnamon bark, copra, petroleum products (reexports)
Imports:	\$440 million (c.i.f., 1999)
Imports - commodities:	machinery and equipment, foodstuffs, petroleum products, chemicals
<b>Currency code:</b>	SCR
Exchange rates:	Seychelles rupees per US dollar - 5.61714 (January 2002) 6.0397 (2001), 5.6009 (2000), 5,3426 (1999), 5.2622 (1998), 5.0263 (1997), 4.9700 (1996)

## CHAPTER 1

### 2. Introduction

#### 2.1 Population and Economy

The Seychelles is an archipelago consisting of 115 granite and coral islands that occupy a land area of 445 sq. km within an Exclusive Economic Zone (EEZ) of 1.3 million sq. km in the South Western Indian Ocean between 4 and 9 degrees south of the equator.

The country's population is currently estimated at around 80,410 (1999). Approximately 90% of the population and infrastructure is located on the main island of Mahe. The country has a per capita income of around US\$ 7,000. Tourism, fisheries and a growing industrial sector dominate the economy of the country.

The Seychelles economy has undergone major structural changes since gaining independence in 1976. As recently as the early 1970's, agriculture accounted for around 9% of total GDP, with cinnamon and copra the major exports. Today, agriculture accounts for a mere 3% of GDP, and employs less than 6% of the labour force.

The opening of the international airport in 1971 transformed the economy by laying the foundations for the development of the tourism industry, which is now the principal industry in Seychelles accounting for more than 12% of GDP and around 17% of the labour force. The sector is also the main foreign exchange earner, accounting for around SR 750 million in 1999 (US\$137 million). The fisheries sector is now the second most important, both in terms of foreign exchange earnings and employment. The artisanal fisheries sector based, which has traditionally provided the major source of protein for the Seychellois population, has in recent years expanded to meet the demand of the tourism industry. There is also an increasingly lucrative export market for high quality fish products. In addition, the development of the industrial fisheries sector is now an important foreign exchange earner, where exports of canned tuna to the European Union generated a record SR 531.9 million (approx. US\$ 96 million) in export earnings in 1999.

Paralleled with the relative decline in agriculture has been the boom in the construction industry, as significant areas of land previous given to agriculture have been developed. The boom in the construction industry is partly linked to the need for development of infrastructure (including an ambitious housing programme) and the needs of the tourism industry. Currently, the construction sector accounts for just over 10% of total GDP.

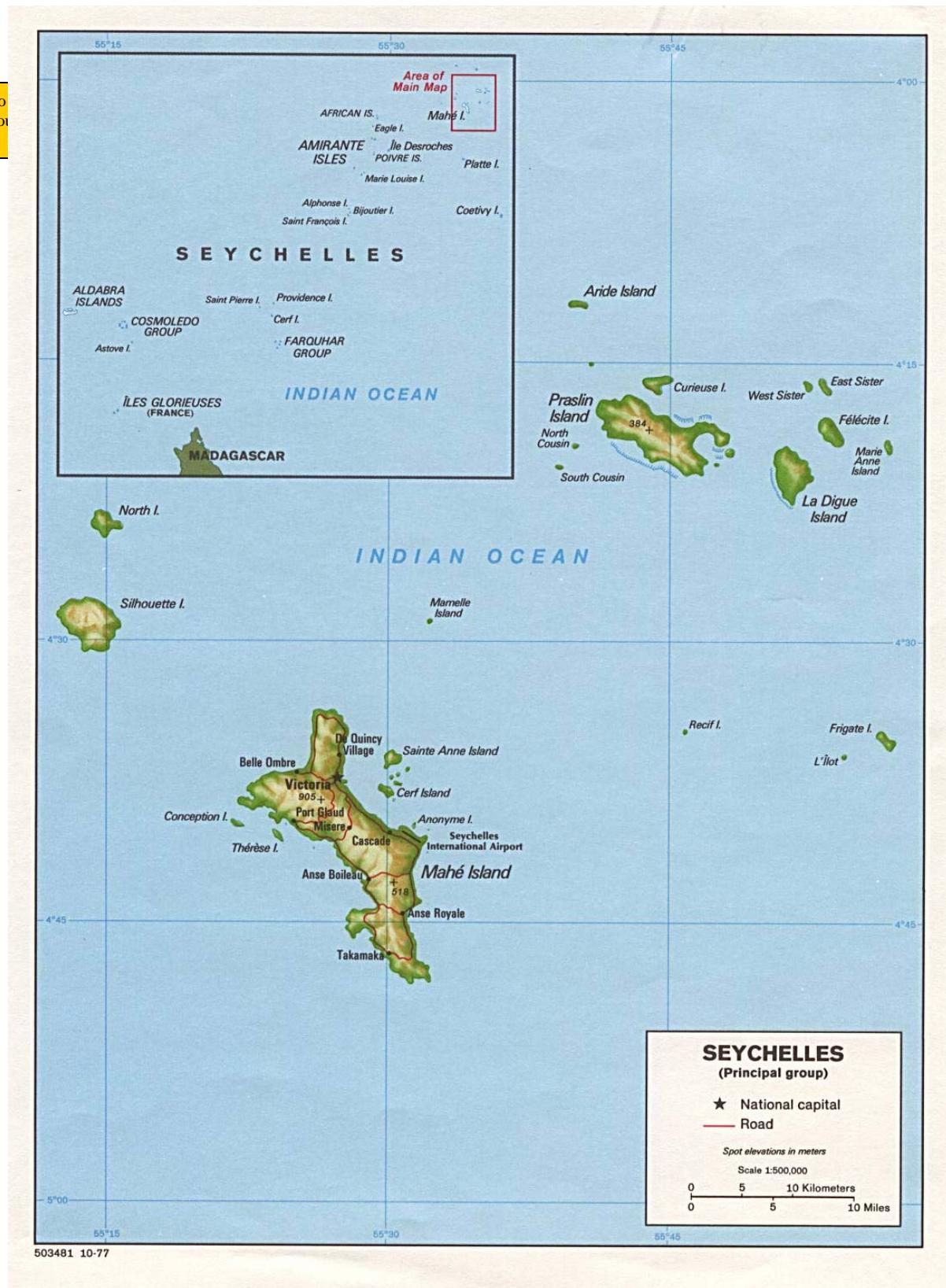
The transformation of the Seychelles economy has been matched in the social sector, and the country has progressed rapidly. This is illustrated by Seychelles ranking as a middle-income country in the UNDP Human Development Index, where was placed in 53<sup>rd</sup> position in 2000, the highest ranking in Africa and ahead of countries such as Mexico (55), Cuba (56), Belarus (57), Bulgaria (60), the Russian Federation (62), Saudi Arabia (75) and Turkey (85).<sup>1</sup>

This commitment to social development is reflected in the increasing life expectancy of the Seychellois people, which at 67.6 years for males and 75.7 years for females is comparable to the highest standards in the most developed countries. Other impressive social indicators include the low infant mortality rate (10.3 per '000), school enrolment figures of nearly 100%, a pupil/teacher ratio of 1 to 13.8, and the high ratio of medical officers to population (1 to 750).

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<sup>1</sup> Numbers in brackets refer to position in UNDP Human Development Index.

### Map 1. Seychelles showing Hot Spots and Sensitive Areas

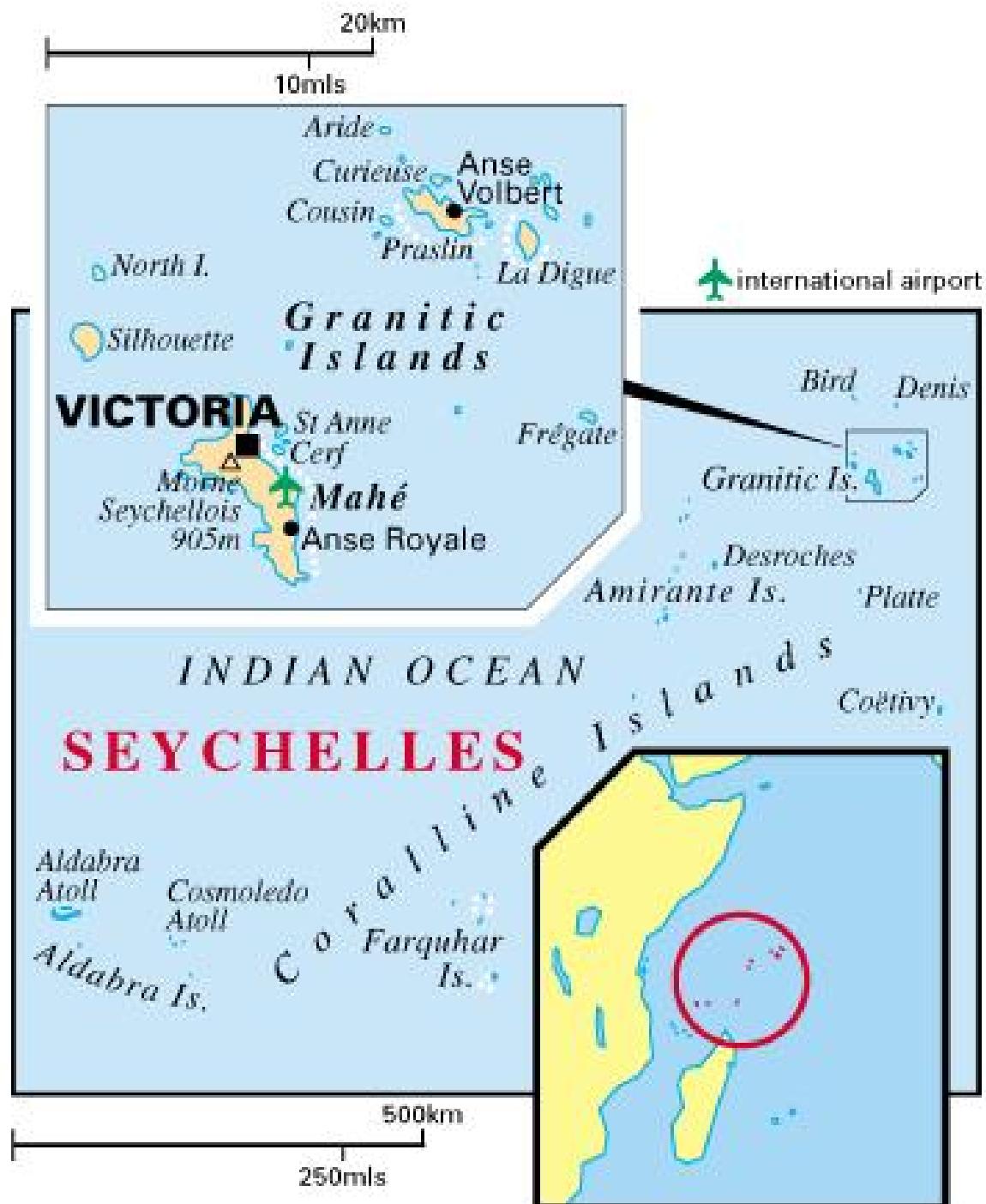


NB: The Mahe Wetlands are not shown, as these are small areas located at numerous areas around the island.

**Map 2. Seychelles Major Island Groups**



**Map 3. Seychelles : Location of Main Island Groups in Relation to Africa**



## 2.2 Geography and Climate

The archipelago is divided into two distinct groups of islands: the granitic group comprising 43 islands with mountainous peaks and narrow coastal lands, and 72 low-lying outer coralline islands.

All of the 43 granitic islands are found within a radius of 50 kilometres from the main island of Mahe. With a land area of 148 sq km, Mahe, the seat of government, constitutes about one-third of the total land area. The other two islands of major importance as regards to size and population are Praslin and La Digue, 33.6 km and 48 km from Mahe, respectively. Of the coral islands, Aldabra is the largest and furthest, located 1,150 km to the southwest.

The granitic islands are of Precambrian origin, formed from the breakup of Gondwanaland around 755 million years ago by tectonic activity (Stephens, 1994). The granite islands rise from the Seychelles Bank, a sunken micro-continent and shoal area of about 31,000 sq km, with depths ranging up to 60 metres. Many islands in the group are characterized by a very narrow coastal plateau, which rarely rises above 2m above sea level. The plateau consists of calcareous reef material, which builds up as sand dunes and pocket beaches known as “anses”. Mahe has about 36 km of sandy beaches. The total plateau area on the islands where most development is occurring (including tourism, transport, and housing) is small in area, with the largest areas occurring on Praslin and La Digue. The 397 km of surfaced roads (MISD, 1999) servicing the transport sector on the three main granitic islands are situated mostly on the coastal zone following the coastline.

The climate of Seychelles is strongly influenced by equatorial maritime air originating either from the Mascarene Anticyclone during the Southern Hemisphere winter or from the inter-tropical convergence zone (ITCZ) during the austral summer months. Temperature and humidity remain generally high throughout the year with a mean temperature of 26.9° C, and humidity of 80%. Daytime temperature is about 5° C warmer than night minimum temperatures. There is very little seasonal variation. From May to October, the Southeast trades usually result in relatively cooler and drier conditions. Seychelles lies outside of the cyclone belt.

## 2.3 Coastal Habitats

### 2.3.1 Coral Reefs<sup>2</sup>

Three main types of reefs have traditionally been identified in Seychelles, namely fringing reefs, platform reefs and atolls. The fringing reefs in the granitic Seychelles have been recently defined as algal reefs or shallow water carbonate platforms instead of the usual type of ‘fringing reef’. Platform reefs include those at Platte, Darros, Cerf Islet at Providence, African Banks and Coetivy. Raised platform reefs are a sub-category, which exceed 8 metres in height and lack a central lagoon. Atolls include Farquhar, Alphonse, St. Francis and St. Joseph. Raised atolls include Aldabra, Cosmoledo and Astove. Other islands have distinct characteristics that do not match classical descriptions. Many of these islands have no upward growth and are therefore prone to sea level change and subsidence.

A number of coral associations, each with its optimum environment, defined principally in terms of water movement and light availability were formulated based on observations on the East Coast of Mahe in the 1970s. The associations included the *Calcareous algal association*, the *Pocillopora association*, the *Faviid association*, the *Porites association*, and the *Foliaceous coral association*. Recently, some of these associations have been confirmed to be present in the other granitic islands. New coral associations that have recently been described on both granitic and coral islands are the *Heleopora association*, the *Pavona association*, the *Millepora association*, and the *Sinularia association*.

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<sup>2</sup> The reef system is loosely defined here as the complex of communities including sea grasses (Seychelles Biodiversity Strategy and Action Plan, 1997).

Reef zones typical of the granitic islands consist of the following zonation patterns: beach, rippled sand zone, marine grass beds, radial zone, algal ridge, reef edge and the outer slopes.

### **2.3.2 Lagoons**

Three main types of lagoon can be identified in Seychelles, all of which are represented amongst the identified hot spots and sensitive areas. These are: -

1. enclosed and/or partially enclosed lagoons associated principally with coral atolls, such as those of Cosmoledo and Aldabra. These lagoons have a mixture of habitats, such as fringing mangrove, sandy foreshores, seagrass beds, mudflats, coral rubble and different coral associations;
2. lagoons associated with fringing coral reefs, which are found principally between the outer fringing reef and the land. These occur both around the granitic islands and many of the coralline islands. These lagoons exhibit similar characteristics to the above, but are generally smaller; and
3. man-made lagoons that have been formed as a result of land reclamation. The best examples of such lagoons are on the East Coast of Mahe, where extensive land reclamation has taken place between the fringing reef and land. The conditions in these lagoons are similar to estuarine habitats, with deposited sediments and mangroves. It is worth noting that on the East Coast of Mahe, land reclamation has resulted in the creation of new estuarine habitats.

Lagoons in Seychelles are rich in biodiversity and have traditionally been exploited for fish and other marine species (i.e. octopus, shellfish, etc). The development of the tourism industry over the last 30 years has led to the exploitation of molluscs and corals for souvenirs, although some attempts have been made to limit such exploitation. They are important as habitats for young turtles.

### **2.3.3 Coastal Marshes (Freshwater Wetlands)**

Most wetlands in Seychelles are found close to the sea along the coastal plains, but some are totally divorced from the sea and a few have developed at higher altitude. The size of freshwater wetlands in the granitic islands is difficult to quantify because of continual impact by human activities.

The typical flora of the freshwater wetlands consists of grasses, sedges and reeds, and the upland also contains endemic plants, and associated organisms such as terrapins, frogs and a wide range of insects. However, many wetlands are threatened by invasive species. Endemic caecilians can be seen, and the two endemic sub-species of terrapin, *Pelusios castanoides interregularis* and *Pelusius subniger parietalis* are restricted to wetlands. The Black Paradise Flycatcher (*Terpsiphone corvine*), a red data bird, depends upon wetlands for its food, constituting insects. Moorhens are also found in wetlands in the granitic islands. There are also numerous native invertebrate species.

### **2.3.4 Sandy Foreshores**

There are approximately 36 kilometres of sandy shores on Mahe, 21 kms on Praslin and 8 km on La Digue. The vegetation on the sandy foreshores of most of the Seychelles islands has been severely modified. Certain species, such as *Pisonia grandis* have disappeared from the shores of the larger islands.

Apart from well known animals, sandy shores are also inhabited by micro-fauna. Besides crabs (particularly *Ocypode spp.*) animals such as marine turtles and sea birds use sandy foreshores as nesting sites. In the intertidal zone the only apparent successful species are of two genera of suspension feeding bivalves (*Atactodea* and *Donax*).

### **2.3.5 Mangroves**

Mangals once covered much of the coastline on the granitic islands, especially close to river mouths and marshland. On the Mahe East Coast, mangals are re-establishing themselves in the lagoon areas created by coastal reclamation. Mangroves are absent from the non-atoll coralline islands where conditions for their colonization are unfavourable. Aldabra, Cosmoledo and Astove are the only important mangroves localities on the outer islands.

Existing mangrove areas show a zonation typical of the Western-Pacific region. The general features of the mangrove assemblies in Seychelles are low species diversity, high species abundance and preponderance of a few species of herbivorous gastropods and bivalves.

The crab *Uca annulipes* and two species of mudskipper are abundant. At Aldabra, the fauna of the mangroves found near the lagoon channels is typical marine fauna.

Mangroves are also important bird habitats. Various species of seabirds such as Boobies (*Sula sula*) and Frigatebirds (*Frigate minor*) are associated in large colonies in mangrove areas on Aldabra.

### **2.3.6 Seagrass Meadows**

Seagrasses are flowering marine plants, which are found mainly in shallow flat sandy areas, and are widespread around all the islands in the archipelago. Seagrass meadows in Seychelles are an important habitat for a wide range of fish species (including many that are commercially important), as well as green turtles, urchins, sea cucumbers, molluscs, etc.

## CHAPTER 2

### 3. Scoping and Description of Methodology

#### 3.1 Identification of Hot Spots, Sensitive Areas and Overriding Issues

A preliminary identification of hot spots, sensitive areas and overriding issues was undertaken at an introductory national meeting held on 22<sup>nd</sup> December 2000. At this meeting the national coordinator outlined the background to the GEF MSP Sub-Saharan Africa Project and the methodology agreed upon at the First Meeting of the Working Group on Integrated Problem Analysis (WGIPA) held in Paris on 14<sup>th</sup> December 2000. The First National Meeting was convened on 25<sup>th</sup> January 2001. The meeting was re-convened on Saturday 27<sup>th</sup> January and again on the 31<sup>st</sup> January and 1<sup>st</sup> and 2<sup>nd</sup> February 2001.

During the introductory meeting the team agreed on a preliminary list of 6 hot spots and 6 sensitive areas. It should be noted that given the small size of Seychelles and the expertise of team members, this preliminary identification was considered as effectively covering all the major hot spots and sensitive areas of the country. Each of the national experts were allocated 2 hot spots and 2 sensitive areas from the list, in order to commence the task of completing the identification sheets (WGRCA-1/4) for each site. Subsequently, prior to the First National Meeting, the national experts met informally on two occasions to discuss and analyse work in progress.

The identified hot spots included three from the main island of Mahe, two from the second island of Praslin, and one from the third island of La Digue (West Coast Plateau). The identified sensitive areas included three from Mahe, one from Praslin; the Curieuse Marine Park & Ste. Pierre, and Cosmoledo Atoll.

#### 3.1.1 Selected 6 Hot Spots<sup>3</sup>

The following six hot spots were identified (see also Annex I and II):

##### ***La Digue – West Coast Plateau***

La Digue is the fourth largest granitic island of the Seychelles, and is an important tourism destination. The flat plateau on the western side of the island is the main population area of La Digue and also houses 90% of the hotel establishments. There has been rapid development over the past five years. Among the main environmental threats are the rapid removal of remaining forest cover, loss and modification of remaining wetlands, changes in hydrology (flooding, shortage of groundwater, etc.), increased pollution due to human activities, and coral bleaching.

##### ***East Coast Mahe (from North Point to Anse Forban)***

The East Coast of Mahe is the most intensively developed region in Seychelles, and has been subject to extensive land reclamation, which is still an ongoing process. The capital city, port, airport and most of Seychelles' industries are situated in the region. There is also increasing construction of high-density housing and other infrastructure. Coastal pollution is increasing, there is air pollution in certain areas, and leachates from landfill. The Ste. Anne Marine Park, located within five kilometres of the East Coast Mahe was affected by the 1997/8 El Nino induced coral bleaching, and flooding of the coastal plateau as a result of accelerated sea-level rise is likely to occur.

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<sup>3</sup> These hot spots are listed in order of eventual prioritization.

**Anse Volbert, Praslin**

The area is located on an extensive plateau area on the second largest island of Praslin, which is undergoing significant tourism development. Anse Volbert is the most developed area of Praslin in terms of hotels and other tourism services. The main issues affecting the coastal environment are coastal erosion, discharge of wastewater and coral bleaching from elevated sea surface temperatures experienced during the 1997/8 EL Nino episode.

**Ste. Anne Marine Park**

The Ste. Anne Marine Park is situated just off the coast of the port and capital city of Victoria, and is the first marine protected area in the region. The main impacts include silt from neighboring reclamation activities, as well as increased tourist visits to the park.

**Beau Vallon Bay**

The area includes the most heavily developed tourism facilities in Seychelles. It is also a densely populated area. At present degradation is being mitigated by interventions under the Environmental Management Plan for Seychelles (EMPS). The major threats to the site are pollution and habitat and community modification, as well as global change.

**Baie Ste. Anne, Praslin**

Baie Ste. Anne is a major inner-island harbour and centre of tourism development that has recently been subject to extensive reclamation activities.

**3.1.2 Selected 6 Sensitive Areas<sup>4</sup>**

The following 6 sensitive areas were identified:

**Port Launay & Baie Ternay Marine Parks/Port Glaud Mangroves & islands of Conception & Thérèse**

The area comprises of two shallow marine habitats, sandy beaches, rocky shores and an adjacent area of mangrove. Two marine parks are situated in the area, which are a breeding place for marine organisms and a resting place for migratory birds. The main human activities related to the site include tourism (diving, snorkelling, picnics), fishing, increasing development of residential areas, and proposed hotel developments. The major threats include; changes in water flow; pollution (microbiological, eutrophication, chemical, solid wastes); modification of eco-systems (mangroves, coral reefs, seagrass beds); over-exploitation of coral reef resources and coral bleaching.

**Cosmoledo Atoll**

The Cosmoledo Atoll is located 1,054 km from the main island of Mahe. The atoll comprises of 15 islands, a lagoon and marine area exceeding 10km<sup>2</sup>. The atoll is important from a global biodiversity point of view, and has the largest grouping of some bird species in the region. It is also a prime turtle nesting area, and has endemic plant and insect species, extensive coral reefs, lagoon fish, crustacea and sea cucumbers. Although there is no permanent human settlement, the Atoll is under severe threat from human intervention (illegal fishing, poaching), and from invasive species, diseases and coral bleaching.

Note: Although the site scored low in the scaling exercise, this was due to the fact that it has no human settlement and is not exploited for national development, and thus criteria 4 recorded a low score (1) and criteria 5-7 recorded zero scores. It was nevertheless felt that the site is under severe threat primarily due to external factors (global change), which is compounded by its isolation and lack of human settlement which makes it a prime target for illegal fishing and poaching. The national team therefore placed the Atoll at number 2 in the prioritised list of Sensitive Areas.

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<sup>4</sup> The sensitive areas are listed in order of eventual prioritization.

### ***Mahe Wetlands/Mangroves***

The remaining wetlands of Mahe exist in scattered patches around the coastal plateau and totals very approximately 130 ha, and includes 40 areas of freshwater marsh/mangrove and 98 small rivers. The main threats to these remaining wetlands are continued modification by human activities, non-point pollution from agricultural run-off, septic tanks, etc. excess siltation due to the clearing of uplands for development purposes, and less throughput of water due to the extraction upriver for human use. Sea-level rise will produce salination of freshwater marshes.

### ***Curieuse Marine Park/Ste. Pierre***

The Curieuse Marine Park is situated just off the second island of Praslin, and is an important site in terms of marine and terrestrial biodiversity. It also has some cultural/historical significance. While the site is scored high in the assessment and is threatened by the same issues that apply to other sites examined (habitat and community modification, unsustainable exploitation of fisheries and other living resources and global change), it was not selected as it is a site that is already a focus of intervention to mitigate such threats.

### ***Intendance/Police Bay/Takamaka***

The area comprises one main village (Takamaka) and extensive unspoilt coastal habitats (including sandy beaches, rocky shores, freshwater marshes and mangroves, turtle breeding beaches) covering approximately 10km<sup>2</sup>. The major threats to the area include new hotel developments, increase in residential population through housing construction, and weak Land Use Planning legislation.

### ***Anse Lazio, Praslin***

Anse Lazio is situated on the second island of Praslin and is internationally renowned as one of the most beautiful beaches in the world. It is thus a focus of increasing tourist activities. The major threats to the site stem primarily from such activities and include pollution and habitat and community modification, as well as global change.

## **3.2 Overriding Issues**

The following were the main overriding issues that were identified:

- pollution;
- habitat and community modification; and
- global change.

At this stage in the exercise, the team restricted itself to listing the overriding issues by broad category (i.e. pollution), rather than by specific issues within each category (i.e. microbiological pollution, eutrophication, etc.).

### **3.2.1 Relevance of the GIWA List of Issues**

Although the team agreed that the GIWA methodology provides a useful method of rating sites, it was felt that it did have some shortcoming so far as small island states are concerned, particularly when measuring against other regional or global sites. In particular, it was agreed the scoring for such criteria as “size of affected area”, “size of affected population” and “population at risk” could be misleading when comparing with sites in other countries and regions (the total population of Seychelles is around 80,000, while the land mass is just 455.3 Km<sup>2</sup>). Likewise, the total absence of local communities at one site in particular (Cosmoledo) made the criteria “*Extent to which the natural coastal and marine resources of the site support the livelihood of local communities*” redundant. The same applied to the criteria, “*Extent to which the natural coastal and marine resources of the site support the national development*”. Even the criteria concerning “cultural value” had little relevance to most sites in Seychelles. Finally, it was noted that (again because of the small size of the population) the criteria relating to “*involvement of communities in local management*” was often redundant.

### **3.3 Scaling: Prioritisation of Hot Spots and Sensitive Areas**

Using their expert knowledge of the 12 sites initially identified, the team undertook the exercise according to the prescribed methodology (see Annex III to V), and arrived at a viable list of 3 prioritised hot spots and 3 prioritised sensitive areas. It should be noted however that the team used considerable discretion in ranking one of the identified sensitive areas, namely Cosmoledo Atoll, (see table above). The final prioritised list of Hot Spots and Sensitive Areas was as follows: -

#### **3.3.1 Hot Spots**

- the Coastal Plateau of La Digue;
- East Coast, Mahe; and
- Anse Volbert, Praslin

#### **3.3.2 Sensitive Areas**

- Port Launay and Baie Ternay Marine Parks (and adjacent areas);
- Cosmoledo Atoll; and
- Mahe Wetlands

### **3.4 Scoping: Prioritisation of Issues**

Notwithstanding the constraints referred to above, the scoping methodology for the prioritization of issues was seen as useful, and resulted in a consistent and valid assessment. The close correlation between the identified overriding and prioritised issues was notable.

**Ten major issues were identified for hot spots**, grouped under:

- I Freshwater Shortage (lowering of water table);
- II Pollution (microbiological, chemical, suspended solids, solid wastes, spills, eutrophication);
- III Habitat and Community Modification (modification of ecosystems or ecotones, loss of habitat); and
- V Global Change (sea level rise).

Two other issues were identified (Coral bleaching and coastal erosion).

**Seven major issue were identified for sensitive areas**, grouped under:

- II Pollution (eutrophication);
- III Habitat and Community Modification (modification of ecosystems or ecotones, loss of habitat);
- IV Unsustainable Exploitation of Fisheries and Other Living Resources (over-exploitation, Impact on biological and genetic biodiversity); and
- V Global Change (sea level rise, changes in hydrological cycle).

The issue of VI Other (Poaching) was also identified.

**The 3 overriding issues** identified in this exercise were:

- II Pollution (eutrophication);
- III Habitat and Community Modification (modification of ecosystems and ecotones); and
- V Global Change (sea level rise).

The following habitats and communities<sup>5</sup> suffering significant loss were identified in order of priority the following:

- coral reefs;
- lagoons;
- coastal marshes;
- sandy foreshores;
- mangroves;
- sea grass meadows;
- fast flowing, stony bottom rivers; and
- ocean fisheries.

The team found the scoping exercise for calculating scores for socio-economic impact rather problematic for a number of reasons. In particular, it was found that indicators were not very appropriate, especially when comparing to other countries in the region. For example, it is well known that the GNP per capita of small island economies such as Seychelles' (US\$ 7,000 approx) is totally misleading as a measure of relative wealth in terms of purchasing power parity. For example, this high GDP per capita does not take account of the high degree of dependence of small island states on imports, which are made more expensive due to distance from markets and the inability to purchase in goods in large quantities. The development of local industries is difficult to achieve due to the lack of resources and economies of scale, which make local production processes uncompetitive. The relative per capita cost of infrastructure development is also high. Small island developing states, which are typically dependent on one or two industries, are therefore highly vulnerable to outside economic shocks. For example, an island economy that is dependent on tourism is vulnerable to the impacts of recession in its major tourism markets, and to disruptions caused by other external factors, such as happened in Seychelles during the 1991 Gulf War, which deterred people from taking holidays due to fears of security on international flights. The terrorist attacks that took place in New York and Washington on 11<sup>th</sup> September 2001, and the subsequent military campaign in Afghanistan are likely to have a similar impact.

In such situations, the decline in foreign receipts has a direct impact on the ability to pay for the imports on which such countries depend. Finally, the economies of many small island developing states are extremely vulnerable to the effects of adverse weather conditions. All these issues are well documented in the *Barbados Programme of Action for the Sustainable Development of Small Island Developing States* (1994), and by numerous studies that have been conducted subsequently by such agencies as the Commonwealth and World Bank.

It was also noted that Seychelles' very advanced system of social welfare (as indicated by human development indicators), and its relatively advanced environmental protection measures, would have the effect of minimizing the perception of its vulnerability to the impact of threats to the marine and coastal environment. The team nevertheless undertook the exercise to calculate socio-economic scores using their best judgment and expert knowledge.

In considering the issues affecting hot spots, sensitive areas and overriding issues, respectively, these were ranked in the following order according to the average score for *perceived changes*:

1. modification of ecosystems or ecotones;
2. sea level rise;
3. loss of ecosystems or ecotones;
4. coral bleaching;

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<sup>5</sup> It must however be noted that due to the small scale of the islands and their respective habitats, it is often difficult to differentiate between different ecosystems.

5. coastal erosion;
6. eutrophication;
7. solid wastes;
8. suspended solids;
9. over-exploitation/Impact on biological and genetic biodiversity;
10. poaching;
11. microbiological pollution; and
12. lowering of water table/spills.

It is to be noted that although pollution was initially identified as a major overriding issue, when considering *perceived changes* the team agreed that this was an issue that is to a large extent being addressed at the national level, and is therefore manageable. On the other hand, issues such as modification and/or loss of habitat, and those associated with global change (e.g. sea-level rise, coral bleaching and coastal erosion), were seen as less manageable and as posing more of a long-term threat.



## CHAPTER 3

### 4. Assessment of Environmental and Socio economic Impacts

In reviewing the methodology and procedures for the assessment it was concluded that in most cases it was not possible to use *monetary values* since there is a serious lack of data to meet the requirements of the assessment. This was felt to be particularly true with respect to the socio-economic impacts of habitat and community modification. It was however agreed that wherever possible an attempt would be made to use *monetary values*, but where data was lacking completely *impact indicators* would be used.

It was also noted that three of the GIWA major issues identified in the *Summary Table for the Scoping Exercise* (modification of ecosystems or ecotones, loss of ecosystems or ecotones, and sea-level rise) were grouped under two GIWA major concerns, namely Habitat and Community Modification (III) and Global Change (V), whereas the fourth identified major issue (coral bleaching) was listed under Other (VI). The team therefore decided to focus the impact analysis on the major concerns of:

- Habitat and Community Modification (III); and
- Global Change (V)

It is notable that modification and loss of habitats reduces the ability of habitats to provide natural services (such as water level regulation on the plateau, plant productivity, prevention of erosion, sediment trapping, natural decomposition), for which little or no data is available (see also Annex VI and VII).

#### 4.1 Modification and/or Loss of Ecosystems or Ecotones

The nature of the impacts on the prioritised hot spots and sensitive areas identified in the scoping exercise differed quite significantly. In the case of the three prioritised hot spots (the Coastal Plateau of La Digue, the East Coast of Mahe and Anse Volbert, Praslin), environmental and social impacts are mostly associated with issues related directly to social and economic development, including land reclamation, housing and tourism development. In the three prioritised sensitive areas (Port Launay and Baie Ternay Marine Parks and adjacent areas, the Cosmoledo Atoll, and the wetlands of Mahe), impacts are typically associated with a greater range of issues, including poaching and over exploitation of resources, upriver water extraction, agriculture and global change, as well as the clearing of land for development purposes.

Nearly 50% of the total landmass of the Seychelles archipelago consists of protected areas and reserves. There are a number of different categories of protected areas, including *Forest Reserves*, *Nature Reserves*, *River Reserves*, *National parks*, *Special Reserves*, *Strict Nature Reserves*, *Areas of Outstanding Natural Beauty*, *Protected Areas*, *Shell Reserves*, *Fisheries Protected Areas*, and *Sensitive Areas*.<sup>6</sup> It is notable that there are no Coastal Reserves. This partly explains why modification and loss of ecosystems is particularly apparent on the coastal plateaus of the 3 main granitic islands of Mahe, Praslin and La Digue. This is illustrated in the three prioritised hot spots, one on each island, which are all situated on the coastal plateau.

While this system of protected areas and reserves has made an important contribution to the protection and conservation of ecosystems and biodiversity, there are a number of critical weaknesses that have been highlighted in the National Biodiversity Strategy and Action Plan. For example, different categories of protected areas are subject to varying interpretations, and several Acts do not provide for the management of protected areas. There is also a lack of statutory and policy guidance regarding the selection and objectives of protected areas, and is notable that these purposes may be for conservation or exploitation, or a combination of both. The direct responsibility for terrestrial national parks and special reserves is ambiguous, and the management of these areas has been relatively passive. Some issues, such as

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<sup>6</sup> Much of the Protected Area systems date from the 1960s. However, current Management Plans exist for only a few of these protected areas (National Biodiversity Strategy & Action Plan – 1997).

boundary determination need to be considered legislatively as well as institutionally, as is the case with the need for sufficient manpower, maintenance or other activities.

As a result of inadequate human resources, existing protected areas and species are difficult to patrol effectively, which has resulted in areas such as the Baie Ternay and Port Launay Marine Parks, and Silhouette, go generally unmanaged as “*paper parks*”. It was also noted that there are a number of restoration and management issues that have arisen related to the allocation of management resources. Human resources (at all levels) and experience in management of protected areas was also identified as a major constraint.

Another weakness identified was the absence of specified provisions regarding buffer zones around protected areas. Among the other weakness identified were:

- inadequate public involvement;
- the lack of effective coordination between tourism and conservation authorities;
- possible conflicts related to land ownership and acquisition in the declaration of new protected areas and habitats; and
- the inadequate enforcement of regulations within protected areas.

Finally, the Plan also highlights the fact that although listed as sensitive areas, the omission of comprehensive protection of wetlands is a major deficiency.<sup>7</sup> It should however be noted that many of these deficiencies are being addressed following the launch of the National Biodiversity Strategy and Action Plan in December 1997.

#### **4.1.1 Environmental Impacts**

In the detailed environmental assessment of ***habitat and community modification***, the most important impacts identified were:

- modification of biodiversity, including loss of species and genetic diversity; and
- modification in natural storm barriers.

The significance of Seychelles’ biodiversity lies in the geological history of the main granitic islands. As an isolated sunken micro-continent Seychelles retains numerous plant and animal species whose ancestors on mainland areas have long since disappeared. Seychelles can therefore be considered a “crucible” of evolution. Its significance to global biodiversity is considerable. On no other isolated oceanic islands do ancient species of caecidians, insects, mosses, frogs and flowering plants occur.

##### **4.1.1.1 Modification of Biodiversity**

The modification and loss of habitat, which is one of the major issues identified in the list of prioritised hot spots and sensitive areas, poses a great threat to Seychelles biodiversity. In addition to ecosystem modification directly associated with development related activities (construction, reclamation, clearing of forests, filling of marshes/mangroves, etc.), ecosystem modification associated with invasive species is also an important issue. The relative importance of these issues is illustrated in the following charts, which estimate the relative importance of the major threats to Seychelles endemic plants, terrestrial vertebrates and terrestrial invertebrates, respectively.<sup>8</sup>

The coastal areas of the main granitic islands have already undergone extensive modification, particularly on the coastal plateaus, as a result of human settlement and development. At the time of first settlement in the late eighteenth century the shores were fringed with indigenous coconut palms and other plants

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<sup>7</sup> Seychelles National Biodiversity Strategy and Action Plan (1997)

<sup>8</sup> Ibid

brought by ocean currents. Endemic flora is little in evidence, except for occurrences of Vakwa Bord-d-Mer (*Pnadanus balfourii*) and Bwa kaful trwa fey (*Allocphylus sechellensis*).

Over time the removal of sand and construction has greatly modified the beach landscape. The same processes have altered the lowland and coastal plains, which were formerly dominated by species such as Terminalia catappa (Badamier), Casuarina equisetifolia (Sed), Intsia bijuga (Gayak), Heritiera littoralis (Bwa-d-tab), Calophyllum inophyllum (Takamaka), Minusops sechellarum (Bwa-d-Nat) and Cordia subcordata (Porse).

The lowland forests at one time extended up to 200-300 metres up the mountainsides, but following settlement nearly all the coastal and lowland forests on the granitic islands were developed for agriculture and cleared for settlement. The greatest remaining abundance of endemic flora lies at the higher elevations, in the intermediate forests and mountain mist forests, as well as on granite rock outcrops known as glacis (Inselbergs).

In the last 25 years the modification and loss of coastal ecosystems on the main granitic islands has accelerated as a result of rapid social and economic development. This is clearly evident in each of the three prioritised hot spots (the Coastal Plateau of La Digue, the East Coast of Mahe and Anse Volbert, Praslin), all of which are situated on the coastal plateaus (one on each of the three main islands), where considerable development has taken place since independence in 1976.

On the Coastal Plateau of La Digue modification of habitat has occurred primarily as a result of land-use conversion for house construction and tourism development. Other contributing factors are pollution (to a limited extent) from domestic and tourism establishments and changes in sand deposition caused by jetty development. Loss of habitat has occurred mainly as a result of land-use conversion (housing and tourism development), which affects woodland and sandy foreshore habitats.

In the case of the three prioritised sensitive areas, two are located on the main island of Mahe (Port Launay and Baie Ternay Marine Parks and adjacent areas, and the Mahe Wetlands) and are subject to similar impacts from social and economic development. In the case of Cosmoledo Atoll, impacts are different due to the lack of human settlement. In Cosmoledo, the main impacts are related to the exploitation of fisheries and other resources (i.e. illegal fishing and poaching of birds and turtles).

### i. Endemic Species and Vegetation

The major threats to endemic species and vegetation on the main granitic islands are related to the rapid pace of development over the past 25 years, which has led to the land use conversion for infrastructure. While many species of plants are naturally rare, due to the small size of the islands and range restrictions of suitable habitats, habitat destruction as a result of fires, logging and construction has resulted in the further fragmentation of habitats, particularly at low altitudes and on the coastal plateau.

Historically, the destruction of habitat, as well as the introduction of animal species (such as rats and tenrecs) has been the major cause for the rarity of invertebrates. The impact of pollutants however is little understood, although the use of pesticides may have had a significant impact in invertebrate fauna at lower elevations. The major threats to vertebrates has been human predation, although in recent years this has greatly declined for most threatened species, with the exception of some seabirds, turtles and fruit bats. Again, habitat loss as a result of social (especially housing) development and tourism is a major factor, particularly in the main granitic islands, and especially for those species that are range restricted.

Of the prioritised hot spots/sensitive areas, while the East Coast of Mahe has long been the major centre of development on the main island of Mahe, the extensive reclamation projects of the past 15 years have had a dramatic impact on reef and lagoon habitats.

## ii. Endangered and Vulnerable Species

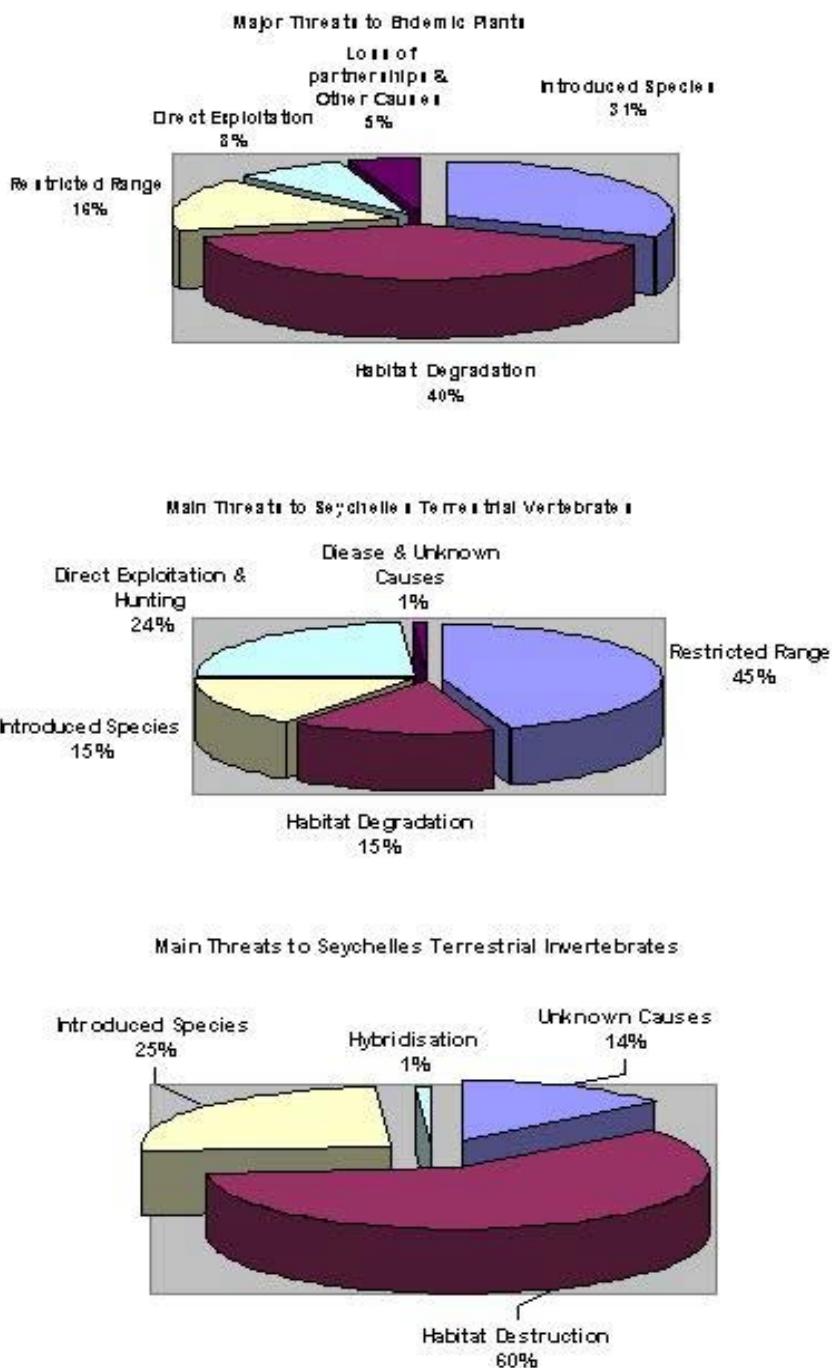
The endemic flora and fauna of the Seychelles' archipelago includes a number of endangered or vulnerable species. The following charts indicate the current status of endemic plants, land molluscs, insect species and reptiles, respectively.<sup>9</sup>

The reptile species includes four species of endangered sea turtles occurring in Seychelles, including green turtles and hawksbills, which still nest and feed in significant numbers, although green turtle nesting has virtually ceased on the granitic islands and is rare in the Amirantes, and since the early 1990s has declined by more than 75% in the southern islands.<sup>10</sup> The Hawksbill turtle remains widely distributed but is still critically endangered, its number having been reduced by at least an estimated 90% during the past century. One significant success story is the Seychelles Giant Tortoise (*Dipsochelys* sp.), which due to extensive conservation efforts on Aldabra Atoll has restored the natural population to around 125,000 animals from an estimated 1,000 animals in the 1890s.

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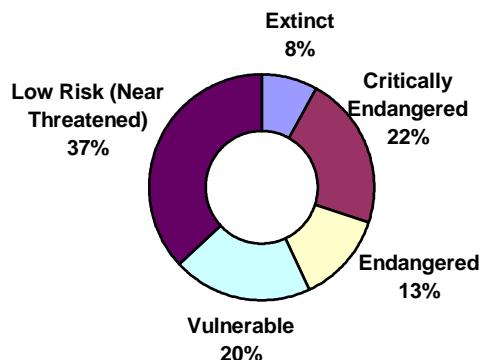
<sup>9</sup> Seychelles National Biodiversity Strategy and Action Plan (1997)

<sup>10</sup> Seychelles National Biodiversity Strategy and Action Plan (1997)

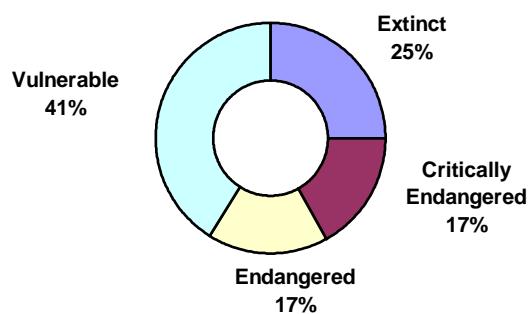


**Figures 1-3. Threats to Seychelles' Biodiversity**

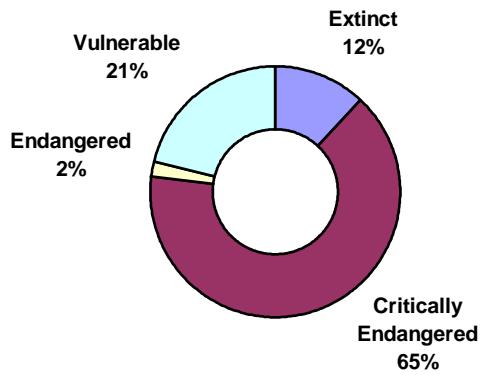
**Figure 4: Present Status of threatened endemic plants**

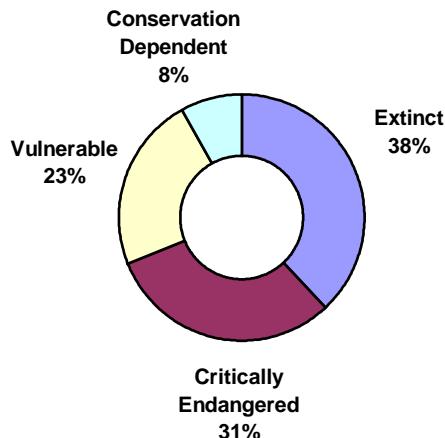


**Figure 5: Present Status of threatened Land Molluscs**



**Figure 6: Present Status of threatened endemic Insect Species**



**Figure 7: Present Status of threatened endemic reptiles**

The bird population of Seychelles includes a number of critically endangered and vulnerable species.

**Table 1. Threatened Endemic Bird Species<sup>11</sup>**

Critically Endangered	Vulnerable	Globally Near Threatened
Seychelles Magpie Robin <i>Copsychus sechellarum</i>	Seychelles Kestrel <i>Falco araea</i>	Drongo <i>Dicrurus aldabranus</i>
Seychelles White-eye <i>Zosterops modesta</i>	Seychelles Swiftlet <i>Collocalia elaphra</i>	Madagascar Pond Heron <i>Ardeola ideia</i>
Seychelles Black Paradise FlyCatcher <i>Tersiphone corvina</i>	Seychelles Warbler <i>Acrocephalus Seychellensis</i>	<i>Nesillas aldabranus</i> (possibly extinct)
Seychelles Scops Owl <i>Otus insularis</i>	Seychelles Fody <i>Foudia seychellarum</i>	

The rare Seychelles Black Parrot (*Coracopsis nigra barklyi*), which occurs only on Praslin, is also of great conservation concern.

The modification and loss of habitat is one of the major threats to many of these threatened endemic species, particularly those that are range restricted and/or that occur in coastal habitats. In other cases, the introduction of alien species, particularly rats, is a major threat. For example, the rapid removal of remaining forest cover on La Digue, consisting of native trees (takamaka/*Calophyllum inophyllum*, bodanmyen/*Terminalia catappa*, and bwa-d-nat/*Mimusops sechellarum*) may have adverse effects on the breeding success of the Black Paradise Flycatcher, which is found only on La Digue. Likewise, the continued modification and loss of the remaining wetlands (from drainage, invasive alien species, and salination), is leading to a loss of wetland biodiversity, which affects the food sources of the Flycatcher, and also results in changes in the hydrology of the Plateau.

Another area of concern is the possible impact of ecosystem modification on fisheries in Seychelles. Annual statistics relating to the artisanal fishery sector have been recorded since at least 1987, including species composition by percentage and measures of catch effort.<sup>12</sup>

<sup>11</sup> Seychelles National Biodiversity Strategy and Action Plan (1997)

<sup>12</sup> Seychelles Fishing Authority (2000) *Seychelles Artisanal Fisheries Statistics for 1999*. Seychelles Fishing Authority Technical Report

However, although there has been some variation in the abundance of certain commercially important fish species over the past decade, no major trend has so far been revealed that could be related to a specific environmental factor or to habitat modification. Nevertheless, such data could be of value in the future (perhaps not specifically for habitat modification), as there are indications that there is considerable pressure on fish stocks in near shore waters.

### **iii. Invasive Species**

Introduced plant species, where they are invasive, are a major threat in the granitic islands of Seychelles. Although the threat is most severe in the remaining areas of high altitude forest, some species are widespread at all altitudes (i.e. cinnamon, albizia). Invasive plant species also pose a threat to biodiversity in coastal areas, including areas such as the La Digue Plateau and the wetlands on Mahe, where water hyacinths and water lettuce are widespread. The prevalence of invasive creepers (such as philodendron) throughout the granitic islands is already a well-known and understood threat to indigenous and endemic plant species, notably in the World Heritage Site of Vallee de Mai, on Praslin. However, recently a number of other invasive creepers have been noted that had previously not been seen on the islands (e.g. the liana *Entanda rheedii* has recently been discovered on Mahe). Creepers threaten Seychelles indigenous plants by forming a canopy over extensive areas, competing unfavourably with an area's indigenous vegetation. In addition, invasive species can host a myriad of pests and insects that could also pose a threat to native flora. Indeed, it is to be noted that several important species of tree (e.g. *Takamaka*, *Sandragon*) are currently under threat as a result of diseases thought to have been introduced.

The introduction of species such as rats and cats has also been a significant factor on many islands, particularly for a number of rare bird species. On some outer islands, the introduction of pigs (on Cosmoledo), goats, (on Aldabra) and mice has had significant impacts on endemic fauna.

### **iv. Successful Biodiversity Conservation Experiences**

While much of Seychelles' endemic biodiversity is threatened by the modification and loss of ecosystems, and other threats, there have been a number of notable success stories in the protection and conservation of biodiversity. The case of the Seychelles Giant Tortoise on Aldabra has already been referred to above. Another successful experience is that of sea turtle nesting, following the introduction of regulations (e.g. CITES) and the enactment of various legislation creating nature reserves and the full protection of all turtles. Both Hawksbill Turtles and Green Turtles nest throughout the Seychelles, however the granitic islands and the Amirantes group are more important for Hawksbills, whereas the outer islands are more important for Green Turtles. The small granitic island of Cousin became an unofficial nature reserve in 1968 and was legally protected in 1969. Turtle monitoring began in 1971 and has continued until the present. During more than two decades of protection, nesting activity at Cousin Island approximately tripled. Recent statistics indicate a continuation of this trend.

Aldabra Atoll is another protected area where turtle nesting has been monitored on a long-term (though sporadic) basis from the 1960s, and on a more regular basis since the 1980s. Although figures have not yet been officially published, a significant increase in numbers of nesting turtles has been noted. It is to be noted that although officially protected, turtles are still extensively poached in the outer islands, such as Cosmoledo, where there is no human presence.

It is important that these efforts continue, and that monitoring is undertaken on a continuous and consistent basis, in order to identify any future trends occurring in the reverse direction. In addition to direct human impacts associated with (for example) land use changes, poaching, etc.

there is also a need to monitor the effects of changes associated with global climate change, such as sea level change and beach erosion.

Another area in which conservation of biodiversity has been successful is with respect to the populations of several coastal endemic bird species. For example, the populations of the highly threatened Seychelles Brush Warbler and Seychelles Magpie Robin have responded well to conservation programmes. The numbers of Brush Warblers have increased from about 40 birds on one island in the 1980s to several thousand birds on three islands at present. In 1990, the Magpie Robin, which had once been widespread throughout the granitic islands had been reduced to around 17 birds on the island of Fregate, due to predation by rats and habitat loss. As a result of conservation efforts initiated by BirdLife International, the population had recovered to 96 birds by the end of 1996, and present on four islands. There are presently a number of other ongoing bird conservation programmes in Seychelles, administered by various agencies.

#### **4.1.1.2 Modification in Storm Barriers**

At the time when Seychelles was first settled in the latter half of the eighteenth century, the coastal zones of the granitic islands were characterised by extensive areas of wetland marshes and mangroves, which played an important role as flood and storm barriers, by breaking the force and impact of wave action. During the nineteenth and twentieth centuries these habitats were gradually removed. Until the 1960s, mangroves were exploited for timber, for use in construction for roofing beams and as firewood. From the time of the first settlement, wetlands and mangroves have also been drained or reclaimed for the purposes of construction of houses and roads, and also for agriculture. Wetlands and mangroves have also been regarded as ideal dumping grounds for solid wastes and wastewater. The pressures on these ecosystems have been further intensified by deforestation and construction on hillsides as the demand for land has increased. The consequent erosion and leaching of Seychelles red earth has led to over-siltation of wetlands. Another feature has been the invasion of many freshwater wetlands by alien species, such as water hyacinth (*Eichornia crassipes*) and water lettuce (*Pistia stratiotes*). Finally, diversion of water from rivers for use by human settlements and for agricultural irrigation has resulted in insufficient throughput of water to wetlands.

While the extensive areas of mangroves around the granitic islands of Seychelles have been gradually removed since the eighteenth and nineteenth centuries, the coral reefs and shallow lagoons generally remained intact until more recent times. The removal of mangroves is most pronounced on the east coast of Mahe, due to intensive coastal development, although there are some new colonies of mangroves re-establishing themselves in the lagoon areas created by land reclamation. However, these new mangrove habitats do not act as storm barriers, since they are located between the shore and areas of reclaimed land.

Since independence in 1976, the country's rapid social and economic development has intensified the pressures as the scarcity of flat land has increasingly been seen as a constraint to further development. In response, land reclamation over the reef flats has continued apace, with a total of approximately 400 ha of land being created by 2001, mainly off Victoria and the East coast of Mahé, and an additional 26 ha in the Baie Ste. Anne area of Praslin. As coral rubble is used as fill, there is consequent loss of all shallow marine habitats in the vicinity, and some modification of surrounding habitats.

An interesting observation is that in some cases reclamation has actually increased the area of mangrove, as at Cascade on the east Coast of Mahe (near to the international airport), where mangroves have re-colonised the shallow lagoon area between the land and the newly reclaimed sections. However, the mangrove is species deficient, and there are no figures available on the extent of such newly colonized areas.

While urban development has clearly had an impact on the range and the extent of coastal wetlands, the actual area of impacted areas is difficult to ascertain. Ordinance Survey maps (1:10,000) do provide some indication of the area covered by wetlands (mangrove and coastal marsh), although many smaller areas are not shown. Aerial photography for these maps was obtained in 1975, with land-based surveys used for

subsequent editions, during the 1980s, and GIS maps produced in the 1990s indicate major changes in the wetland cover. While no assessment has yet been carried out, there is an ongoing project to analyse wetland areas using remote sensing techniques, with results expected in around 2004.

Another contributing factor to the modification of storm barriers is the increase in beachfront developments, for housing, hotels and roads, which has resulted in the removal of coastal vegetation from dune land, thus increasing the vulnerability of beaches to sand erosion. Again, there is little quantifiable data available, since the monitoring of beach profiles only started very recently, in 1999/2000. As detailed above, coastal vegetation has also been affected by a notable reduction in the abundance of certain native plant species, together with an increase in the number of alien species in the coastal vegetation. However, again there are no detailed figures available.<sup>13</sup>

#### 4.1.2 Socioeconomic Impacts<sup>14</sup>

In Seychelles, the modification of ecosystems and/or ecotones has always been significant in the socio-economic development of the country. The inner granitic islands, which are the main centres of population, are characterized by mountains and a very narrow coastal plain where most development has taken place. For the most part, the upland areas are unsuitable for either agriculture or other types of development (e.g. housing) without some type of modification (terracing, levelling, etc.). On the coastal areas, where land is at a premium, reclamation (both small and large-scale) has been practiced extensively ever since the islands were first settled in the late 18<sup>th</sup> century, and has affected both marine and freshwater habitats.

In spite of the acute shortage of land to meet the demands of development, the country has maintained a conservationist approach to land use. Areas protected for environmental purposes now cover nearly 50% of the land area. As the entire country can be considered as “coastal”, coastal zone management is now considered to be an important element of environment management. This is because the small size of all of Seychelles’ islands, even the relatively larger granitic islands of Mahe and Praslin, and their topography characterised a narrow coastal plain and adjacent steep hillsides, means that all land areas impact directly on coastal and marine habitats.

As far back as the 1960s, land reclamation has been viewed as a strategy to support social and economic development. The construction of Seychelles’ international airport, which in 1971 opened the country to tourism development, was built on the first major reclamation work to be undertaken. Since then, the scarcity of land and the high environmental and infrastructure servicing costs of hillsides has driven the Government to undertake four major land reclamation works off Victoria and the East Coast of Mahe. In addition, significant reclamation has recently been undertaken on Praslin in connection with the development of the Baie Ste. Anne harbour area.

The land reclaimed has been used for many purposes, including port and infrastructure development, industrial zones, housing estates, leisure and recreation facilities, etc. It is notable that as a result of the Government’s emphasis on social development, which includes the aim of providing each family with

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<sup>13</sup> Carlström, A (1996); *Endemic and Threatened Plant Species on the Granitic Seychelles. Report for Ministry of Environment*  
Commission de L’Ocean Indien (1998); *Atlas de Sensibilité et de Vulnérabilité de la Zone Cotière de Mahé, Seychelles*  
De Georges, AP (1990); *An Environmental Appraisal of Impacts from Dredge Fill and Reclamation Activities in East Coast Mahé, Seychelles. USAID/REDSO/ESA*  
Government of Seychelles (various dates); *Maps of Seychelles Ordinance Survey (UK)*  
Government of Seychelles (1998) Geographical Information System maps.

<sup>14</sup> The Team agreed that the Table Set provided for the Socio-Economic Impacts of Habitat and Community Modification was appropriate. However, it was felt that there was some difficulty the set under “Socio-Economic Impacts of Sea Level Change”, insofar as both the two issues of *sea-level change* and *coral bleaching* were both a consequence of **global change**. The team therefore decided to include *coral bleaching* in the “Other” column in the Table Sets for *Socio-economic Impacts of Sea-level Change*. The other impacts assessed were *beach / coastal erosion* and *storm surges*.

housing through home-ownership, there has been an increased demand for housing. This has also been influenced by changing family structures, notably the decline of the extended family and consequent decline in average family size. The urbanisation rate has been the highest in Africa; about 60% of the population is considered urban. There are presently over 18,000 houses nationally, which reflects an average family size of 4.4 persons.

Under such circumstances, in Seychelles it is difficult to identify immediate negative socio-economic impacts in terms of the loss of human use. Much of the development that has led to habitat modification and/or loss has been associated with improvement to infrastructure for tourism, housing and recreation. Thus, the development of hotels and related establishments (on Anse Volbert, Praslin and the Coastal Plateau of La Digue), as well as the large sports complex and housing estates built on reclaimed land on the East Coast of Mahe have benefited local populations in terms of jobs and leisure facilities, both in the construction phase and afterwards.

In terms of loss of “resources for subsistence of local populations”, this is not an issue since there are no groups depending on subsistence farming or fishing. Moreover, it is probable that fish sales by artisanal fishermen have been enhanced due to improved facilities for landing and marketing. Employment opportunities have certainly expanded as a result of habitat modification, to the extent that Seychelles now has to import unskilled labour in the construction and tuna-caning industries, both of which have been directly or indirectly fuelled by land reclamation. Nor has there been any direct negative socio-economic impacts in terms of “other exploitation activities”, “cultural heritage” or “human conflict (due to loss of resource)”.

In summary, due to the physical characteristics of Seychelles, habitat modification has invariably led to increasing socio-economic opportunities for the Seychellois people, as additional land area has been created on which the construction of a wide range of infrastructure (including housing) has taken place.

Naturally, the costs of management of such “modified habitats” has increased, particularly on the large reclamation areas on the East Coast of Mahe, and the threat of sea-level change will greatly add to such costs as additional coastal protection measures will be required.

The social-economic cost of the control and removal of invasive alien species, particularly on the wetland areas of Mahe and La Digue, has been significant, as Government has had to establish a permanent “Marsh Unit” in the Ministry of Environment.

In terms of loss of wildlife (sanctuary, biodiversity), the social-economic impact of habitat modification is often difficult to quantify. For example, in the case of the impact on fisheries, while fish landing statistics are available these do not necessarily reflect the true picture, since fisherman increasingly have access to improved equipment (i.e. better boats, outboards, etc.). On the other hand, as a result of recognition of the threats to marine habitats, and their social economic importance to fisheries and tourism, Government has established a Marine Parks Authority (MPA) to manage designated marine parks and reserves.

In general, what has been gained from habitat modification in terms of additional land area, has been at the expense of generally marine habitats (especially coral reefs, lagoons, coastal marshes, sandy foreshores, mangroves and sea grass meadows), which were previously only marginally exploited for their resources.

Nevertheless, the loss and modification of ecosystems, and consequent impacts on biodiversity, are not purely ecological issues in the Seychelles. They are also economic issues, as biological resources form the basis on which national economic prosperity is built. The major economic sectors in Seychelles, particularly fisheries and tourism, are directly dependent on biological resources. In addition, ecosystems/biological resources provide many indirect values, including acting as a sink for wastes and residues and in the protection they afford to beaches and watersheds. Such resources also have the potential for future economic returns, including possible pharmaceutical, industrial and agricultural

applications. Finally, there is also an intrinsic value to Seychelles' biological resources in terms of their cultural and aesthetic significance.

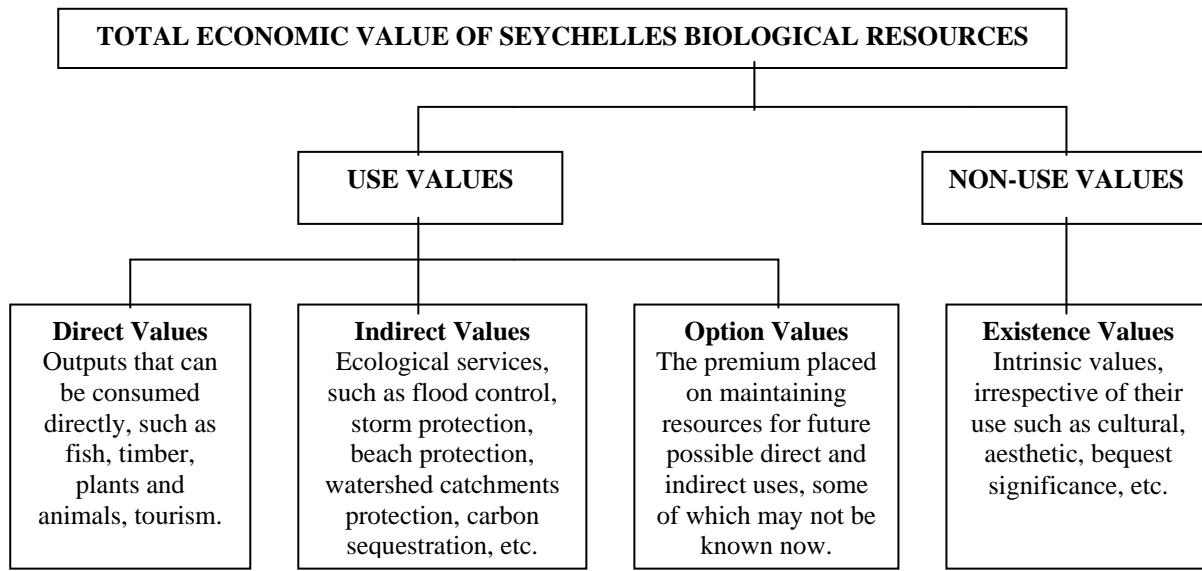
Such economic activities that have been identified exert a profound effect on Seychelles' biodiversity resource base, upon which its economic prosperity is so dependent. This is especially significant given the fragility of the archipelago's ecosystems.

Thus, despite the socio-economic benefits that have thus far accrued, there are considerable risks involved for an economy that is so heavily dependent on its natural resource base.

The loss of biodiversity associated with modification and/or loss of ecosystems leads to a number of costs to the Seychelles economy, both in terms of direct impacts on biodiversity dependent activities, and as a result of indirect impacts in other economic sectors. For example, the economic costs of biodiversity loss might include:

- lost production and consumption opportunities through the direct use of biodiversity resources (i.e. fishing and tourism);
- expenditure necessary to prevent or mitigate effects of damage to resources and ecosystems (i.e. cleaning up wastes and effluents, purifying water, etc.);
- replacement of lost or depleted biological resources (such as finding alternatives to biological resource based sources of livelihood, costs associated with implementing coastal protection or soil/water conservation infrastructure); and
- costs of future economic opportunities foregone (i.e. future tourism development).

In summary, providing Seychelles' biodiversity is protected and conserved, it will continue to provide economic benefits in terms of future production and consumption. However, if the country's biodiversity resources are lost or significantly diminished, the benefits that can be accrued from biological goods and services will diminish progressively, and will have a major impact on Seychelles' economy and society in general.



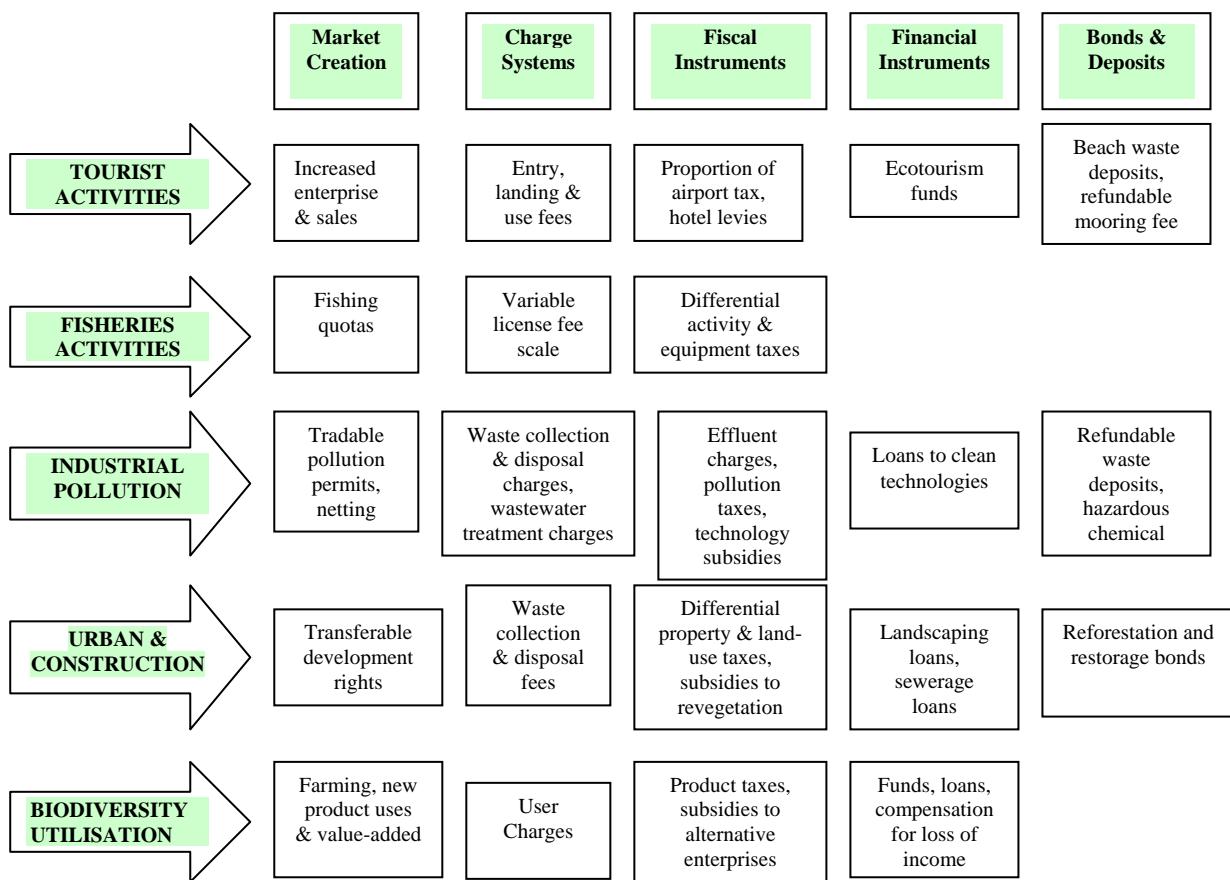
**Figure 8. Value of Seychelles' Biological Resources**

However, biodiversity conservation also has cost implications, both in terms of direct expenditures and in terms of limiting certain production and consumption activities. For example, the cost of mitigating and protecting Seychelles' ecosystems includes:

- the **cost of foregoing or diminishing unsustainable activities**, such as limiting the extractive use of biological resources to sustainable levels in the tourism and fisheries industries, and prohibiting activities that impact on threatened species;
- the **costs of replacing and/or adapting technologies** that impact negatively on biodiversity, such as the adoption of environmentally friendly production and waste disposal technologies in the tourism industry, as well as in the industrial and domestic sector; and
- the **direct physical costs of biodiversity management and protection**, including the capital and recurrent expenditures incurred by Government (and other agencies) to enhance biological resource management and the conservation of protected areas.

Seychelles *National Biodiversity Strategy and Action Plan* estimates the quantified economic benefits of biodiversity at SR 1.46 billion, against quantified economic costs of SR 198 million. It is therefore beyond doubt that there are clear economic benefits to biodiversity, particularly in view of the dependence of Seychelles' main economic sectors on biodiversity goods and services, and that the costs of conservation represent a small proportion of the economic benefits. The challenge facing Seychelles is to identify ways and means for apportioning the costs of conservation in the most efficient and equitable manner and, taking account of the financial constraints of Government, how to generate revenues to finance biodiversity conservation. However, while in many respects economic instruments are easy to apply in a small economy such as Seychelles, there are a number of factors that limit Government's ability to impose such instruments, including the high price of goods in Seychelles, most of which are imported from distant markets and in small quantities, which severely limits economies of scale. Thus, the option of passing costs onto the consumer would be politically sensitive and therefore has limited application, particularly as direct and indirect taxes are already high due to Government's limited opportunities for raising revenue. For this reason, the best options open to Seychelles are those that focus on measures to encourage more efficient production techniques, and which therefore also present the prospect of economic savings in production processes.

To this end, there is a range of potential economic instruments that are theoretically available to Government. These are illustrated in the figure below.



**Figure 9. Economic Instruments for Biodiversity Conservation (from: Emerton. L 1997)<sup>15</sup>**

## 4.2 Global Change

In the study of impacts, three issues were identified as being of particular importance, namely:

- saltwater intrusion;
- coral bleaching; and
- loss of habitats.

In common with other small island developing states, Seychelles is vulnerable to global climate change.<sup>16</sup> The country is threatened both environmentally and economically from the effects of such global change, including sea-level rise (with impacts on coastal erosion), the increasing incidences of extreme weather conditions, and climate-induced changes to ecosystems (such as coral bleaching and an increasing incidence of invasive species). Such impacts will undoubtedly have adverse effects on efforts to achieve sustainable development.

### 4.2.1 Environmental Impacts

In the *detailed environmental assessment of global change*, the following environmental impacts were highlighted:

<sup>15</sup> From: Emerton. L. 1997, op.cit

<sup>16</sup> For example, see: Payet,R. (1998) (Ed.) *Vulnerability Assessment of Seychelles to Climate Change (ENVIRO)*

- intrusion of seawater to freshwater aquifers;
- modification of aquatic habitats, as a result of coral bleaching; and
- loss of habitat and damage to coastal zones including productive land, as a result of coastal erosion.

While the nature and extent of the threat to Seychelles' endemic habitats and biodiversity remains an issue that needs to be researched, it is clear that most habitats are at risk and will be severely modified by climate change, with some being more vulnerable than others. First of all, any increase in sea level will flood the remaining areas of mangroves, since most mangroves areas on the granitic islands are typically situated behind dunes and are often below sea level. Climate change will also have a variety of impacts on coral reefs. The modification and loss of mangrove and coral reef habitats will in turn have major impacts on a range of coastal and marine organisms, as well as fish species, with far reaching socio-economic consequences.

#### **4.2.1.1 Saltwater Intrusion**

On the main populated granitic islands (Mahe, Praslin) water supply is derived mainly from water catchments (dams), and directly from rivers and streams. Nevertheless, saltwater intrusion to freshwater aquifers is increasingly becoming a problem on both the smaller granitic islands and coralline islands. Moreover, while it is only on the granitic islands of La Digue and Fregate, and most of the coralline islands, that groundwater is extracted for use, coastal habitats and biodiversity are also dependent upon the integrity of groundwater aquifers and freshwater lens.

On La Digue, about 50% of the water supply is sourced from the groundwater aquifer, which occupies almost the entire area under the western coastal plateau. The recharge of the aquifer is mainly from the direct infiltration of rainfall, as well as surface and subsurface runoff from numerous rivers and streams. The current annual recharge is estimated at about 0.33 million m<sup>3</sup> derived from borehole data.

As a result of population growth and increasing visitors, together with decreasing rainfall, there is some evidence that the level of the water table has fallen. While it is acknowledged that the data available is very limited and is therefore inconclusive, the increasing demands placed on water resources, together with changing climate patterns, pose a significant threat to the fragile ecosystems of La Digue, and particularly to the biodiversity of the remaining coastal wetlands, which will (for example) impact on species that depend on wetland biodiversity for food sources, such as the endangered Paradise Flycatcher.

Although not one of the identified hotspots or sensitive areas, the island of Fregate is important for its biodiversity, as it is home to the endangered Magpie Robin. Recently, an exclusive five-star hotel has been developed on the island, and great efforts have been made to rehabilitate the natural ecosystems. A rat eradication project has also been successfully implemented. Nevertheless, the island's ecosystems remain fragile. There are six wells on the island, of which three are in use. Current consumption is estimated at 30m<sup>3</sup> a day. The recharge rate has been computed as being 49,600 m<sup>3</sup> per year and represents the theoretical limit. Critical periods for aquifer yield are during the dry season. For example during the rainy season standing water in some areas are at about 0.5 m AMSL, which dry out during the dry season. Terrapins seem to have adapted, but long spells will affect their reproduction and feeding cycles. Lack of adequate dry season data does not enable a proper assessment on whether there are instances of salt intrusion.

Another of the smaller granitic islands, Cousine, supports a very important bird breeding colony (including five species of breeding endemic land birds and one endemic sub-species) and forage habitats. There are two boreholes, which yield about 72 m<sup>3</sup> per day. However, since the groundwater is strongly acidic, at pH 4.2, it is only used for cleaning and non-consumptive purposes. With changes in rainfall patterns, soil moisture is likely to be affected, which will in turn affect soil organisms and insects. These invertebrates play a very important role in the food web and may affect the important bird populations on that island. Extractive uses have therefore been reduced to a minimum.

On the coralline islands no firm data is available on the status of the freshwater lens. However, it is probable that infrequent rainfall and increasingly long periods of drought is having a significant impact, with as yet undetermined impacts on the ecosystems of these islands. Whilst the use of desalination plants can provide a solution for human uses, any decrease in ground moisture and water for ecosystem functioning is a critical issue, particularly as most of the coral islands possess unique habitats supporting a number of endemic species.<sup>17</sup>

#### 4.2.1.2 Modification of Habitats (Coral Bleaching)

Over the past 200 million years, coral reefs have adapted to numerous changes, although over most of this period there was no pressure from human activities. However, reefs are now faced with a combination of threats, including over exploitation, pollution and especially global climate change. All of these threats are increasing, and in particular human activities are leading to the acceleration of global climate change that may make it difficult for coral reefs to adapt and survive. One recent study predicts that global change is likely to have the following impacts on coral reefs:<sup>18</sup>

- ***sea level rise*** - while it is estimated that most unstressed coral reefs will be able to cope with predicted sea level rise,<sup>19</sup> notably those that are exposed at low water which limits upward growth, corals that are weakened by temperature increases or other factors may be unable to grow at ‘normal’ rates. Under such circumstances, low-lying islands will be more exposed to wave energy and storm surges. This is a particular concern to low lying island states such as the Maldives, and to some of Seychelles low lying coralline islands;
- ***temperature increase*** - it has been estimated that sea-temperatures might increase by between 1-2°C by 2100.<sup>20</sup> Temperature increases of 0.5°C have already been observed over the past 20 years in many tropical seas.<sup>21</sup> While these are small changes it means that during periods of warmer seasonal fluctuations temperatures may exceed the tolerance levels of most coral species, leading to increasing frequencies of coral bleaching;
- ***reduced calcification rates*** - global emissions of greenhouse gases have raised concentrations of carbon dioxide in the atmosphere and in the oceans to a level that may gradually reduce the ability of coral reefs to grow through normal calcification processes, thus reducing the capacity of reefs to recover from coral bleaching events and also compromising their ability to keep pace with sea-level rise;<sup>22</sup>
- ***altered ocean circulation patterns*** - which could have impacts on the development and distribution of reefs worldwide, by altering the dispersal and transport of coral larvae; and
- ***increased frequency of severe weather events - which could cause increased damage not only to coral reefs, but also to coastal communities.***

During 1997 and 1998, in association with changes in ocean and climate conditions, coral reefs throughout the world started to die as a result of bleaching. The most prominent factor of climate change impacting on reef ecosystems was an increase in ocean water temperatures. The coral reefs in the granitic islands of Seychelles suffered widespread hard coral mortality, and as a result the most widespread and

<sup>17</sup> References:  
Mcarley & Lindberg, 1987; Water Resources Evaluation - La Digue, Public Utilities Corporation;  
Neufeld, D. 1992; *Survey of Habitats on La Digue. INFORM Series. Ministry of Environment*;  
PUC, (1988); 'La Digue Water Supply Development, Project Memorandum' Public Utilities Corporation, Seychelles;  
PUC, (1990); *Groundwater Vol.3, Hydrological Yearbook for Seychelles*;  
Weaver, J., (1994). *Review of the Fregate Island Hydrology and Hydrogeology and the environmental implications of future water supply. CSIR Environment Services*

<sup>18</sup> Westmacott,S; Teleki,K; Wells,S & West, J. "Management of Bleached and Severely Damaged Coral Reefs" (IUCN, 2000).

<sup>19</sup> Estimated at 50cm by the year 2100 (IPCC, 1995)

<sup>20</sup> Bijlsma *et al.* 1995 (quoted in Westmacott *et al*)

<sup>21</sup> Strong, *et al.* 2000 (quoted in Westmacott *et al*)

<sup>22</sup> Westmacott *et al*

severe mass coral bleaching on record caused system-wide degradation that has affected virtually all of the islands' coral reefs.<sup>23</sup>

Coral reef monitoring that has been conducted in Seychelles waters over the past two years and provides evidence of the impacts of the El Nino Southern Oscillation (ENSO) during 1997 and 1998, which resulted in the spread of a mass of warm water in the Western Indian Ocean.

In the summer of 1997-1998, temperatures in some of the Seychelles reef flats were as high as 37<sup>0</sup>C, the highest recorded in the area. Baseline data for 14 sites in the Seychelles is available on videotape, recorded in mid-1997. From March to May 1998, extensive bleaching down to 23 m was recorded in the Aldabra, Providence and Alphonse island groups.

Shallow coral reefs on Mahe suffered a reduction in living hard coral cover to less than 10%, from a cover of 25-80% before the bleaching event. The branching and tabular *Acropora*, and branching *Pocillopora* species suffered the most with the *Porites* being more resilient. There was also a decrease in the number of species and genera observed from observations in 1998 and 2000, from 143 species to 109 species, and from 55 genera to 42 genera. The report concludes that although the diversity at most sites surveyed was low after the bleaching event, data collected so far indicate that most species of corals have survived somewhere in the region. Observations of filamentous algae on dead corals were observed in January 1999. An assessment for the potentially toxic dinoflagellates was evaluated.

While the global impacts on coral reefs associated with rising sea temperatures are evident, the IPCC has concluded that the threat of sea-level rise to reefs (as opposed to reef islands) is negligible. This was based on projected rates of global sea-level rise of between 2-9 mm per year over the next hundred years, and on the assumption that healthy reef flats would be able to keep pace with such a rise taking account of an approximate upper limit of vertical reef growth of 10mm per year. However, these assumptions may not apply in the context of reef systems around many small island states in the Caribbean and Indian Ocean, where reef structures have been weakened by a variety of anthropogenic stressors.<sup>24</sup> As is pointed out in Seychelles National Biodiversity Strategy, a further variation applies in the case of high islands surrounded by coral reefs, such as those around the main granitic islands of Seychelles. Here, any increase in heavy rainfall patterns and flood conditions (such as on Mahe and Praslin) would result in more sediment in the form of soil and sand washed from the hillsides, and which would be deposited in the lagoons, thus contributing to the further deterioration of fringing reefs already under stress as a result of rising sea temperatures, and other human activities.<sup>25</sup>

Although the full impact of the bleaching event has not been quantified, it had considerable impacts on both coastal (artisanal) fisheries, resulting in a reduction in fish availability.<sup>26</sup> The impact on the tourism industry was also significant, as healthy coral reefs in the marine parks are an important attraction.

It is therefore important to consider possible interventions to further protect and conserve those areas of reef that have been relatively less affected, and to implement measures and programmes to restore damaged reefs. One such programme is included in the National Biodiversity Strategy and Action Plan. The overall objective of this project is to restore selected reefs and to improve their ability to protect shorelines from erosion and to provide habitat for marine biodiversity, and fish for tourists and fishermen.

<sup>23</sup> Engelhardt, U., (2000); *Fine Scale survey of selected ecological characteristics of benthic communities on Seychelles coral reefs one year after the 1998 mass coral bleaching event*.

Burnett, W. & Johnson, M. (1999); *Initial Assessment of mortality of Seychelles reef corals following the 1998 bleaching event and establishment of monitoring sites. Unpublished report of the Shoals of Capricorn Seychelles baseline Project Reefcare International. Technical Report to WWF Sweden, 65pp.*

Linden, O., Sporrong, N., (1999). *Coral Reef Degradation in the Indian Ocean*

<sup>24</sup> Zann (1994) – quoted in Seychelles' National Biodiversity Strategy and Action Plan

<sup>25</sup> Government of Seychelles, 2000 First National Communication under the UN Framework Convention on Climate Change.

<sup>26</sup> The total landing by the artisanal fisheries sector declined from 4,500 metric tonnes in 1996 to 4,095 metric tonnes in 1997 and to 3,334 metric tones in 1998, before recovering to 4,842 metric tones in 1999.

This will be achieved by constructing artificial reef structures using the material accretion method to build a growing limestone structure on which corals can grow at rapid rates.<sup>27</sup>

#### 4.2.1.3 Loss of Habitat Due to Coastal Erosion<sup>28</sup>

As has already stated above, one of the likely impacts of global climate change would be a greater frequency and intensity of coastal flooding, particularly during severe storms or during abnormal high tides. The typical topography of the main granitic islands, which is characterized by steep mountain slopes means that the narrow coastal zones are particularly vulnerable.

Seychelles' has over 600 km of coastlines of which about 90% are exposed to waves during the two main seasons: the Southeast monsoon and the Northwest trade winds. Altogether there are about 482 km of beaches and about 118 km of rocky coasts. The coral reefs and coastal vegetation protect the coast against storms and beach erosion, while the wetland and mangrove areas around the coast act as flood and storm buffer zones. Any degradation of these environments therefore makes beaches and coastal areas generally more vulnerable to erosion, with serious economic impacts, notably on the tourism industry.

The existing size of the flood plain is about 237 km<sup>2</sup> or 53% of the entire surface area. The estimated total area at risk from flooding on Mahe Island, where a large part of the population is located is about 23 km<sup>2</sup>, where population density exceeds 1040 persons/km<sup>2</sup>. The remaining part of the island is very hilly, with over 74.8% of the surface area with a slope exceeding 25%.

In most cases rainfall above 200 mm in 24 hrs causes severe flooding in a number of areas. In August 1997, extreme rainfall conditions lead to floods and landslides last experienced more than a hundred years ago, in 1862.<sup>29</sup> Between 13-16<sup>th</sup> August 1997, there were exceptionally heavy and continuous rains over Seychelles. A record maximum of 480 mm of rain fell over a 24-hour period at Grand Anse, Mahe, while the International Airport meteorological Station registered a monthly record of 694.1 mm of rain as compared to the long-term mean of 107.1 mm.

The most immediate impact of the 1997 floods and landslides was the socio-economic damage caused to more than 500 houses at an estimated cost of 2.0 million US dollars, and almost 40% of the public roads, with temporary repair estimated to cost 1.5 million US dollars. There were also considerable environmental impacts, such as those caused by increased heavy run-off of soils from the hillsides, with resulting increased siltation of wetlands and coastal lagoons and coral reefs and sedimentation on beaches (red soil).

Abnormal high tides, probably due to thermal expansion as a result of higher sea-surface temperatures spewed seawater into coastal houses and hotels all over the island. This event may have led to an accelerated destabilization of the coastline over a shorter time period than anticipated within the climate change scenario.

Increased wave intensity has also been observed in many areas and many beaches face increased erosion and threat from increased high tide levels. This is apparent on the island of Praslin, where beach erosion

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<sup>27</sup> National Biodiversity Strategy and Action Plan (Project No. 9)

<sup>28</sup> References:-

Cazes-Duvat, V. (1999); *Les Littoraux des Iles Seychelles*. L'Harmattan

Micock, B., (1998); *Urban Planning in Seychelles: A GIS Approach*. MSc Dissertation University of Durham

Payet, R.A., (ed.), (1998a); *Seychelles: Vulnerability Assessment to Climate Change*, Government of Seychelles/UNFCCC

Payet, R.A., (1998); *Environment Impact Assessment for the Phase III of the East Coast Reclamation*, Government of Seychelles

Payet, R.A. & Lajoie, R. (in press). *Implications of sea-level rise and climate change for Seychelles*. Proceedings of SURVAS Workshop, Cairo, November 2000

<sup>29</sup> Between 13-16<sup>th</sup> August 1997, there were exceptionally heavy and continuous rains over Seychelles. A record maximum of 480 mm of rain fell over a 24-hour period at Grand Anse, Mahe, while the International Airport meteorological Station registered a monthly record of 694.1 mm of rain as compared to the long-term mean of 107.1 mm.

control on Anse Kerlan Beach, has been attempted using a mixture of incompatible measures (groynes have been too closely placed, combined with gabions on the foreshore, rock armoring and seawalls). Reactive and 'panic' approaches to coastal erosion are very common and often lead to accelerated coastal erosion. The reduced capacity of the reef to withstand and absorb wave energy as a result of the coral bleaching may also be a reason for this increased coastal erosion on many islands.

The range of complex sensitivities associated with shoreline change and erosion also indicates the influence of human-derived impacts on coastal systems, which increases the sensitivity of systems to climate change. For example, human induced coastal erosion is evident from a survey conducted in 1987 in Mahe, Praslin, La Digue and Curieuse islands. Out of 40 coastal sites visited, the survey identified 11 sites where erosion was mainly due to natural causes, i.e. sea level changes, topography and marine hydrology factors, while in 29 other cases, accidental erosion was mainly attributed to human activities and ill-conceived development. However, data on rates of erosion is not available.

#### **4.2.2 Socio-Economic Impacts**

##### **4.2.2.1 Sea-Level Rise**

While socio-economic studies to determine the implications of sea-level rise in the Seychelles have not been attempted as yet, it is clear that sea-level rise will affect coastal communities and livelihood in a direct and indirect manner. Direct socio-economic impacts include coastal erosion, salinization of the coastal plateau and damage to coastal infrastructure, including housing and industry, much of which is located on the coastal plateau. Indirect and secondary socio-economic effects may include loss of tourism revenue, fisheries and access to resources, as well as the costs of protection measures..

A 1998 study <sup>30</sup> that assessed Seychelles' vulnerability to climate change (Seychelles' First National Communication under the UN Framework Convention on Climate Change -UNFCCC) <sup>31</sup> addressed a number of sectors for sensitivity and vulnerability to climate change, namely natural habitats and biodiversity, the coastal zone and human settlements, agriculture, fisheries, health, industry, energy and tourism.

An estimated 85% of human settlements and infrastructure are situated on the coastal zones of Seychelles' main granitic islands, and would be severely affected by rising sea levels. Any changes in sea level, as envisaged in the Intergovernmental Panel on Climate Change (IPCC) reports would result in the displacement of a large portion of the population. Resulting coastline recession would also affect infrastructure and biodiversity. A number of the low-lying coral islands and sand cays would disappear. Another impact would be more frequent and greater intensity of coastal flooding, particularly during severe storms or during abnormal high tides, resulting in erosion of shoreline and beaches, with consequent impacts on tourism. In addition, the steep mountainous topography of the granitic islands makes the narrow coastal zone especially susceptible to flooding during heavy rains, which seem to be getting more frequent. Another impact will be on the quality and quantity of water resources, especially on the coral islands. <sup>32</sup>

One "impact" that has already been felt relates to the economic cost of protecting vulnerable infrastructure from anticipated sea-level rise in the future. As has been outlined elsewhere in this report, coastal settlements, which accommodate the overwhelming majority of the population, are concentrated in areas where there is intense demand for land. As a result, land reclamation has become a common practice in order to provide the necessary land for the development of social and economic infrastructure. Previously, coastal development had taken place without taking the possibility of sea-level rise, or any increase in the frequency and intensity of extreme weather events such as tropical cyclones, flooding and storm surges. Thus, important infrastructure, including airports, port facilities, roads and coastal

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<sup>30</sup> Payet (1998) op.cit

<sup>31</sup> Government of Seychelles, 2000 First National Communication under the UN Framework Convention on Climate Change.

<sup>32</sup> Ibid

protection walls and bridges would all vulnerable to eventual sea-level rise and extreme weather conditions. It is in anticipation of the possible impacts of climate change that the recent and ongoing phases of the East Coast Reclamation projects have elevated the height of reclamation by an additional 70 cm to allow for sea level rise and/or subsidence. This has inevitably added to the cost of such works.<sup>33</sup>

Climate change will have impacts on agriculture, the most direct of which will be through changes in temperature, rainfall and the timing and frequency of extreme or critical weather events. Any resulting decrease in agricultural productivity would render the country even more dependent on imported food items. A rise in sea level would also have a direct impact on agricultural production by contaminating coastal land where a high proportion of agricultural production is centred. Another likely impact is the potential for changed climatic conditions to lead to consequent changes in diseases, pests and weed propagation. The impacts of climate change on water resources will vary according to a variety of factors, including the physical characteristics of islands and the extent of human habitation.<sup>34</sup>

Climate change may have significant indirect impacts on human health, including higher rates of transmission of vector-borne diseases. Increased temperatures and increased incidence of flooding could even result in increases in non-vector-borne infectious diseases, as well as the introduction of common tropical diseases, such as malaria, yellow fever and bilharzias, which are currently not present in Seychelles.

The potential impact of climate change and sea level rise on economically and ecologically important fisheries resources is another issue of great concern for island states, such as Seychelles. Among the possible impacts are those relating to reproductive patterns, migration routes (especially of economically important migratory species) and ecosystem relationships. Any rise in sea level will have a direct impact on rivers, marshes and wetlands, many of which are important in the life cycle of economically important fisheries resources. An increase in sea-temperatures will also affect fish species that are dependent on coral reef habitats.

Finally, as sea surface temperatures increase, the frequency of tropical cyclones is expected to increase. While Seychelles is outside of the cyclone belt, a feeder-band within an active convergence zone passes over the main island of Mahe, and can bring winds gusting in excess of fifty knots, with accompanying torrential rains which can cause flash floods. Any ocean warming would make Seychelles a lot more vulnerable as a result of changes in frequency, intensity and locality of tropical cyclones.<sup>35</sup>

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<sup>33</sup> Payet (1998)

<sup>34</sup> Ibid

<sup>35</sup> Ibid

***Box 1: Impact of the 1997/98 ENSO Event on the Tuna Industry***

The tuna canning industry, which is now the second largest foreign exchange earner in Seychelles, was affected by the 1997/99 ENSO event. As a result of significant investments by the H.J. Heinz Company, the tuna-canning industry in Seychelles increased output from 165 tons per day at the end of 1997 to 350 tons per day by 1999, making it the third largest tuna-canning factory in the world, and the second most important foreign exchange earner after tourism. However, it is estimated that production would have been even higher had it not been for the effects of the adverse weather conditions resulting from the effect of the El Nino and La Nina weather phenomenon.

The El Nino event that began in 1997 caused the migration of tuna away from Seychelles EEZ. As a result, revenue declined as a result of reduced transhipment activity through Port Victoria. The main effect of the La Nina event was a period of drought during the latter part of 1998 and early 1999, which not only affected agriculture but also manufacturing (including the tuna cannery) as a result of water shortages which forced the suspension of manufacturing operations for a number of weeks.

#### **4.2.2.2 Coral Bleaching**

The socio-economic impacts of coral bleaching are primarily and most directly linked to the tourism and fishing industries. In the case of tourism, the direct socio-economic impact of coral bleaching is related to the important market segments of the industry (i.e. scuba diving) that Seychelles is striving to capture. However, to date no detailed studies have been carried out to quantify these impacts.

However, immediately following the bleaching event in the Indian Ocean, the CORDIO (Coral Reef Degradation in the Indian Ocean) programme conducted a preliminary analysis on the secondary effect of the coral bleaching on the socio-economic conditions in the coastal communities of the Seychelles.

Whilst the study did not conclude any direct adverse effect, a more in-depth analysis is envisaged for late 2001, especially with respect to its impact on fisheries and tourism, two key sectors that depend upon the integrity of coral reefs to generate value.

#### **4.3 Summary of Gaps/Problems**

While the actual impacts of global change are difficult to quantify due to a lack of data and inconclusive information, it is clear that Seychelles, in common with other small island developing states, is particularly vulnerable to many of the anticipated impacts of climate change. This assumption is based on the conclusions of the IPCC Second Assessment Report, which defines vulnerability as the extent to which climate change may damage or harm a system, taking account not only a system's sensitivity to change, but also its ability to adapt to new climatic conditions. Thus, while impacts depend on sensitivity defined as the degree to which systems will respond to changing climatic conditions, adaptation refers to the degree to which adjustments are possible in practice, processes or structures of systems, to projected or actual changes in climate.<sup>36</sup>

While Seychelles' First National Communication to the UNFCCC refers to observations of trends indicating climate change in Seychelles (in terms of warming of air and ocean temperatures, increased heavy rainfalls, and sea-level rise), these remain inconclusive and will require further monitoring and fine-tuning of data. Nevertheless, the threats are of great significance to the country's environmental and economic sustainability.

In order to be able to respond to these threats, there is a need for comprehensive and qualitative assessments, upon which an informed policy framework can be developed, to provide for the

<sup>36</sup> Government of Seychelles, 2000 First National Communication under the UN Framework Convention on Climate Change.

implementation of cost-effective adaptation strategies. The implementation of such strategies will in turn depend on a number of factors, including the availability of financial resources, capacity building, transfer of technology, and an enhancement of integrated planning and management.

In order to respond to future climate change, which inevitably will include impacts that are as yet unknown, there is an urgent need for enhanced research efforts (at national, regional and international levels), including observational networks, monitoring and modelling. This is essential in order to provide improved climate projections, and to enhance the understanding of responses of ecosystems and social-economic systems to climate change, which will facilitate the development of effective adaptation strategies. In addition, the absence of adequate climate and oceanographic forecasting systems (and disaster management infrastructure) adds to the vulnerability of impacts of climate change.

## CHAPTER 4

### 5. The Causal Chain Analysis

The causal chain analysis took place during the period between the Second Meeting of the Working Group on Integrated Problem Analysis (WGIPA)/Second Regional Meeting (Mombassa, 12-14<sup>th</sup> March 2001) and the Third National Meeting (held in Victoria, Seychelles on 11<sup>th</sup> and 12<sup>th</sup> May 2001). During this period, the national team met formally on a number of occasions, to review and discuss individual assignments.

The analysis is based upon the GIWA methodology and the Guidelines issued by the GEF MSP Sub-Saharan Africa Project Committee. The GIWA issues that had been identified during the previous phases of the exercise as having the greatest environmental impacts were:

- modification of ecosystems and/or ecotones;
- loss of ecosystems and/or ecotones;
- global change/sea level rise (coastal erosion); and
- global change/coral bleaching.

At an early informal meeting, the national team discussed whether the issues of modification of ecosystems and loss of ecosystems should be “merged” in view of the difficulties in making a distinction between the two. The team decided to take each of the 3 prioritised hot spots and sensitive areas, and seek to identify where ecosystem modification and/or ecosystem loss had occurred and to tentatively identify the causes:

On the basis of this analysis it was concluded modification had occurred as a result of a wide range of causes, including:

- land use conversion which has resulted in modification of mangroves and beach fringe (especially for housing and tourism development);
- land use conversion (secondary impacts), such as changed currents resulting from land reclamation which have impact on sand deposition;
- extraction of sand and gravel;
- changes in sand deposition caused by jetty development;
- sedimentation flow resulting from agriculture and new housing construction (and other development) on higher ground;
- pollution (eutrophication) as a direct result of agriculture, tourism, port and housing development;
- dumping of wastes;
- introduction of alien species (i.e. water lettuce/hyacinths) and fish and terrapin introductions;
- extraction of species (i.e. crabs, freshwater prawns, etc.); and
- global change (i.e. impacts on coral reefs in particular).

It was noted that the nature of the threats/impacts facing Cosmoledo (and other outer coral islands) differed greatly from those faced by the main (granitic) inner islands, mainly because of the absence of significant human settlements. Such islands are subject to modification mainly as a result of global change (on coral reefs), and as a direct result of biodiversity changes caused by poaching of living species, such as turtles, and the over-exploitation of fisheries resources. It was noted that Cosmoledo (and other outer islands) are also under threat from future tourism/leisure development.

When considering the causes of loss of habitat, it was concluded that the major issue is **land use conversion**. Reclamation, especially on the East Coast of Mahe, was noted as having a particularly significant impact on coral and lagoon habitats, as well as on freshwater marshes and mangroves. Road construction was also identified as a cause of the loss of mangroves. On the coastal plateau of La Digue,

land use conversion for housing and tourism development has had a significant effect on woodland and sandy foreshore habitats.

The team therefore agreed to commence the separate analyses of causal chains with respect to modification and loss of ecosystems, although it was anticipated that it would be difficult to draw distinctions at subsequent levels of analysis of the causal chain.

Concerning the impacts of global change, the team decided to focus on two GIWA issues, namely:

- coastal erosion; and
- coral bleaching.

Although they may not appear to be a regional issue of significance for the mainland African states, and are also part of the current debate on what really causes global change, the earlier phases of the analysis revealed that the impacts of global change would far outweigh, in a small island context, the problem of localized impacts. This is particularly true in Seychelles, which has invested extensively in wastewater treatment for the main urban centres and has strong pollution effluent standards. Furthermore, Seychelles has maintained a policy of non-heavy industries for the last fifteen years, resulting in only light industries being established in the Seychelles. Although these two issues may not appear to have any catalytic opportunities for the development of regional projects, they can easily be integrated into other issues.

To determine the root causes of the issues identified through the prioritization of issues on the basis of selected hot spots and sensitive areas, as well as the analysis of environment/socio economic impact and threats, the Pressure-State-Response (PSR) framework developed by OECD is used. For reasons of harmonization among the various country reports the standard formats available on the GIWA methodology CD-Rom were used. However, since there were no formats established for the Global Change causal analysis exercise, these were developed by the team using published sources of information.

## **5.1 Modification and Loss of Ecosystems and/or Ecotones**

### **5.1.1 Immediate Causes**

At the first level, there are some clear differences between the immediate causes of modification of ecosystems, and loss of ecosystems. However, as the analysis of the causal chain moves to the second level (sectoral pressures) and third level (responses) it becomes more difficult to make separate the causal chains. For this reason, the analysis of immediate causes deals with modification and loss separately. For subsequent levels modification and loss are examined simultaneously.

#### **5.1.1.1 Modification of Ecosystems and/or Ecotones**

##### **i. Land development**

The immediate cause of modification of ecosystems in Seychelles is mainly a result of land development (land use changes), associated especially with urbanization and tourism development. Changed freshwater and sediment supply is also an important contributing factor, again linked especially with urbanization and tourism development. This is illustrated in Chart 1 below.

It is estimated that land development as a result of urbanization and tourism and leisure development each account for around 30% of the immediate causes of modification of ecosystems.

Housing and associated infrastructure development has expanded rapidly over the past 20 years, due to both natural populations increase and a declining household size, which has greatly accelerated the demand for housing. From 1987 to 1994, MISD (1994) census data revealed that over 2,000 houses (roughly about 250 per year) were built as part of the government's commitment to providing housing for all. Until recently, housing development was typically based on single-storey detached houses, although more recently there has been a trend towards the development of higher density housing estates, particularly on the East Coast (Mahe) reclamation areas.

Where the traditional type of housing development has continued, this has often involved poor land use practices, particularly on hillsides, including the indiscriminate felling of trees and leveling. However, it is to be noted that in the middle of 2001 government announced that in future there would be stricter controls on the use of heavy-duty machinery, such as JCBs (mechanical diggers) in land clearing operations.<sup>37</sup>

Another problem associated with such practices is the runoff of soil during heavy rains, which impacts negatively on coastal habitats. Pollution from septic tanks is another cause for concern, although there are no scientific studies on the incidence of pollution in coastal habitats directly from this cause.

The increase in tourism and leisure developments, especially along the coast is a significant factor in ecosystem modification in all of the identified hot spots. The development of land and construction of buildings for tourism and leisure has not given sufficient consideration to environmental factors, and the planning authority has at times allowed questionable developments to go ahead. For example, some developments have taken place too close to the high water mark, in disregard of the 25-metre limit.

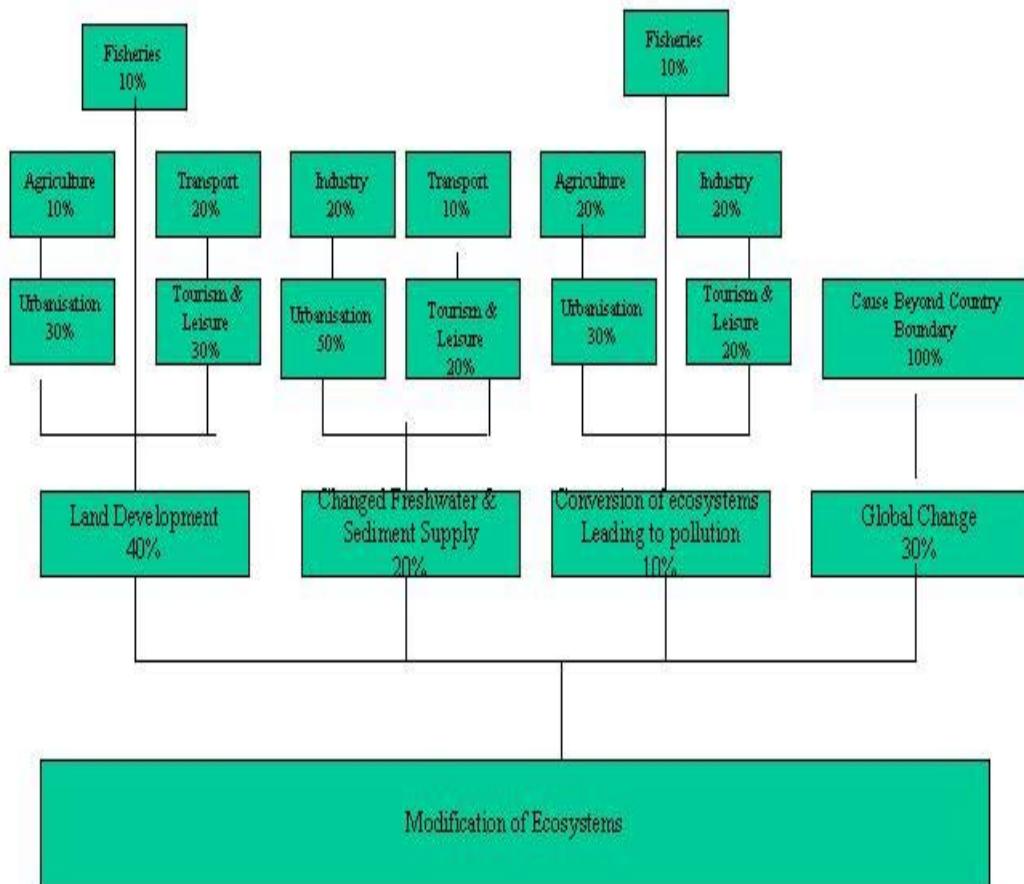
Developments have also often ignored natural land formations (such as large granite boulders and beach vegetation and marshes, although some hotel developments have tried to incorporate natural features into their planning, resulting in less severe impacts on local and surrounding habitats. There has been some degree of pollution of both terrestrial and marine ecosystems resulting from poor sewage disposal. However, there have been few scientific studies on impacts on ecosystems resulting from such developments.

Transport developments were also identified as contributing to around 20% of immediate causes, both with respect to new road construction and port development. New road construction has been fuelled by a rapid rise in the number of motor vehicles, from 4,100 in 1981 to 6,153 in 1993, and over 11,000 in 1999, around one vehicle for every seven persons, although some private companies, including government, have large fleets. Surfaced roads increased from 135 km in 1977 to 323 km in 1994. The development of Port Victoria (New Port) has permitted port access for more and larger vessels (including large cruise ships) with resulting increase in pollution and the possibility of introduction of alien marine species.

Road construction techniques have not been environmentally friendly, and little attempt has been made to import environmentally friendly vehicles. As a result, there has been increased incidence of soil erosion affecting marine and coastal ecosystems, and increased air pollution and waste engine oil. There have however been efforts at mitigating such negative effects, notably through the introduction of stricter testing of vehicles for emissions. Again, few verifiable studies have been undertaken to measure environmental impacts.

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<sup>37</sup> The Nation, 30 May 2001

**Chart 1 : Immediate causes of modification of habitats or ecotones**

## ii. **Changed freshwater and sediment supply**

Changed freshwater and sediment supply was identified as contributing to 20% of the causes of habitat modification. Again, this was mainly the result of housing and associated development (and also tourism developments) including poor construction techniques. The increased demand for water for household purposes was also identified as a contributing factor. Soil erosion affects marine habitats, while increased water demand affects ecosystems through changes in the amount of water flowing in rivers downstream to the sea. A further concern is the proposed development of desalination plants to address water supply shortages, as this will alter marine habitats where the saline is discharged. It is to be noted that to date no EIAs have been undertaken in connection with the proposed development of desalination plants. Once again, there is a general lack of data and scientific studies on impacts on ecosystems.

### iii. Global change

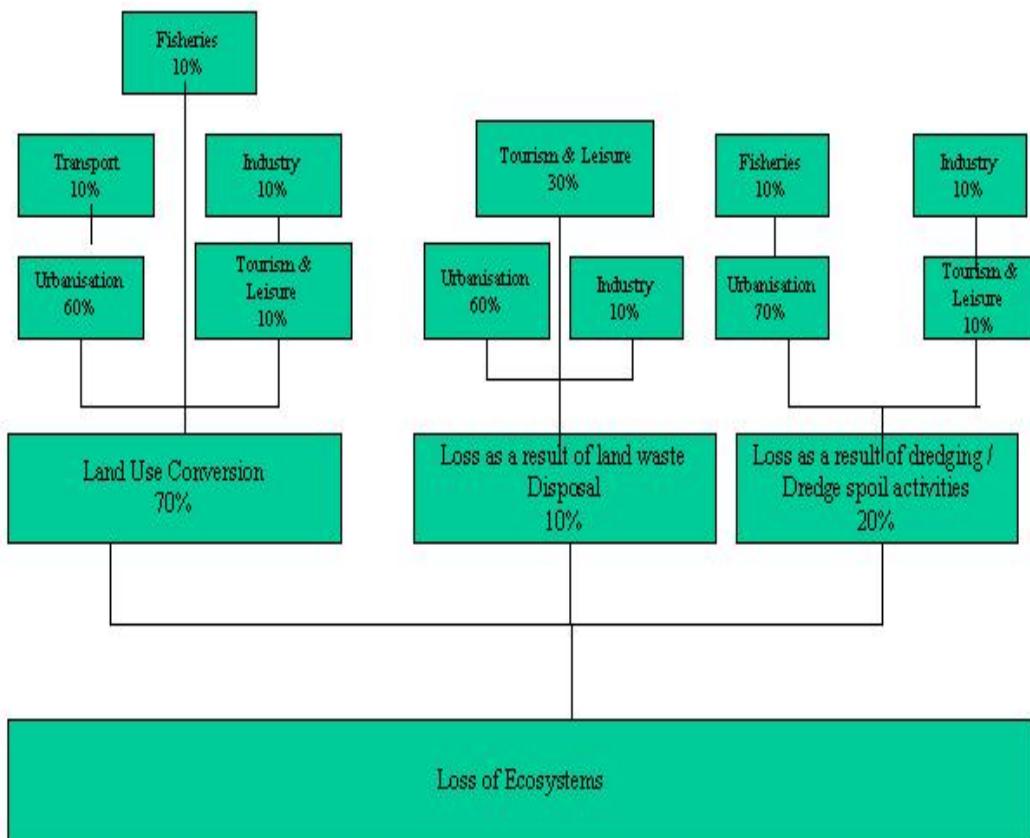
Finally, global change was identified as a significant immediate (100% transboundary) cause of modification of marine habitats, accounting for an estimated 30%. The impact of such causes is particularly evident on coral reefs (bleaching), but the increasing likelihood of global climate change induced weather anomalies and sea-level rise will affect many coastal habitats.

#### 5.1.1.2 Loss of Ecosystems and/or Ecotones

##### i. Land use conversion

The immediate cause of loss of ecosystems and/or ecotones in Seychelles is overwhelmingly associated with land use conversion, associated principally with urbanization. This is particularly true on the main island of Mahe, where large-scale reclamation projects have taken place on the East Coast over the past 30 years, and are still ongoing. Closely related are losses of marine ecosystems as a result of dredging/dredge spoil activities (including losses as a result of deposition of sediments). This is illustrated in Chart 2.

**Chart 2 : Immediate causes of loss of habitats or ecotones**



It is estimated that 70% of loss of ecosystems results from land use conversion. Since 1970, there have been three phases of large-scale land reclamation from the sea, which have impacted on coral reefs and coastal lagoons. The total area reclaimed from the sea during this period is as follows:

**Table 2. Area of Reclamation 1973-2002**

Reclaimed Land -Year	Size (ha.)	Cost
1973	102	
1986 (Phase 1)	133	
1991 (Phase 2)	85	
1996 (Phase 2 cont.)	14	SR 15.5 m
1998-2002 (Phase 3)	295	U\$ 77 m

(Payet, 1998)

These reclamation projects have added a combined total of 629 hectares, representing just over 4% of the total land area of Mahe, which is around 15,470 hectares, of which the coastal plateau is only 108 hectares.<sup>38</sup>

In addition to these large-scale reclamation projects, there have been many small private reclamation works (usually for housing development) that have had an impact of coastal ecosystems.

The loss of habitat associated with land use conversion has however not been limited to the East Coast of Mahe. Throughout the main populated islands of Mahe, Praslin and La Digue, significant loss of freshwater marshes (and some mangroves) has occurred, though data on the total area is not available.

On the third island of La Digue, there has been significant loss of lowland forest, principally for housing and tourism and leisure developments.

## ii. Dredging/dredging spoil activities

Closely related to the large scale reclamation projects on the East Coast of Mahe has been the loss of marine ecosystems as a result of dredging/dredging spoil activities. This refers to the loss of habitats as a result of pumping coral fill for the purpose of land reclamation. It is estimated that the total area lost during the four main phases of reclamation totals about 20 million cubic metres of fill (about 10% live coral), and about 600,000 tonnes of rock, creating more than 20 km of new coastline. In addition, these dredging activities have led to the modification of surrounding habitats due to siltation, particularly in the earlier phases of reclamation when silt screens were not utilized.

## iii. Waste disposal

Another cause of loss of habitat is the reclamation of land from the sea for the purpose of waste disposal. On Mahe, the principal sites for waste disposal over the past 20 years have been at La Retraite and Providence, both sites that have been reclaimed from the sea. More recently, the Anse Royale Landfill site, due to open in the middle of 2001, is located on the coastal strip about 400 metres from the sea.

<sup>38</sup> Estimate from GIS (Payet)

### 5.1.2 Sectoral Pressures (for Modification and/or Loss of Ecosystems and/or Ecotones)

Seychelles economy rests on tourism and fishing. Presently, tourism accounts for about 12.7% of GDP and the manufacturing and construction sector (including industrial fishing) accounts for about 28.8%. Most of the other industrial activities are limited to small-scale manufacturing, particularly agro-processing and import-substitution. Agriculture (including artisanal fishing and forestry), once the backbone of the economy, now accounts for only around 3% per cent of GDP. The public sector, comprising the government and state-owned enterprises, dominates the economy in terms of employment and gross investment. It employs two-thirds of the labour force, and public consumption absorbs over one-third of the GDP.

**The Tourism Sector** - Despite the leveling off of arrivals over the past 5 years, tourism remains the most important pillar of the Seychelles economy through direct and indirect contributions to the domestic economy (GDP), and through inflows of foreign currency (Balance of Payments), including tourism receipts and foreign direct investment. According to Central Bank of Seychelles statistics on trade in services, tourism earnings have increased steadily from SR 353 million in 1986, to SR 663 million in 1993, reaching about SR 750 million in 1999. Based on these figures, the average per diem expenditure per visitor was about SR 580 (US\$ 105) in 1999. In 1999, tourism was calculated to contribute about 29% of total export or foreign exchange earnings of the country, approximately 5,000 direct jobs or about 17% of total employment, and about 20% of the Gross Domestic Product. Throughout the 1990s, the amount of government revenues generated by the direct and secondary impact of tourism is estimated to be some 40% of total expenditures. However, the actual size and overall contribution of tourism to the national economy is much more significant, since all the statistics referred to above are based on conventional national accounting, and do not take account of all the indirect contributions of tourism to gross domestic product.

**The Fisheries Sector** - Within the 1.3 million km<sup>2</sup> of the Seychelles Exclusive Economic Zone (EEZ), there are approximately 40 thousand km<sup>2</sup> of plateaus and shallow banks of less than 200 m depth. Given this vast and easily accessible maritime domain, fishing has traditionally played an important role in the Seychelles economy. The importance of this sector in the national economy has grown significantly with the development of the Industrial Tuna fishing activity in the west Indian Ocean in early 1980 and the setting up of the tuna canning factory in 1987. Seychelles strategic position in the centre of the tuna fishing grounds enables the country to reap immense benefit from this activity. Exports of canned tuna accounted for around 93.7 percent of domestic exports (excluding tourism and re-exports) in 1999, in contrast to 36 percent in 1983. This represented gross foreign exchange earnings of SR 577.7 million. The cannery has recently expanded its present daily processing capacity from 112 tons of raw materials to a daily processing level of 300 - 400 tons and increase cold storage facility from 2,000 to 7,000 tons. The processed tuna is exported mainly to the European market (83% to UK and France).

**The main sectoral pressures** for both modification and loss of ecosystems in Seychelles are urbanization and tourism development, both of which have led to significant land use changes/ conversion. Urbanization is estimated to contribute as much as 60% of the pressure for land use changes/land use conversion. As is described above, much of this is accounted for by land reclamation from the sea, mainly for housing development and associated infrastructure (schools, sewage treatment facilities, energy generation, waste disposal sites, etc). The large area of land reclaimed from the sea on the East Coast of Mahe has also been utilized for the construction of industrial estates and a large and well-equipped sports complex built for the 1993 Indian Ocean Games. The total area of land reclaimed on the East Coastal of Mahe during the past 30 amounts to around 629 hectares and represents just over 4% of the total land area of Mahe. The earlier reclamation projects were particularly destructive of marine habitats, as they did not sufficiently utilise measures to mitigate negative consequences.

**Table 3. Major Export Items, 1995 – 2000<sup>39</sup>**

	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000<sup>40</sup></b>
<b>Exports (f.o.b) in value (Rupee millions)</b>	128.0	315.1	358.7	490.9	596.5	581.3
1. Copra <sup>41</sup>	0.3	0.0	0.0	0.0	0.0	0.0
2. Cinnamon bark	3.5	4.7	3.4	2.8	2.2	1.2
3. Frozen & fresh fish	10.1	11.2	20.4	13.2	28.2	18.1
4. Canned tuna	88.0	169.8	286.2	413.3	531.9	456.0
5. Shark fins (dried)	2.9	2.4	0.8	0.2	0.3	N/A
6. Frozen prawns	6.9	10.9	22.7	34.1	7.7	15.6
7. Other exports	16.2	116.1	25.2	27.4	26.1	N/A
<b>In quantity</b>						
1. Copra (tonne)	157	0	0	0	0	0
2. Cinnamon bark (tonne)	416	320	277	287	471	190
3. Frozen & fresh fish (tonnes)	406	487	962	309	824	567
4. Canned tuna (tonnes)	6,291	12,813	20,611	21,626	34,605	31,714
5. Shark fins (dried) kg.	11,289	9,200	6,024	4,281	N/A	N/A
6. Frozen prawns	131	188	406	581	159	257
7. Other exports	N/A	N/A	N/A	N/A	N/A	N/A

Elsewhere, the development of hotels and other tourism establishment on coastal areas has contributed to loss of ecosystems. There has also been extensive land-use conversion resulting in loss of habitats on the upland areas, especially for housing development. The usual method of house construction on the hillsides involves clearance and levelling prior to construction. Another impact of such practices has been considerable run off of sediment during heavy rains, which has had a considerable impact on marine habitats in some areas.

The policy of extensive reclamation of land from the sea has often been justified as necessary for future socio-economic development, and a “trade off” against further development of the upland areas, much of which is designated as national parks and protected areas. In this regard, it is notable that successive governments have attached greater value to the preservation of terrestrial habitats than to marine habitats.

This is illustrated by the responses of the Minister for Land Use and Habitat to questions asked in the National Assembly in May 2001 concerning the utilization of land currently being reclaimed under the third phase of the East Coast Project and how the Government was going to fund the planned development of the land reclaimed from the sea. The Minister noted that the East Coast project reflected the Government’s long-term vision for the future sustainable development of Seychelles (in which the

<sup>39</sup> Statistical Abstract 1999 & Trade Bulletin (Jan 2001)

<sup>40</sup> 2000 Figures provisional

<sup>41</sup> In 1996, Pakistan (the only export market for Seychelles’ copra) imposed a ban on the import of Seychelles copra, citing presence of coconut diseases in the East African region.

private sector had a major role to play). He went on to explain that it was on account of environmental reasons that the government had chosen to push for development along the coast rather than move up the mountains.<sup>42</sup>

Among the proposed development projects that will be facilitated by the newly reclaimed land are the following:

- the construction and development of a new international commercial port, with gantry facilities, on a 25-hectare reclaimed island within the present harbour to provide sufficient quay space to for all international trade and Freeport requirements. Seychelles presently has only 350 m of quay that can accommodate ships of not more than 11 m draft;
- the development of a new international commercial port will also further fuel development of the islands into an important international business centre, whose main features would consist of registration of International Business Companies, trusts, banks, insurance companies, ships and aircraft as well as the development of Freeport and export procession zone activities;
- a Petroleum Products Storage Terminal on the Offshore Island will provide the necessary infrastructure for engaging in cost-effective regional trading in oil products. Seychelles is well placed to supply oil to countries of the region, with an estimated annual demand of 1.1 million tones;
- the fishing port, being one of the most important tuna fishing ports in the world, already handles over 60 percent of tuna presently caught in the S.W. Indian Ocean per annum. The fishing port needs to be upgraded, and further physical expansion is required to allow for more onshore facilities and triple quay space;
- expansion of the artisanal fisheries port and related infrastructure to cater for the larger vessels and provide more on-shore and safe berthing facilities;
- the development of a ship repair facility, which is urgently required as a result of the increased number of foreign fishing vessels, which are currently compelled to use such facilities in other neighbouring countries;
- relocation of inter-island passenger and cargo port to the Yacht Club Basin, to remove congestion and allow the tuna cannery and fisheries facility to expand;
- a special bypass road through the Victoria Central Business District is necessary to allow flow of heavy transport vehicles and also provide the link for all Southbound and Northbound traffic entering and leaving Central Victoria;
- the conversion of existing commercial port into a new cruise ship terminal with related onshore facilities entails the construction of new infrastructure and reception facilities;
- the relocation of Seychelles Yacht Club, Marine Charter terminal and National Water-Sports Centre will allow an increase in water sports facilities, and provide additional facilities for yacht mooring;
- development of part of the reclaimed seafront into an exclusive real estate development with associated berthing facilities for private yachts and pleasure boats;
- allow for the development of an exclusive yacht marina with an associated 5-star Hotel development;
- a 40 hectare offshore island, which is to be reclaimed, within the vicinity of the marina would provide land for the development of high value real estate for wealthy individuals (mostly foreigners) wishing to invest in a water-front residence;
- since the Government attaches very strong importance to the development of adequate social and housing needs for its people, it plans to accommodate some 3,500 housing units at a slightly higher density on the proposed reclaimed land;

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<sup>42</sup> (The Nation, 28<sup>th</sup> May 2001)

- community facilities such as schools, clinics, recreational and sports facilities will also need to be constructed to meet the needs of the new population of the area;
- areas for industrial expansion, as part of promoting the development of small business and ongoing liberalisation programme, Government is aiming to allocate substantial land with basic infrastructure for development; and
- to provide additional areas which could be transformed into recreation parks, aquarium, bird sanctuaries and other nature sites.

The various land reclamation projects have impacted on around 3.43 km<sup>2</sup> of coral reef out of a total of 18.54 km<sup>2</sup> on the east coast of Mahe. This represents about 18% of the coral reefs on the East Coast of Mahe, but just 0.001 % of the total global area of reefs.<sup>43</sup>

The root causes of land use conversion/land reclamation is the need for land suitable for social and economic development, in a situation where there are high expectations and strong political pressures to maintain recent levels of growth and social development. In particular, the emphasis on providing housing for all, as well as associated social infrastructure, demands additional land area.

To this end, there has been a preference to sacrifice shallow water marine ecosystems in order to provide land systems (at considerable cost) as an alternative to developing steep hill slopes, and the destruction of upland forests, many of which are protected areas.

The loss of marine ecosystems as a result of dredging/dredge spoil activities is of course directly linked to reclamation activities, and is a consequence of the same sectoral pressures described above.

### **5.1.3 Responses**

#### **5.1.3.1 Environmental Management Policies and Tools Designed to Address Environmental Problems**

##### **i. Environmental management**

Despite its small size and small gross domestic product, the Government of Seychelles has since 1990 allocated a considerable annual budget of approximately US\$ 2 million to the Ministry of Environment and its predecessors. In addition, Government provides substantial budgets for solid waste management, sewerage and fisheries management. Moreover, since the launch of the 1990-2000 Environmental Management Plan (EMPS), Government has matched donor funding for EMPS projects through budgetary and other financing (see section 6.2.1.1. below).

A considerable body of general management tools exists for the protection of the environment, including specific laws relating to protection of trees, removal of sand & gravel, protection of endangered species, etc. Legislation also defines protected areas, special reserves and natural parks, which comprise nearly 50% of the total land mass.

In addition to such national management tools, Seychelles is also party to a range of international and regional conventions for the protection of the environment. For example, Seychelles has ratified the Convention on Biological Diversity (CBD), and is implementing a National Biodiversity Strategy and Action Plan (NBSAP). The NBSAP is a 5-year plan that contains 11 major goals:

- provide support for general measures for conservation and sustainable use;
- strengthen identification and monitoring of biodiversity;
- increase in-situ conservation;

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<sup>43</sup> Ref: (Payet, in draft, Environment Cost Benefit Analysis of the Phase III of the East Coast Reclamation.

- promote ex-situ conservation;
- introduce ways and means for sustainable use of biodiversity;
- introduce incentive measures for biodiversity conservation;
- improve appropriate biodiversity related research and training;
- augment public education and awareness of all facets of biodiversity;
- minimize adverse impacts on biodiversity;
- ensure access to and judicious control of genetic resources; and
- evaluate and use appropriate technology.

The NBSAB contains actions in the form of thirty-eight projects that have been developed to implement many of the policies and to address the gaps. It also provides a schedule of implementation and identifies the implementing agencies. Finally, a budget details the funding requirements for the plan's implementation. The total cost of implementing the plan is in the region of US 14.5 million over a five-year period.

Seychelles is also a party to the Climate Change Convention, and has submitted its first national Communication to the Conference of the Parties. Seychelles is also participating in the Global Programme of Action to Protect the Marine Environment from Land Based Activities (GPA), and is committed to implementation of Habitat II. At the regional level, Seychelles hosts the Regional Coordinating Unit of the Nairobi Convention.

One major international convention that Seychelles has not signed is the RAMSAR Convention.

Legislation exists governing all development projects, including tourism projects, which are subject to environmental authorization, and an environmental impact assessment (EIA) procedure is required for all projects that may have environmental impacts. The EIA procedure provides the basis for preventing environmental problems through appropriate design of projects. In addition, tourism projects (and other types of development) are required to have an environmental management plan prepared and approved by the Ministry of Environment, who then monitor the project to ensure that the management plan is being followed.

While the earlier reclamation works did not make use of sediment control, measures (i.e. silt screens), it is notable that recent reclamation projects have been more controlled, particularly in the vicinity of the Ste. Anne Marine National Park.

The introduction of EIAs for some developments, especially in sensitive areas is a step in the right direction in order to mitigate negative impacts on ecosystems, as is the gradual introduction of internationally recognized standards for construction and attempts to mitigate the effects of soil erosion and flooding, including the periodic clean-ups of marshes.

In addition to the recent attempts at mitigating the negative consequences of reclamation (silt screens), the requirement for EIAs prior to approval of development projects has to some extent acted to reduce negative impacts on habitats, as has recent attempts to integrate freshwater wetlands into tourism developments.

Another positive response has been the efforts made with some recent developments to minimize habitat loss by building on natural contours and retaining as much of the original vegetation/forest cover as possible.

While these tools and international commitments are important, there is often inadequate implementation/enforcement, as well as loopholes in the accompanying legislation, and a degree of abuse of influence is evident, particularly with respect to the implementation of private development projects. However, in most cases there is little or no data available to measure such

weaknesses. Another weakness affecting the effectiveness of existing management and policy tools is the inadequacy of resources at the national level, both in terms of manpower and financial resources. Finally, the situation is exacerbated by the scale of the system of protected areas, in a situation of very limited human and financial resources.

## ii. Land use changes

In addition to the legislation referred to above, the following tools and policy instruments are available, including:

- Town & Country Planning Act (1974) - TCPA;
- Environmental Protection Act (1994) - EPA;
- Environmental Management Plan of Seychelles;
- 1990-2000;
- 2000-2010<sup>44</sup>; and
- Plan d'Amenagement du territoire (PAT).

Proposed projects involving land use changes must be approved under the Town and Country Planning Act (1974), and the Environmental Protection Act (1994). There is no doubt that provisions provided under this legislation have had a positive effect in the protection of the environment. At the same time, there are significant weaknesses. The Town and Country Planning Act is in need of revision, but there have been difficulties in introducing a new act due to concerns from some ministries and departments, about the weakening of decision making powers. In particular, despite the existence of a draft new Act, this has not been possible to put in place due to fears that the greater transparency proposed would reduce the power of the Ministry responsible for land use development and housing. In the case of the Plan d'Amenagement du territoire (PAT), the main weakness is related to its lack of legal status, and the fact that it is often ignored.

One positive development in good practice that is worth noting are the attempts being made by the Planning Authority to minimize habitat loss by encouraging new housing and other developments to build on natural contours, and to retain as much of the original vegetation/forest cover as possible.

In summary, while both the Town and Country Planning Act and Environmental Protection Act have had many positive impacts, there is an urgent need for revision in order to take account of changed circumstances, including modern concepts of integrated coastal zone management. Among the major limitations are loopholes in the law that enables the provisions of these Acts to be overruled. In some cases, abuse of influence is considered to be a significant factor. Conflicts with other policies, particularly those related to the commitment to social development, are also an important factor.

Again, a major constraint in developing more effective policy tools is the lack of baseline studies and data, and poor monitoring of the effects of land use changes on surrounding ecosystems.

However, it must be acknowledged that while implementation and enforcement of existing legislation has significant weakness, when compared to most other countries in the region Seychelles has very high environmental standards and aspirations.

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<sup>44</sup> Plan d'Amenagement du territoire (PAT)

### iii. Major project decision-making

A strength of the management and policy environment in Seychelles is the existence of inter-ministerial project appraisal and planning committees. Project proposals are initially circulated to various ministries and agencies for comment, before being submitted with recommendations to an Inter-Ministerial Committee (NIC), comprised of Chief Executives. For example, projects in the tourism sector are initially considered by a Project Appraisal Committee (PAC), which is chaired by the Ministry of Tourism & Civil Aviation, and consists of representatives from other government departments, including the Ministry of Land Use & Habitat, Ministry of Environment, and the Planning Authority. The PAC may request further information about the project, or else pass it directly to the NIC with appropriate recommendations. This system ensures that no government department or ministry can approve a project without taking account of the views of other department or ministries.

#### 5.1.4 Sectoral Policies (that Directly Increase the Pressure)

The main sectoral policies that directly increase the pressure on ecosystem modification and loss are related to:

- urbanisation;
- tourism; and
- fisheries.

##### 5.1.4.1 Urbanisation

As has already been referred to above, Government's strong commitment to promoting social development on an equitable basis has been at the root of the trend towards greater urbanization. In particular, the policy of promoting home-ownership for all has meant that land suitable (and available) for house construction is in increasingly short supply.

##### 5.1.4.2 Tourism

Seychelles tourism industry started to take off in the early 1970's, following the opening of an international airport in 1971. Since then tourist arrivals grew to around 50,000 per year in the early 1980s, to a peak of 130,046 in 1996. While arrivals declined slightly between 1996 and 1999, they recovered to 130,046 in 2000.

The growth in the tourism industry has largely been the foundation for the remarkable advances in national socio-economic development achieved by Seychelles. These achievements are highlighted by Seychelles' ranking in the UNDP Human Development Index, which ranks countries according to indicators such as life expectancy, infant mortality rates, literacy, access to health and education, gender equality, and so on. Indeed, the Seychellois people have come a very long way since independence in 1976, and now have the highest standard of living in Africa, with a quality of life that is comparable to many middle-income countries worldwide. However, in order to sustain previous levels of socio-economic development, and also to meet the rising expectations of the population, Government has found it necessary to promote the further growth of the tourism industry. This will inevitably result in increased pressures of coastal and marine ecosystems, despite Government's policy to promote sustainable tourism development, as is highlighted in the soon to be published document "*Vision 21: for Tourism Development 2001-2010*" (See Section 6.2.1.2)

In particular, the targeted growth in tourist arrivals from 130,046 in 2000 to around 190,000 by the year 2010 will place a huge strain on the carrying capacity of coastal areas that are considered as prime sites for tourism development, as well as on natural resources such as water.

**Table 4. Tourism Arrivals and Income (1995-2000)**

	<b>Visitor arrivals</b>	<b>% Change</b>	<b>Average length of stay (nights)</b>	<b>Visitor nights ('000)</b>	<b>Bed occupancy rate (%)</b>	<b>Income (2) (R million)</b>
1995	120,716	9.8	9.5	1,146	53	466.3
1996	130,955	8.5	9.7	1,270	57	524.5
1997	130,070	-0.7	10.3	1,340	56	612.5
1998	128,258	-1.4	10.5	1,347	53	583.8
1999	124,865	-2.7	10.4	1,299	53	596.2
2000	130,046	3.9	10.4	1,352	52	600.0

#### 5.1.4.3 Fisheries

After tourism, fisheries is the second most important sector of the economy. The Seychelles Fishing Authority (SFA), which was incorporated in August 1984 under the Seychelles Fishing Authority (Establishment) Act, is the executive arm of government in the fisheries sector. It was established at a time of intense development in the foreign industrial tuna fishing, with the aim of developing Seychelles' fishing industry to its maximum potential, while safeguarding the resource base for sustainable development. The functions of the SFA, as defined under article (5) of the Act are:

- to promote, organize and develop fishing, fishing industries and fishing resources in Seychelles;
- to assist in the formulation of the national policy with respect to fishing, fishing industries and fishing resources and in the implementation of that policy;
- to conduct negotiations, or engage in meetings, seminar or discussions, with regard to fishing or fisheries or the establishment of fishing industries, whether at a national or international level, on behalf of the Republic or otherwise; and
- to identify the manpower training requirements of Seychelles with regard to fishing and fishing industries.

Since the establishment of the SFA, the fisheries sector in Seychelles has expanded significantly. The artisanal fisheries sector, which has traditionally provided the major source of protein for the Seychellois population, has in recent years expanded to meet the demand of the tourism industry. There is also an increasingly lucrative export market for high quality fish products. In addition, the development of the industrial fisheries sector is now an important foreign exchange earner, where exports of canned tuna to the European Union generated a record SR 531.9 million (approx. US\$ 96 million) in export earnings in 1999.

**Table 5. Exports by the Fisheries Sector 1993-1999 (SR)**

	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>
Frozen & Fresh Fish	2.3	2.3	3.5	4.7	3.4	2.8	2.2
Canned Tuna	58.3	100.0	88.0	169.8	286.2	413.3	531.9
Shark Fins (dried)	3.1	1.9	2.9	2.4	0.8	0.2	0.3
Frozen Prawns	2.8	1.9	6.9	10.9	22.7	34.1	7.7

**Table 6. Tuna Catch Statistics (by main species) 1994-1999<sup>45</sup>**

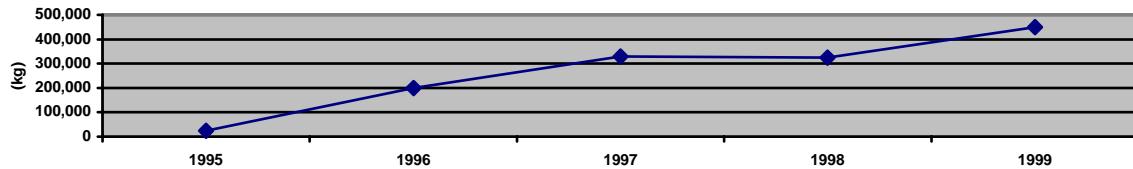
<b>Year</b>	<b>Total Catch (MT)</b>	<b>Catch Rate (MT/day)</b>	<b>Yellowfin (MT)</b>	<b>%</b>	<b>Skipjack (MT)</b>	<b>%</b>
1994	280,114	22.21	94,610	34	154,002	55
1995	307,135	21.27	108,123	35	159,591	51
1996	265,658	20.52	92,429	35	145,134	55
1997	271,100	17.41	71,370	26	171,404	63
1998	252,595	16.35	69,905	28	151,894	60
1999	331,422	23.66	87,663	26	213,188	64

Local fishermen exclusively operate the artisanal fisheries sector, where an estimated 1,000 fishers are active, possessing a fleet of about 400 fishing vessels. After a sharp decline in fish landings in 1998, the 1999 catch recovered to the highest level since 1993.

**Table 7. Total Artisanal Catch (1994-1999) in Metric Tonnes<sup>46</sup>**

<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>
4,428	4,313	4,510	4,095	3,334	4,842

This semi-industrial fishery, which commenced in 1995, targets mainly the swordfish, yellow fin and big eye tunas, with catches increasing from 26 tonnes in 1995, to 212 tonnes in 1996, to 456 tonnes in 1999.

**Figure 10. Semi Industrial Fisheries: Total Catch (kg) 1995-1999**

A number of management policies and tools exist to manage the fisheries sector, including bans on the use of spear guns, limitations on the use of fish traps (traditional fishing method for reef fish) restrictions on the size of nets, and closed seasons for certain types of fisheries (i.e. lobsters).

In addition to local management measures, Seychelles is a member (and host) of the Indian Ocean Tuna Commission (IOTC), and is also signatory to other international fisheries agreements. Despite regulations and management measures, illegal commercial fishing is a serious problem that is difficult to control, due to an extremely large EEZ totaling around 1.3 million square kilometres, and very limited resources for effective surveillance and enforcement.

Another indirect impact on marine ecosystems associated with the fishing industry is related to the need for additional port facilities and landside infrastructure for fish processing industries, as well as associated pollution from the tuna-canning factory located at Port Victoria.

<sup>45</sup> Source: Seychelles Fishing Authority: Annual Report 1999

<sup>46</sup> Source: Seychelles Fishing Authority (SFA) Annual Report 1999

### **5.1.5 Community Response (Initiatives from Community or Social groups, which may Alleviate Pressure on the Issue)**

The major issue leading to loss of ecosystems and ecotones on Mahe and the other granitic islands is land use conversion associated with land reclamation to support socio-economic development and tourism. There are almost no community-based initiatives that address the major land reclamations, other than informal discussions among small groups of concerned citizens. On the contrary, the community view towards reclamation tends to see such developments as necessary for development. A minority of “environmentally-concerned people” do express their views in order to have an influence on policy decision-making.

At the community level there remains a demand for smaller scale reclamation projects, in spite of a moratorium on such developments. The lack of knowledge among the general public on the importance of marine ecosystems and of how ecosystems link together thus acts as a major constraint to addressing the issue.

The local media does produce programmes/articles on environmental subjects and issues, which does contribute towards raising awareness of some of the immediate causes of ecosystem loss and modification, though perhaps not of the underlying sectoral pressures. Such initiatives are to a large extent inspired by similar coverage in the international media, and because of Seychelles’ commitment to several international environmental conventions.

Increasing awareness is also helping to alleviate some negative environmental impacts (i.e. control of waste disposal and littering, some pollution control, and control of exotic plants) and is also promoting more environmentally friendly practices (e.g. efficient water use).

One community based initiative that has had an important impact is the growing number of *Wildlife Clubs* in schools and local communities, which have increased community awareness of environmental issues, particularly among the younger population. Again, there are links to international environmental movements and education programmes, and members have been exposed to regional and international programmes. However, despite growing awareness, and the positive effect that children and youth can have on adult perceptions, these clubs have to date had little effect on addressing actual problems. This is because of the limited ability of children and youth to have a direct impact on decision-making, although this is changing as a result of recognition of the importance of youth opinion in a society where 40% of the population is below the age of 20.

Unlike other countries, notably in the northern industrialized countries, there are no pressure groups that exert pressure on government and private developers. This is perhaps partly explained by the fact that Government is the largest employer and a consequent fear of reprisals (especially in terms of jobs), which means that protests rarely generate sufficient momentum to have an impact on policy decisions.

#### **5.1.5.1 Market Responses**

##### **i. Expansion of small businesses and industries (local and foreign owned) on reclaimed land**

The land reclamations, particularly on the East Coast of Mahe, have provided the space for the further development of small businesses and industries, and with it the associated threat of additional pollution. The policy of government is to encourage both the development of import substituting industries, and export-orientated industries under the International Trade Zone Act. Industries established under the latter are eligible to receive various incentives and concessions, including the right to import labour. Seychelles membership of regional economic integration communities, such as the Southern African Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA) provide an additional incentive for the development of such industries.

The policy of promoting industrial development will, if successful, increase the likelihood of further reclamation in the future, and with the threat of increased pollution problems, leading to further habitat modification and loss and pressure on nearby coral reefs and lagoons.

While the drive towards increased economic development is inevitable, the lack of national capacity in the economic evaluation of environmental assets is of great concern, and is an issue that needs to be urgently addressed and integrated into the planning process.

## **ii. Expansion of industrial fisheries**

While the Seychelles Fishing Authority is the executive arm of government in the fisheries sector (see Section 4.1.4.3 above), the recent development and expansion of the industrial fisheries sector has been largely private sector driven.

The industrial fisheries sector has grown in recent years, and is now second to tourism as a foreign exchange earner. In 1999, the export of canned tuna generated SR 531 million (US\$ 96 million, compared to an estimated SR 750 million (US\$ 136 million) generated by tourism.<sup>47</sup> The Indian Ocean Tuna (IOC) Company, a joint venture between the Government of Seychelles and the Heinz Corporation, is established under the ITZ legislation, and is one of the world's largest tuna canning factories, employing over 2000 people. The cannery is located in Port Victoria, on land reclaimed from the sea during the past 10 years. There are a number of environmental concerns, including a lack of facilities for adequate disposal of wastes from the production process. The factory is supplied with raw materials from foreign fishing fleets, under licensing arrangements with the European Union, with the end product being exported to the EU free of duty under the terms of the Lome Convention.

The increased global demand for fish products, and the depletion of fisheries stocks elsewhere is expected to lead to increased exploitation of the fish stocks of the Western Indian Ocean, and possibly to the establishment of a second tuna canning operation in Seychelles, which would have to be located on land currently being reclaimed from the sea. The establishment of a further canning factory would greatly exacerbate the pressure already being placed on nearby marine habitats, including the Ste. Anne Marine Park.

## **iii. Eco-labeling**

A small number of hotels in Seychelles have already started to launch eco-labeling initiatives, and many hotels have made an effort to introduce environmentally friendly policies. This is linked to international trends towards the promotion of sustainable tourism and ecotourism, both of which are supported and actively advocated by Government.

At the international level, such initiatives are encouraged by the World Tourism Organisation (WTO) and the International Eco-tourism Society (TIES), amongst others. These trends are important elements in alleviating pressures on ecosystems, as hotels and other tourism establishments increasingly have to take account of environmental concerns in the major tourism markets, particularly in Western Europe, which are Seychelles' main markets. However, the costs of introducing local or regional eco-labeling or of becoming a member of internationally recognized eco-labeling initiatives are very high, and there is also a lack of trained personnel to implement the necessary changes.

## **iv. Promotion of ecotourism concepts**

There has been an increase in eco-tourism ventures over the past few years (i.e. on Cousine, Bird and North Island), while the draft policy document of the Ministry of Tourism & Civil

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<sup>47</sup> Central Bank of Seychelles Quarterly Report (Oct-Dec 2000)

Aviation, Vision 21, advocates the promotion of ecotourism and community benefits as one of its central strategies for the next ten to twenty years. While these developments are consistent with Seychelles long-standing commitment to promoting environmental conservation, they are given added impetus by the recognition that eco-tourism is a fast growing and lucrative segment of the travel industry. In any case, regardless of the motivating factors underlying the promotion of eco-tourism, these developments will contribute to reducing pressures on ecosystems. However, it should also be recognized that there are considerable constraints in developing eco-tourism products that are economically viable and sustainable.

**v. Promotion of environmentally friendly practices by diving operations**

In recent years, local scuba diving (and snorkelling) operations serving the tourism industry have started to promote environmentally friendly practices, in an attempt to mitigate impacts on the marine environment. While this has certainly helped to relieve the pressure of dive tourism on coral reefs, there is still a need for further improvements, particularly through the provision of more permanent anchoring points at popular dive sites.

**vi. Cruise ship operations**

While cruise ship operations remain relatively small scale compared to other regions (such as the Caribbean), the increase in the depth of the harbour at Port Victoria as a result of the recent reclamation works now permits larger cruise ships to visit Seychelles. At the same time, there is still a lack of adequate facilities for the disposal of nautical wastes. It is therefore important that any expansion of cruise ship tourism is accompanied by the introduction of adequate measures to address the threat of increased pressures on the marine environment.

**vii. Recycling**

Seychelles currently produces 24,000 tons of solid waste per year (1995 data) and is projected to generate about 34,800 tones by 2016. On a per capita basis each individual generates about 0.34 tonnes per year. Most solid waste is currently disposed of at the Providence Landfill Site, situated on land reclaimed from the sea on the East Coast of Mahe. An estimated 33 % of the waste is biodegradable green waste, which is composted and sold as soil conditioner on the local and external market. A few local enterprises have taken the initiative to introduce recycling of their products, most notably Seychelles Breweries. Scrap metal and waste oil are also exported for re-cycling. However, some other major companies have not made such efforts to recycle their products (e.g. plastic bottles).

Although there are economic constraints to re-cycling in the context of small islands (due to lack of economies of scale), more concerted efforts could be made to encourage environmentally friendly process in the production process, as well as the adoption of re-cycling strategies to reduce the pressure on landfill sites.

**5.1.6 Root Causes**

Chart 3 (below) illustrates the root causes that were identified under “social changes”, “institutional drivers” and “economic structure”, respectively:

**5.1.6.1 Social Change**

Although Seychelles is a developing country, it has experienced very rapid social and economic development over the past 20 to 30 years. This development is placing increasing pressure on ecosystems, despite the Government’s enlightened approach towards environmental conservation.

### i. Population pressure and demographic change

The increase in population and demographic change have been a significant factor in the increased demand for flat land suitable for housing development, and this has been one of the driving factors behind land reclamation. While the rate of population increase has been relatively slow by comparison with many other developing countries, from 61,786 in 1977 to 74,331 in 1994, the decline in the average size of households from 4.9 in 1977 to 4.3 in 1994 has been a significant factor in increasing demand for land in view of the Government's commitment to providing housing for all families. The commitment of government to social development is indicated by the high budgets allocated to the social sectors (including housing). In addition to housing, the commitment to promoting socio-economic development has driven demand for land for social infrastructure (including for construction of schools and sports facilities<sup>48</sup>).

In addition to population increase and changes in household structure the increase in tourist arrivals from 54,490 in 1971 to 130,046 in 2000 has led to land use conversion for hotel development, concentrated on beachfront areas.

### ii. Social development

As has already been highlighted above, the Government commitment to social development has been a major factor in increasing the pressure on ecosystems. In particular, the increase in population, coupled with the decreasing size of family units, has resulted in a rapid increase in the number of households and consequently for housing construction, and associated infrastructure.

### iii. Beliefs and value systems

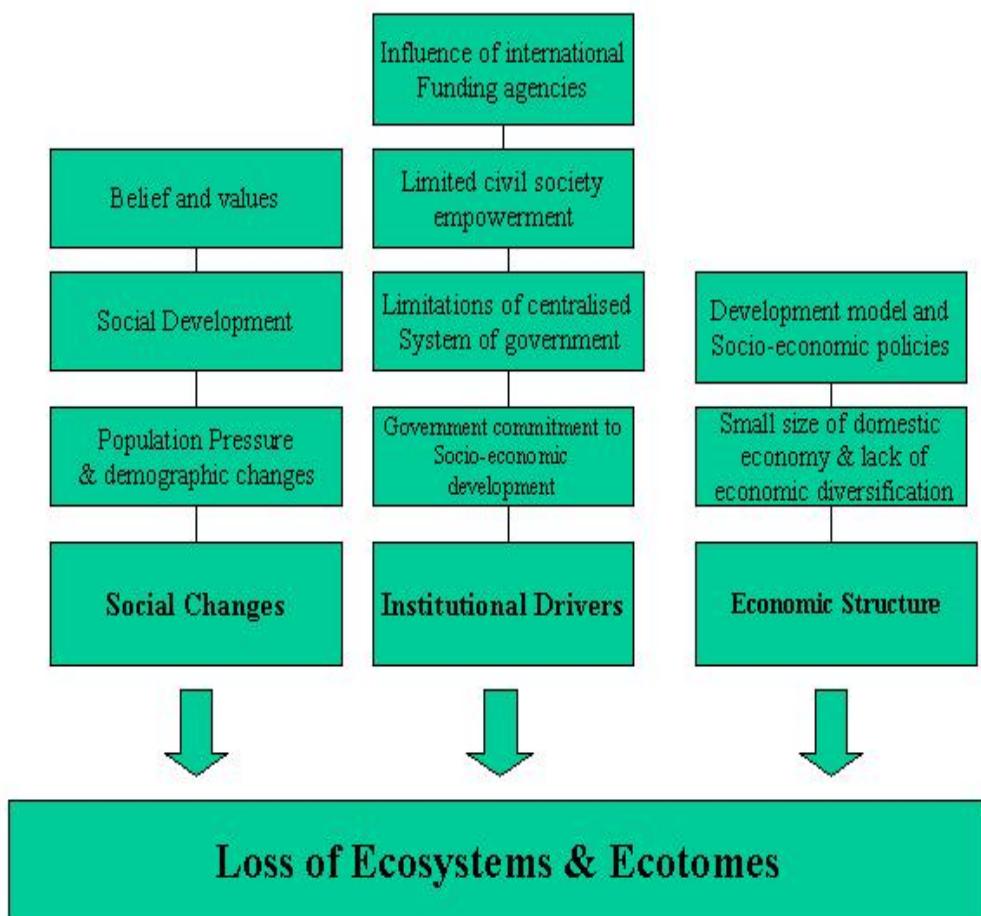
One of most notable features of modern Seychellois society is that it is highly consumer orientated, characterized by a population with a relatively high level of disposable income, linked to a welfare state that provides free education and health and social security safety nets. It has also traditionally been a very open society, subject to outside influences. In many ways, Seychelles is typical of other former colonies that were originally based on slavery, insofar as "traditional society" never existed.

The GDP per capita has increased from US\$ 3,600 in 1975 to US\$ 7,192 in 1998. Among the indicators illustrating the high consumerism of Seychellois society is the ownership of motor vehicles, which has increased from 4,100 in 1981, to 6,153 in 1993, to 11,000 in 1999 (or around one vehicle for every seven persons), and the ownership of mobile phones, which were 16,316 in 1999 (or around 1 for every 4.5 persons).

The rapidly changing lifestyles of the Seychellois population, including increased consumption patterns and rising expectations, are thus major root causes of the pressure on ecosystems.

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<sup>48</sup> The infrastructure for the 1993 Indian Ocean Games (football stadium, multipurpose gymnasium, Olympic swimming pool, tennis courts, etc. was constructed on land reclaimed from the sea.

**Chart 3. Root Causes of Loss of Ecosystems and Ecotones**

### 5.1.6.2 Institutional Drivers

#### Government commitment to socio-economic development

Government's commitment to social and economic development is undoubtedly the major institutional driver exerting pressure on ecosystems, as such development requires increasing areas of land suitable for development. This is illustrated by Government budgets for the social sectors of housing, health and education, which has resulted in Seychelles reaching middle income status at 53<sup>rd</sup> place in the UNDP Human Development Index (2000), the highest ranking in Africa and ahead of countries such as Mexico (55), Cuba (56), Belarus (57), Bulgaria (60), the Russian Federation (62), Saudi Arabia (75) and Turkey (85). <sup>49</sup> This commitment to social development is also reflected in the impressive school enrolment figures (at nearly 100%), a pupil/teacher ratio of 1 to 13.8, and the high ratio of medical officers to population (1 to 750).

#### Limitations of centralized system of government

Although the country is divided into 23 administrative districts, government in Seychelles tends to be very centralized. This is understandable given the small size of the country. However, this means that in implementing development projects local concerns are not always fully taken into account, particularly

<sup>49</sup> Numbers in brackets refer to position in UNDP Human Development Index.

when such projects are considered to be in the national interest. In such cases, local environmental impacts may not always be fully considered. Specific examples include the development of the Silhouette and Ste. Anne jetties, as well as some hotel and private developments that have bypassed the normal planning procedures.

### **Limited civil society empowerment**

Although NGOs and other civil society organizations have developed rapidly during the past 10 years in particular, and have been encouraged to participate in decision-making processes, they are not always effective, in part due to their lack of maturity. Moreover, many NGOs lack roots in local communities, which is illustrated by the low levels of participation at the local level.

### **Influence of international funding agencies**

International funding agencies, such as the African Development Bank (ADB), World Bank, UN Specialized Agencies, etc., have had a positive effect on the socio-economic development of the country, and have also contributed significantly to projects aimed at protecting and conserving the natural environment. Such agencies have provided significant financial resources for social development (particularly during the immediate post-independence period), notably for the construction of schools, hospitals and clinics. The World Bank has also provided significant support (under the Global Environment Facility) for a number of projects under the Seychelles Environmental Management Plan (EMPS) 1990-2000.

In recent years, Government has increasingly had to resort to obtaining commercial loans to finance development projects, such as for environmentally sensitive land reclamation projects and power supply, while recent five-star hotel developments have been funded mainly through foreign direct investment.

#### **5.1.6.3 Economic Structure**

##### **i. Small size of domestic economy and lack of economic diversification**

Seychelles shares the same special characteristics (specificities and vulnerabilities) as other small island developing states, which are usually heavily dependent on one or two main industries. These characteristics (including economic and environmental fragility) are well documented in the Barbados Programme of Action for the Sustainable Development of Small Island Developing States (1994), and include, *inter alia*, limited resources and limited economies of scale for the development of manufacturing industries, distance from both sources of raw materials and other inputs, and from markets for exports, etc. The Seychelles economic structure is characterized by the small size of domestic economy and lack of economic diversification – which is centred mainly on services (tourism and associated infrastructure) and fisheries (and associated port and industrial developments such as the cannery).

**Table 8. Percentage Contributions of the Affected Sectors to GDP in Seychelles**

<b>GROSS DOMESTIC PRODUCT</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>
(1999 Preliminary estimated figures)				
Net national product at factor cost				
(National Income) (Rm)	1 834.6	2 134.6	2 175.6	2 211.2
GNP at current market prices (Rm)	2 450.3	2 825.0	2 986.9	3 080.4
GDP at current market prices (Rm)	2 500.3	2 844.6	3 060.0	3 155.4
-- by industrial origin:				

Agriculture, forestry & fishing	3.9%	3.3%	3.0%	3.2%
Manufacturing and construction	22.9%	24.0%	25.7%	28.8%
Tourism related (direct)	14.8%	14.7%	13.7%	12.7%
Other transport and distribution	24.3%	24.8%	25.3%	23.7%
Government services	14.0%	13.2%	13.2%	13.8%
Finance and services	11.5%	11.30%	10.2%	10.0%
Other services	8.6%	8.7%	8.9%	7.8%
GDP at constant (1986) market prices (Rm)	2 029.0	2 267.2	2 391.9	2 461.6
GNP per capita (R)	32 065	36 537	37 883	38 309

(Source: *Seychelles in Figures*, prepared by the Statistics and Database Administration Section (MISD-Seychelles)

The links to resource use changes and responses consists of increased pressure for land use conversion for the construction of infrastructure associated with tourism, as well as port development and the provision of land for the secondary fishing industry (i.e. canning/processing).

## ii. Development model and socio-economic policies

As has already been outlined above, Seychelles development model and socio-economic policies place strong emphasis on the provision of an extensive range of social and economic infrastructure, typical of a welfare state. The need for additional land for social-economic development over the next 25 years is perceived as necessary to sustain social and economic development, and has been the driver of major reclamation and tourism development projects.

## 5.2 Global Change (Coral Bleaching and Coastal erosion)

### 5.2.1 Immediate Causes

#### 5.2.1.1 Coral Bleaching

The dominant immediate causes of coral bleaching are large-scale “global threats” that have resulted in an increase of sea temperatures, which is estimated to contribute to the coral bleaching in Seychelles waters on a scale of at least 70%. These global threats are the result of natural causes (estimated at 10%) and global pollution (estimated at 60%). Of course, these are transboundary issues that are beyond the control of any national government.

In Seychelles, coral bleaching during the 1997/1998 EL Nino period when the sea surface temperature exceeded 34 degrees C with some lagoons exceeding 37 degrees C. Overall about 50% to 90% coral were bleached as far down as 23m.<sup>50</sup>

Although the major cause of coral bleaching is a global phenomenon, there are local threats (totaling an estimated 30% of the pressure), particularly around the main islands of Mahe, Praslin and La Digue, that can be identified as contributing factors and/or factors that inhibit full recovery, including:

- sediment discharge (10%);
- sedimentation from reclamation activities (10%);
- local increase in seawater temperature (5%);

<sup>50</sup> (Linden et. Al., 1999)

- land use conversion (1%);
- industrial pollutant discharge (1%);
- increased discharge of freshwater (1%);
- disease and parasite introduction (1%); and
- maritime accidents, such as oil or chemical spill (1%).

While the global impacts on coral reefs associated with rising sea temperatures are evident (see Section 3.2.1.2 above), the threat of sea-level rise to reefs (as opposed to reef islands) is negligible on a global scale. However, sea-level rise poses more of a threat to reef systems around small island states where reef structures are under stress from human activities. Additionally, in the main granitic islands of Seychelles, which are mountainous islands surrounded by coral reefs, the increasing frequency of heavy rainfall patterns and flood conditions results in increased sediment flows that contribute to the deterioration of fringing reefs already under stress as a result of rising sea temperatures, and other human activities. Thus, while on the one hand such increasing flows of sediment result from land use practices on higher elevations (including those associated with construction and agriculture), the impact of such practices is further exacerbated by the effects of climate change.

It is therefore important to consider possible interventions to further protect and conserve that areas of reef that have been relatively less affected, and to implement measures and programmes to restore damaged reefs. One such programme is included in the National Biodiversity Strategy and Action Plan. The overall objective of this project is to restore selected reefs and to improve their ability to protect shorelines from erosion and to provide habitat for marine biodiversity, and fish for tourists and fishermen. This will be achieved by constructing artificial reef structures using the material accretion method to build a growing limestone structure on which corals can grow at rapid rates.<sup>51</sup>

### **5.2.1.2 Coastal Erosion**

As with coral bleaching, the issue of coastal erosion is also identified primarily as a transboundary issue and a consequence of global change, probably contributing to more than 50% of the problem. These transboundary causes include:

- sea level rise (30%);
- increased wave intensity (20%); and
- abnormal high tides (5%).

In addition, there are a number of more localized contributing causes, including:-

- marine structures built along the coast (15%);
- beach and sand mining; (10%);
- land use change (5%);
- reclamation (5%);
- changed freshwater and sediment supply due to dams, diversion, etc (5%); and
- channels and passages across reefs (5%).

These main (localised) causes of coastal erosion are a result of:

- construction of infrastructure (including private homes and tourism developments) built on coastal dunes, which in many cases do not utilize environmentally friendly techniques;

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<sup>51</sup> National Biodiversity Strategy and Action Plan (Project No. 9)

- disturbance of beach profiles, as a result of interventions such as reclamation and the construction of piers, groynes, etc., which besides having an impact on sand deposition may also result in beach erosion; and
- disturbance of dune land by removal and/or destruction of vegetation, removal of sand (for building purposes), damage caused by people (and vehicles) visiting beaches.

## 5.2.2 Sectoral Pressures (Coral Bleaching and Coastal Erosion)

### 5.2.2.1 Sectoral Pressures (Coral Bleaching)

As the main causes of extensive coral bleaching in Seychelles waters are of a transboundary nature, the sectoral pressures are outside the country. These external pressures are mainly the result of global pollution, although natural causes are a contributing factor. For the remaining local causes it is possible to estimate the contribution of each sector to the buildup of pressures on coral reefs, which has been estimated to account for 30% of total pressures. The following chart illustrates that local contributions to coral bleaching emanate from a range of sources, namely:

- industry (23%);
- urbanisation (22%);
- tourism (15%);
- transport (14%);
- agriculture (13%);
- fisheries (8%); and
- energy (6%).

The impact of industries on coral reefs is almost exclusively localized along the east coast of Mahe. Although the Seychelles has a policy favoring light industries, certain rather large manufacturing industries such as the Seychelles Breweries, the Indian Ocean Tuna Canning Factory and the paint factory all have localized impacts on the health of coral reefs. Whilst in the case of the brewery the effluents are primarily organic in nature, it is not treated to local standards. The greatest threat however is from the Indian Ocean Tuna (IOT) factory. Although up to secondary treatment has been installed, the effluents are so strong that treatment is not complete. Efforts are underway to improve the treatment effectiveness of the canning factory. The local paint factory only reformulates the paint, so the effluents only contain oil and water based paint additives. Since lead was banned in the use of paints in the early nineties, other measures for treatment of these wastes have been explored.

Urbanisation generates sources of both point source (sewage systems) and non-point (runoff) sources of pollution, which will have a direct impact on coral reefs in terms of coastal water enrichment as well as sediment deposition. The Victoria Sewerage plan aims to provide sewer facilities to almost 30% of the total population who live in the most urbanized area, the east coast of Mahe. Although the central sewage system will meet the Seychelles water quality standards, non-point sources of pollution is still a problem.

Tourism infrastructure located close to many coral reef areas may cause bleaching in reefs through increase discharge of laundry and sewage into the sea. This is of particular concern in the Beau Vallon area, which is the mostly densely developed tourism area in the Seychelles. Most of these hotels built in the early seventies and eighties do not have proper treatment facilities, and it has been difficult to get many of these hotels to comply with existing regulations. However, their contribution to coral bleaching is far less than from urbanization in some areas.

Both agriculture and fisheries have little impact on coral reefs when it comes to bleaching. In fact, there are few cases when this has been though to occur.

By far the largest threat to coral reefs within the Seychelles is mass coral bleaching arising from global change effects, such as increased sea surface temperatures. Due to the severity of the bleaching experienced in 1997/98 within the Seychelles area, it was though wise to include it's contribution as being 70% to represent a single moment in history when such calamitic events occur. In contrast to the hurricane prone reefs of the Caribbean, the reefs of the Seychelles do not experience severe weather and wave conditions, thus is not adapted to such sudden changes in environmental conditions.

Fine scale surveys done in the granitic islands of the Seychelles (Engelhardt, 2000) following the 1997/98 coral bleaching event showed that in many parts live coral cover has been reduce to 10%. This is by far the largest extent of bleaching of several orders of magnitude higher than was ever recorded in Seychelles. The impact of such a natural catastrophe linked to climate change, more specifically global warming, is yet to be completely evaluated especially its relevance to fisheries stock, coastal stability and tourism.

### **5.2.2.2 Sectoral Pressures (Coastal Erosion)**

The same situation applies to coastal erosion, where an estimated 55% of the sectoral pressures are estimated to originate from global sources, which have led to sea level rise, increased wave intensity and higher tides, all of which have contributed to coastal erosion in Seychelles.

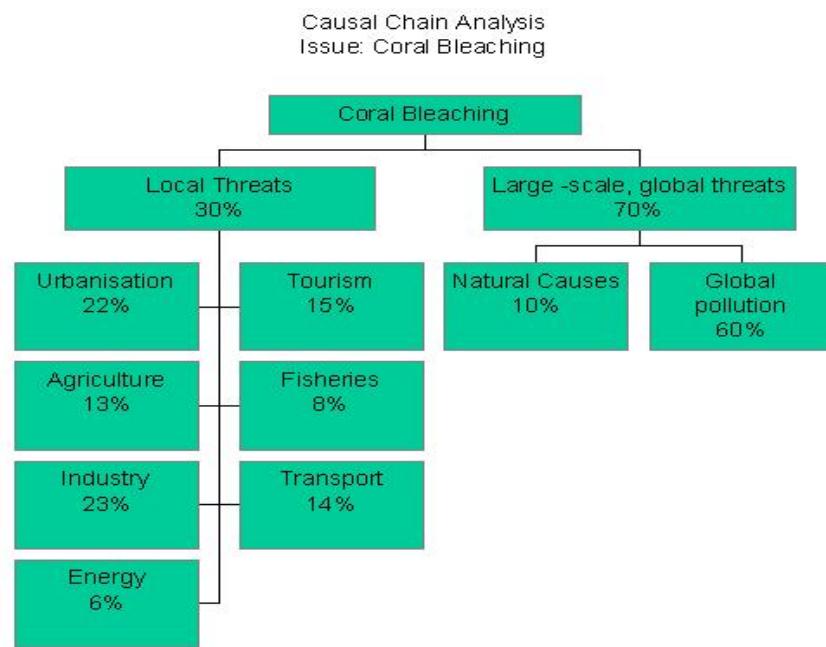
The local threats mentioned above arise from a range of sectoral pressures. It is estimated that urbanization (30%), tourism (27%) and industry (23%) combined total around 70% of the problem, while lesser pressures also originate from transport (13%), fisheries (10%) and agriculture (8%).

Local threats to coastal erosion are as significant to global threats to coastal erosion. Since there has always been an acute scarcity of coastal land to support urban development, coastline modification along the east coast of Mahe have been happening since colonization in the eighteenth century, and recently on a much larger scale. Coastline modification interferes with long term coastal equilibrium achieved during long periods of exposure to oceanic forces, and often leads to coastal erosion within the areas impacted. Furthermore, use of beach sand in construction has also been a significant cause of coastal erosion in many areas, especially those that are secluded. Sand use in construction has considerably reduced due to a ban on the use of dredged sand and the promotion of granite dust (crushed granite) as an alternative material.

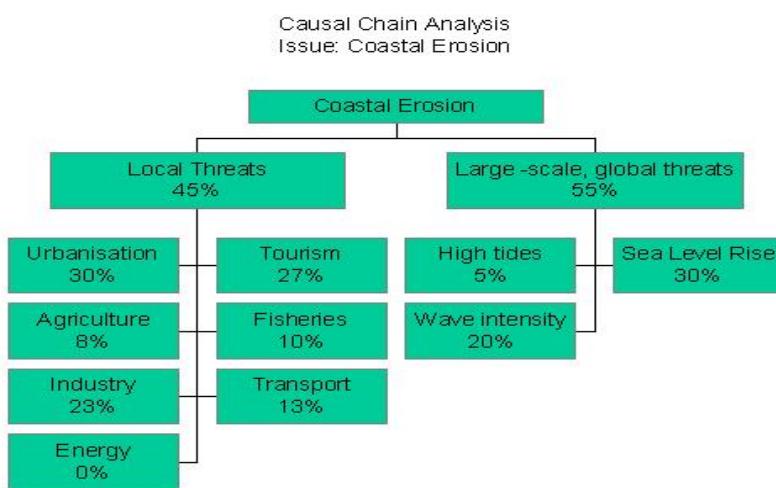
Tourism is also a primary cause of coastal erosion, primarily arising from attempts to cosmetically improve the beach and swimming areas, as well as the provision of marine facilities such as marinas and piers. Both activities have led to severe degradation especially in Praslin at the Coco de Mer Hotel. Sand replenishment activities are now planned to restore the beach to its natural state.

The impacts of sea level rise will also have a huge impact on these stressed coastlines. There is already evidence of severe degradation in areas not impacted by man. Climate Change is also predicted to cause increase in weather and wave extremes. Extreme wave conditions have been recently observed in the Seychelles and have overnight exposed 50-year-old coastal trees, through undermining. High tides were observed during the El Nino 1997 event, when low-lying coastal areas were flooded and tonnes of sand were thrown up onto roads.

**Chart 4. Coral Bleaching Causal Chain**



**Chart 5. Coastal Erosion Causal Chain**



### **5.2.3 Responses**

#### **5.2.3.1 Environmental Management Policies and Tools Designed to Address Environmental Problems**

##### **i. Coral bleaching**

The main management tool for the management and protection of Seychelles' coral reefs is the designation of a number of marine protected areas. There are currently eight national parks and three other special reserves with marine components. In addition, there are marine areas set aside as *shell reserves*. In total, over 23,000 hectares of reef and marine areas are under protection. The marine parks are in principle managed by the Marine Parks Authority (MPA), although currently four marine parks remain unmanaged, due to a lack of financial and human resources.

Nevertheless, improvements have been made to the management of marine national parks under the Environmental Management Plan 1990-2000,. For example, demarcation buoys and anchoring buoys have been placed in some marine parks, though maintenance has been inadequate.

Some programmes that include elements relating to coral reefs have been implemented, including the Shoals of Capricorn Project (Royal Geographic Society), which among other things is seeking to improve management capacities.

Despite such programmes, there is still very little known about the marine environment in Seychelles. In particular, the implications of climate changes have been little studied. There is therefore a need to improve the assessment of the extent and rate of coral bleaching, and monitoring of the recovery of corals following the 1998 bleaching event related to El Nino.

Seychelles is also active in a number of international programmes that aim at improving the management and protection of coral reefs, including the International Coral Reef Initiative (ICRI) and CORDIO. Seychelles also participates in specific programmes under the Indian Ocean Commission (COI).

A major weakness is that coral reefs that lie outside designated marine protected areas are not protected. Indeed, there is currently no national policy on coral reefs.

In conclusion, the proper management of marine protected areas in Seychelles is severely handicapped by “a lack of integration, partnerships and capacity” and marine protected areas “need urgent attention in terms of monitoring, research, capacity and partnership building, awareness and advocacy, and systems planning” (EMPS, 2000-2010).

Among the relevant management priority areas identified by the EMPS 2000-2010 are:

- initiate research and assessment in the coastal environment, looking at assessment of critical habitats and coastal hydrodynamics and nutrients; and
- develop an integrated approach to marine protected area management, linking Marine National Parks to other marine areas managed by different agencies (e.g. the Seychelles Fishing Authority).

##### **ii. Coastal erosion**

A number of management tools and policies have been used to redress some of the major causes of coastal erosion. For example, although the removal of sand continues to be a serious

problem, there has been stricter monitoring and enforcement of the relevant laws (Removal of Sand and Gravel Act), coupled with a strategy to produce sufficient quantities of suitable alternatives for construction purposes.

Another practice has been to attempt to limit damage to sensitive dune areas by constructing barriers to prevent vehicles from parking, as well the construction of boardwalks in some locations (i.e. Grand Anse). This has contributed to the regeneration of dune vegetation. In addition, efforts have been made to replant dune vegetation where this has been lost, or to introduce native varieties of vegetation in order to increase resilience to erosion

There has also been a moratorium on the private reclamation of small areas of land for housing developing, although there remains great demand for such developments.

Despite such efforts, much more needs to be done, particularly in the area of monitoring and enforcement, and in raising awareness of the importance of dunes and the consequences if they are not protected. In addition, the effective implementation of existing regulations governing construction on coastal areas (including “setback lines”) needs to be improved, pending the revision of the Town and Country Planning Act (1975).

There is also an urgent need to put an effective monitoring programme in place, in order to better understand the extent of the processes at work, and to develop appropriate responses.

#### **5.2.4 Sectoral Policies (that Directly Increase the Pressure)**

##### **5.2.4.1 Urbanisation**

As has already been outlined, urbanisation is one of the main (local) causes contributing to pressures on the marine and coastal environment in terms of coral bleaching and coastal erosion. The major policy tools have also been outlined, namely the Town and Country Planning Act (1975) and the Plan d’Aménagement du territoire (PAT). Finally, the sectoral policies that contribute to increasing the pressure, and in particular the Government’s social policies relating to housing provision, have also been extensively referred to above.

The major weaknesses of sectoral policy tools are that although they are necessary to guide and plan development within any given area, the Town and Country Planning Act is now out of date and needs revision, while the PAT has no legal status as a mandatory instrument.

As a result, development is often haphazard, and consequently the cumulative effects cannot be predicted, which means that mitigating measures are often almost impossible to implement effectively.

##### **5.2.4.2 Industry**

The tools and/or policies in use are those relating to (i) industrial policy; (ii) industrial estate management; and (iii) trade effluent standards. The major issue is in terms of pollution discharges, which may cause coral to lose photosynthetic zooxanthellae. Although the occurrences of bleaching from industrial wastes are minimal and are not accounted for, there is a need to address the issue of pollution and consequent effects on the marine environment. While industrial policy in Seychelles is focused on the promotion of light (and relatively non-polluting) industries, some existing industries such as the tuna canning factory, paint formulation factories and printing presses during times of poor treatment can lead to potential bleaching events. Many of these industries do not have the proper waste treatment facilities. However, it is to be noted that policies are in place to limit the establishment of heavy industries. Where “heavy” industries are proposed, strict environmental discharge standards will be imposed.

### 5.2.4.3 Tourism

As has been highlighted above, Government has felt it necessary to promote further tourism development in order to sustain previous levels of socio-economic growth and development, and to meet the rising needs and expectations of the population.

While the continued expansion of the tourism industry poses enormous threats to the environmental, and particularly the marine and coastal environment, it is recognized that tourism depends upon protecting, conserving and managing the environment upon which the industry is based, including coral reefs.

The soon to be released policy paper for tourism development, *VISION 21*, thus places particular emphasis on the need to nationally integrate the industry for environmental sustainability. *VISION 21* also advocates the development of ecotourism and community benefits, as one aspect of a sensitive approach to the environment.

In planning tourism developments, attention is paid to the proper location of infrastructure, in order to reduce the impact on the coastal fringe and to preserve dunes, while the proper treatment of hotel wastewater will reduce impact on coastal marine water quality.

Another issue directly related to the tourism industry is the potential damage to coral reefs by trampling by scuba divers and anchoring. Finally, it is not known whether tourists can bring in diseases, although there is evidence to show that tourists or those that travel abroad can bring in invasive species. This is another issue that needs to be monitored closely.

### 5.2.5 Community Response (Initiatives from Community or Social Groups which may Alleviate Pressure on the Issue)

Community initiatives to directly alleviate pressures on the environment have been limited, as most initiatives have been government driven. Nevertheless, there have been some community responses that have been important in raising awareness, even where this has been limited to demanding government to intervene. Also, personal participation in EIA appraisal committees has made a contribution.

Non-governmental Organisations (NGO's) in Seychelles are governed under the Register of Associations Act 1959, with a minor amendment in 1991. An umbrella organisation, the Liaison Unit of non-Governmental Organisations (LUNGOS) groups up to 50 NGO's, Unions and Associations for purposes of addressing similar needs and concerns, as well as enabling better representation at the various multi-stakeholder meetings. Non-governmental organisations mainly consist of professional academic, scientific, school-level, or industrial associations affiliated with a particular area of business, social or environmental interest. There are seven main ones with specific interest in environment, and at least 33 school wildlife clubs, which are affiliated to the Wildlife Clubs of Seychelles NGO.

Government has shifted its policy to increase stakeholder consultation, as well as embrace a more participatory approach to decision-making. Although the benefits of these actions are still too early to quantify, numerous initiatives such as the development of the new Environment Management Plan (EMPS, 2000) demonstrate how Government can successfully interact with the private sector and NGO's in ensuring a multi-ownership process. Government is also engaged in developing collaboration agreements with some NGO's either on a common understanding or a Memorandum of Understanding.

The level of stakeholder representation on policy and working committees has increased significantly as a result of government policy, and constitutes almost 10% of many national committees, and as much as 50% in a few others. Other participatory mechanisms such as the Environment Impact Assessment process allow interaction of the public with the policy aspects of environment management, however this is still very limited in scope.

Community-based activities are mainly organised by District Administration (DA) offices, which is overseen by the Ministry of Local Government and Sports. Most of these DA offices have set-up local community-based committees on youth, women, sports and environment. However, only a few of these are active, primarily due to lack of funds and proper support, and possibly to some extent because of a perception that they have been imposed from above. An attempt at creating a coastal zone community committee (the Grand Anse Environment Interim Committee, GAEIC) was undertaken under the regional COI project at Grand Anse (Stirling, 1998). This was progressing very well until the project encountered technical problems. The committee now exists somehow without a discrete programme of action. With the development of the eco-tourism policy at district level it is expected that community participation in coastal issues will likely increase in a more consistent manner.

The largest environmental NGO in Seychelles is the Wildlife Clubs of Seychelles with over 700 members, of which the majority are school children. They play a very active role in promoting environment protection and education. Activities include exploration of Seychelles habitats and islands, turtle monitoring, and publication of educational materials. Wildlife clubs are however not always represented on many stakeholder committees, and a forum where the views of children and young adults can be heard without bias from adults is non-existent. Although not community driven, the development of the Environment Management Plan in 1999 involved the participation of young adults, where they played an active role. For example, the issue of role models in civil society was seen as being an important issue among the young. A national youth study was undertaken in 1998, and it was found that the environment featured very high on the expectation agenda of the young people of Seychelles.

#### **5.2.5.1 Market Responses**

There have been few market driven responses to alleviate pressures on the environment by coral bleaching and coastal erosion. The only examples identified are the promotion of quarry dust as an alternative to beach sand in construction, and initiatives by dive operations to limit impacts on coral reefs. Also, some hotels have seen the merit of keeping beach/dune vegetation and putting cleared seaweed under it as an organic manure and stabilizer, rather than building walls

As government has introduced legislation (Removal of Sand and Gravel Act, 1982), and subsequently reinforced implementation, to prevent the removal of sand and gravel from beaches and rivers, building contractors have had to use quarry dust as an alternative to traditional materials. However, quarry dust has widely been seen as an inferior material, and illegal removal of sand still occurs, though at a greatly reduced level.

Reference has already been made to the promotion of environmentally friendly practices by local scuba diving (and snorkelling) operations serving the tourism.

#### **5.2.6 Root Causes**

In considering the coral bleaching and coastal erosion, it has been noted that the causes can largely be identified as arising as a result of global change, which contributes an estimated 70% to the issue of coral bleaching in Seychelles, and an estimated 55% to the issue of coastal erosion.

Chart 7 below therefore illustrates only the local “root causes” that were identified under “social changes”, “institutional drivers” and “economic structure”, respectively:

It will be noted that so far as the local/national level is concerned (i.e. excluding the strong element of causes associated with global change), the root causes of coral bleaching and coastal erosion were very similar to those described for the modification and loss of ecosystems and ecotones, namely:

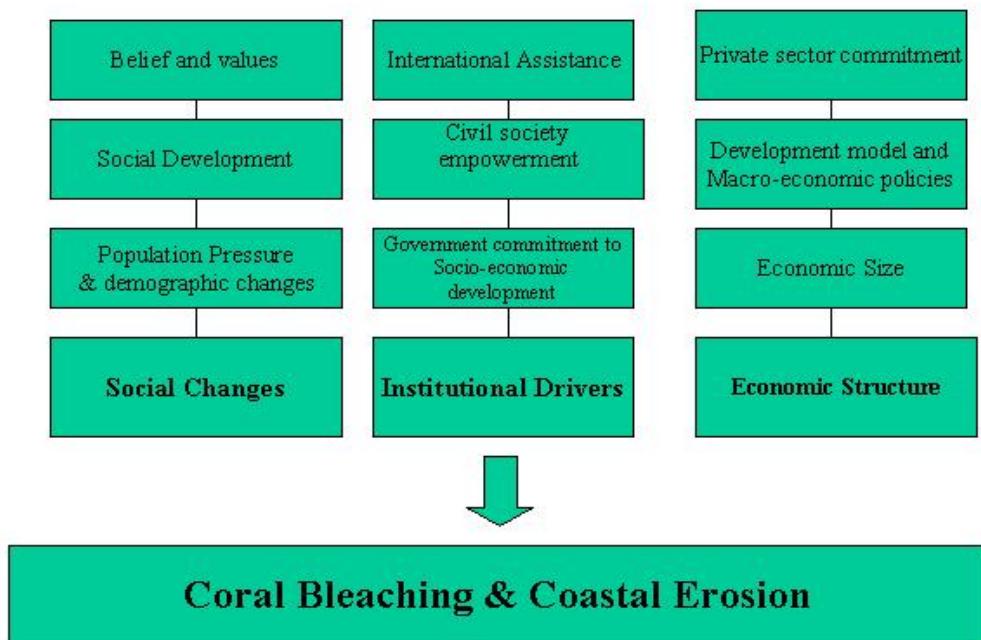
- social changes, associated with population and demographic change and changing values/life-styles, together with social and economic development, based on the development of industries and especially on the development and continued expansion of the tourism industry;

- institutional drivers, and especially a strong government commitment to social and economic development, under circumstances where there is relatively weak civil society empowerment and where the availability of international assistance has been a critical factor; and
- an economic structure that is small in size and exhibiting the typical features of other small island developing states (SIDS), and a development model that emphasizes growth.

While there is a strong awareness at government level of the need to promote sustainable development, which is indicated by the proportion of the national budget set aside for environmental management, there are many gaps and limitations in addressing environmental problems.

**Chart 6. Root Causes of Coral Bleaching and Coastal Erosion**

### **Root Causes at the local / national level**



## CHAPTER 5

### 6. Gaps and Commonalities

#### 6.1 Gaps

The major constraint in addressing environmental problems in Seychelles is the critical lack of data. In most cases this includes a general lack of baseline studies. This lack of data was apparent in both the *impact analysis* and *causal chain analysis*. While it was possible to observe some critical examples of impacts on the marine and coastal environment, and to identify their causes, there is little hard data and few studies available that could form the basis for informed decisions to be taken on interventions to mitigate such impacts. This is in large part due to the absence of any institutions of higher learning or research in Seychelles.

Nevertheless, some biodiversity studies are now being undertaken, notably relating to birds and invertebrates on some small islands, and on the impact of coral bleaching.

#### 6.2 Commonalities

In the course of the causal chain analysis (and in the earlier parts of the exercise) a number of commonalities were clearly identified.

##### 6.2.1 Impacts Associated with Socio-Economic Development

In the first place, the issue of social and economic development was identified as a major cause of environmental problems throughout the causal chain. This is in marked contrast to many other countries in the region, where inequitable models of development and the existence of widespread poverty are probably important issues. At the same time, government has consistently given a relatively high priority to the management and protection of the environment, and is committed to promoting development that is economically, socially and environmentally sustainable. These features of Seychelles socio-economic development model are illustrated by Seychelles' high ranking in the UNDP Human Development Index, which at 53 is the highest for Africa, with social indicators that are comparable to many middle-income countries in Europe

Seychelles commitment to the environment is illustrated by its high per capita spending on environmental management and protection. For example, only the Ministries of Health, Education, Defence and Internal Affairs exceeded the central government budgetary allocation to the Ministry of Environment, which totalled SR 48.3 million in 2000. In addition, during the implementation of the Environmental Management Plan for Seychelles (1990-2000), a total of SR 427 million was invested in a total of 45 national projects and 6 regional projects, of which SR 336 million was from funds obtained externally (including foreign borrowings and grants raised for project financing).

The issue of land reclamation (for socio-economic development generally) and coastal developments associated the tourism industry were recurring themes throughout the causal chain analysis, particularly with respect to impacts on ecosystems (loss and modification). The issues were also among the local factors (as opposed to the impacts associated with global change) impacting on coral bleaching and coastal erosion.

##### 6.2.2 Specificities and Vulnerabilities as a Small Island Developing State

However, these positive indicators must also be considered from the perspective of the country's extreme economic and environmental vulnerability. In this regard, Seychelles typically shares most of the features of other small island developing states (SIDS). The vulnerabilities and specificities of SIDS have been well documented, and are comprehensively laid out in the Barbados Declaration and Programme of

Action, adopted by the 1994 Global Conference on the Sustainable Development of Small Island Developing States. Since then, the Commonwealth Secretariat and the World Bank have produced studies detailing the vulnerabilities of SIDS. One important conclusion to be drawn from such studies is that while many SIDS, including Seychelles, have attained relatively high standards of social development and per capita GDP, these achievements are extremely fragile, particularly given the limited resource base and dependence on one or two industries (typically tourism and fisheries) and their susceptibility to outside shocks.

In addition to social and economic vulnerability, many SIDS are faced with extreme environmental fragility, and are particularly vulnerable to the threats posed by global warming, notably sea-level rise. This is clearly an important issue in Seychelles, as global change was one of two issues identified during the causal chain analysis.

These observations will be particularly important in subsequent phases of the project, since there is a tendency on the part of the international donor community to focus attention on the least developed countries (LDCs), on the basis of the relatively high GDP per capita of many SIDS. However, this view fails to take account of the high per capita costs of confronting environmental problems in a situation of extreme vulnerability and very limited human and financial resources.

### **6.2.3 Commonalities in the Causal Chain**

A notable feature in the causal chain analysis was that the immediate causes of the issues identified tended to be different, whereas there were more commonalities identified as the analysis progressed up the causal chain.

Among the recurring themes were the issues of enforcement, and limited resources (financial and human). Although Seychelles boasts a wide and comprehensive range of laws and other instruments aimed at the protection and conservation of the environment, monitoring and enforcement is often a major problem. This is particularly true of the marine environment, and specifically in relation to surveillance and enforcement within the country's large exclusive economic zone (EEZ), which covers 1.3 million square kilometres.

One aspect of the weaknesses associated with effective implementation of existing policy tools and instruments is an inadequate degree of inter-sectoral coordination.

### **6.2.4 Transboundary Issues**

The major transboundary issues identified in the causal chain analysis were those associated with global change (i.e. global warming and sea level rise). In addition, the protection, conservation and management of Seychelles' endangered and endemic species may also be considered as a transboundary issue, from a number of perspectives. In the first place, threats to endangered species have a global (transboundary) biodiversity significance, regardless of the nature or origin of threats. Secondly, a number of endangered species are migratory and range across national boundaries (e.g. turtles). Conservation efforts therefore require cooperation at the regional and/or global level. Thirdly, the exploitation and trade in endangered species is transboundary in nature. Finally, the Seychelles' unique granitic islands are important from a geological and evolutionary perspective.

## CHAPTER 6

### 7. Conclusions and Recommendations

#### 7.1 Main Conclusions

Although Seychelles has achieved much in terms of the conservation and protection of the coastal and marine environment, particularly when compared to most other countries in the region, this report highlights a number of issues that need to be addressed in order to ensure continued sustainable development. The preliminary identification and prioritisation of hot spots and sensitive areas identified the habitats suffering significant impacts, including: coral reef lagoons, coastal marshes, sandy foreshores, mangroves, sea grass meadows, fast flowing stony bottom rivers, and ocean fisheries.

The subsequent scaling and scoping exercise in turn identified a number of overriding critical issues that threaten these habitats, which were in turn prioritised according to the perceived impact of future changes. Although pollution was recognized as a major overriding issue, it was considered that it is an issue that is largely being addressed at the national and local levels, and is thus manageable. On the other hand, issues such as modification and/or loss of habitat, and those associated with global change (e.g. sea-level rise, coral bleaching and coastal erosion) were considered as posing more of a long-term threat.

Phase 2 of the study, which was based on the conclusions of the scaling and scoping exercise, focused on an analysis of the major environmental and social impacts. One important observation was that the nature of the impacts on the prioritised hot spots and sensitive areas differed quite significantly. The environmental and social impacts on the identified hot spots are mostly directly related to social and economic development, including land reclamation, and housing and tourism development. On the other hand, in the prioritised sensitive areas impacts are more typically associated with a greater range of issues, including poaching and over exploitation of resources, upriver water extraction, agriculture and global change, as well as the clearing of land for development purposes.

In the detailed environmental assessment of *habitat and community modification*, the most important impacts identified were (i) *modification of biodiversity*, including loss of species and genetic diversity; and (ii) *modification in natural storm barriers*. The modification and loss of coastal ecosystems on the main granitic islands has accelerated during the past 25 years as a result of rapid social and economic development. This is very evident in the prioritised hot spots, all of which are situated on the coastal plateau. In the case of the prioritised sensitive areas, those on Mahe are subject to similar impacts from social and economic development, while on Cosmoledo Atoll the lack of human settlement has been a factor in the illegal exploitation of fisheries and other resources.

The major threats to endemic flora and fauna on the main granitic islands are thus directly related to rapid social and economic development, and particularly associated land use conversion, which has resulted in a loss and fragmentation of habitats, particularly at low altitudes and on the coastal plateau. The introduction of alien plant and animal species, and to a lesser extent human predation, has also had significant impacts on biodiversity. Housing and tourism development is also a major factor, particularly in the main granitic islands, and especially for range-restricted species.

The disappearance of extensive areas of wetland marshes and mangroves has led to a modification of flood and storm barriers, which has been further intensified by deforestation and construction on hillsides, which has led to erosion and leaching of red soils and to over-siltation of wetlands. Other factors impacting on wetlands and marshes include the invasion of freshwater wetlands by alien species and the diversion of water from rivers for use by human settlements and for agricultural purposes. Recent patterns of social and economic development have intensified the pressures as the scarcity of flat land has led to land reclamation with a consequent loss of shallow marine habitats and the modification of surrounding habitats. Beachfront developments for housing, hotels and roads have resulted in the removal of coastal vegetation from dune land, which has further increased the vulnerability of beaches to sand erosion.

It is difficult to identify immediate negative socio-economic impacts, since the factors that have impacted on habitats have been associated with improvements to infrastructure for tourism, housing and recreation, which have benefited local populations. However, the loss and modification of ecosystems and the consequent impacts on biodiversity are important since the country's major economic sectors, notably tourism and fisheries, both depend directly on environmental and biological resources. Further loss and modification of ecosystems will therefore have a major impact on Seychelles' economy and society in general.

Like other small island states, Seychelles is vulnerable to global climate change, both from environmental and economic perspectives. Sea-level rise, increasing incidences of extreme weather conditions, and climate-induced changes to ecosystems (such as coral bleaching and an increasing incidence of invasive species) will have far reaching consequences. Three issues were identified as being of particular importance; (i) saltwater intrusion into freshwater aquifers; (ii) coral bleaching; and (iii) loss of habitats and damage to coastal zones as a result of coastal erosion.

Although the extent of the threat to endemic habitats and biodiversity still needs to be researched, it is likely that most habitats are at risk, with some being more vulnerable than others. Any rise in sea levels will flood the remaining mangroves, while changes in climatic patterns will have a variety of impacts on coral reefs, and there will be consequent impacts on a range of coastal and marine organisms, including fisheries resources, which will have significant socio-economic consequences. Saltwater intrusion to freshwater aquifers is increasingly becoming a problem on both the smaller granitic islands and coralline islands, both in terms of availability of potable water resources, and for coastal habitats and biodiversity that are dependent on the integrity of groundwater aquifers and freshwater lens.

While coral reefs have adapted to numerous changes over the past 200 million years, they are now faced with a wide range of threats, including over exploitation, pollution and especially global climate change that may make it difficult for coral reefs to adapt and survive. Global change will impact on coral reefs as a result of sea level rise, temperature increase, reduced calcification rates, altered ocean circulation patterns, and increased frequency of severe weather events. Another anticipated impact might be the greater frequency and intensity of coastal flooding, particularly during severe storms or during abnormal high tides. Seychelles' granitic islands, with their steep mountain slopes, make the narrow coastal zones particularly vulnerable, as coral reefs and coastal vegetation protect the coast against storms and beach erosion, while the wetland and mangrove areas around the coast act as flood and storm barriers. Further degradation of these environments will make beaches and coastal areas more vulnerable to erosion, with serious economic impacts

Phase 3 of the study concluded that modification of ecosystems is mostly caused by land use changes associated with urbanisation and tourism development, each accounting for an estimated 30% of the immediate causes. Transport developments, mainly road construction and port development, and changed freshwater and sediment supply, were identified as each contributing to around 20% of immediate causes. Global change also makes a contribution to modification of marine habitats, particularly on coral reefs and other coastal habitats. Land use conversion as a result of urbanisation is also an immediate cause of loss of ecosystems and ecotones, particularly on the East Coast of Mahe, where large-scale land reclamation has taken place over the past 30 years. Loss of habitat associated with land use conversion has also occurred throughout the main islands of Mahe, Praslin and La Digue. The main sectoral pressures are urbanization and tourism development, which contribute as much as 60% of the pressure. The root cause of land use conversion (including reclamation) is the need for land development purposes, fuelled by increasing population and demographic changes and rapid social and economic development. Another related factor is increased and changing consumption patterns, which exerts additional pressures on ecosystems.

The main immediate causes of coral bleaching are related to global change, and particularly increased sea temperatures, which is estimated to contribute to as much as 70% of coral bleaching in Seychelles waters. These global threats result from both natural causes and global pollution. There are also local causes, particularly around the main populated islands that are contributing factors and/or factors that inhibit

recovery. These local causes include sediment discharge, including sedimentation from reclamation activities, and local increases in sea temperature. Seychelles' reef systems are particularly vulnerable to sea level rise as reef structures are also under stress from human activities. The mountainous topography of Seychelles' granitic islands and the increasing frequency of heavy rainfall patterns and flood conditions results in increased sediment flows to fringing reefs already under stress as a result of rising sea temperatures. It is estimated that local contributions to coral bleaching result from a range of sectoral sources, including industry, urbanisation, tourism, transport and agriculture.

The issue of coastal erosion is also identified primarily as a consequence of global change, including sea level rise, increased wave intensity, and abnormal high tides. There are also a number of localized immediate causes, including coastal development, beach and sand mining, land use change, reclamation, changed freshwater and sediment supply due to dams, diversion, etc., and the clearance of channels and passages across reefs. The local threats are the result of a range of sectoral pressures, including urbanization, tourism and industry, which account for an estimated 70% of the problem. Any future sea level will have a major impact on these already stressed coastlines, as will any increase in the incidence of extreme weather and wave conditions.

At the local level the root causes of coral bleaching and coastal erosion are very similar to those identified as root causes for modification and loss of ecosystems and ecotones. These root causes include population and demographic change, and social and economic development.

While Seychelles' has a strong commitment to the protection and conservation of the environment, there are many gaps and limitations in effectively addressing environmental problems. A major constraint is the critical lack of data, including a general lack of baseline studies, on which to make informed decisions on interventions to mitigate such impacts. This is partly due to the small size of Seychelles and the lack of institutions of higher learning and research.

A number of commonalities were clearly identified during the study, of which the issue of social and economic development was seen as the major cause of environmental impacts throughout the causal chain. This is in contrast with most other countries in the region, where the continuing existence of widespread poverty is a major root cause of pressures on the environment. The specific issues of land reclamation and coastal developments associated the tourism industry figured consistently throughout the causal chain analysis, and were especially related to impacts on loss and modification of ecosystems. The issues were also among the local causes of coral bleaching and coastal erosion.

Among the major weaknesses identified throughout the study were inadequate monitoring, and weak enforcement of environmental laws and other instruments, which are mainly related to limited financial and human resources. This is especially the case with the marine environment, particularly in relation to surveillance and enforcement within the large exclusive economic zone (EEZ) covering over 1.3 million square kilometres. These weaknesses are often exacerbated inadequate inter-sectoral coordination.

Concerning transboundary issues identified in the causal chain analysis, these were mostly associated with global change, although the protection, conservation and management of endangered and endemic species is also a transboundary issue.

## **7.2 Recommendations**

### **7.2.1 General Recommendations**

The Report highlights the impacts of land use changes associated with social and economic development, and particularly tourism development, as posing the major threats to marine and coastal ecosystems. At the same time, it has been noted that there are a number of critical areas of weakness in addressing and mitigating threats to marine and coastal ecosystems, including weaknesses associated with monitoring and enforcement of existing laws and instruments, and a general lack of scientific studies and baseline data to guide interventions, particularly with respect to threats posed by global change.

It is therefore recommended that the priority for interventions should focus (i) improved land use planning; (ii) enhancing the effective management of protected areas; (iii) reducing impacts from development, including tourism related activities; and (iv) promoting and facilitating scientific studies on the marine and coastal environment.

In making specific recommendations for interventions, particular account must be taken of two important policy documents/plans that are to be launched this year, namely the "*Environmental Management Plan for Seychelles 2000-2010*", and "*VISION 21 for Tourism Development 2001-2010*".

### **7.2.1.1 Environmental Management Plan for Seychelles (EMPS, 2000-2010)**

The first Environmental Management Plan for Seychelles (EMPS 1) covered the years 1990 to 2000, and included a total of 51 projects presented in 11 different programme areas, with an original cost estimate in the region of SR 272 million (US\$ 50 million). To date, of the 51 projects, 16 have been fully implemented, 29 are ongoing, 3 were discontinued and 3 have not started. The revised cost for the implementation of the programme is estimated at around SR 427 million (US\$ 85 million), of which foreign borrowings and grants raised for project financing have totalled approximately SR 336 million (US\$ 61 million). In addition, a large number of other environment-related projects (mainly large infrastructure projects in the water and waste management sector), as well as responses to emergencies, were implemented outside of the EMPS framework.

The extent of government commitment to environmental management is illustrated by the substantial recurrent budgetary provisions during the EMPS period, including the recurrent and capital budgets to the Ministry of Environment, the Marine Parks Authority and the Solid Waste and Cleaning Agency (SWAC), as well as to specific environmentally related portfolio within other organizations and agencies, which total led up to SR 700 million (US\$ 130 million) during the period 1990-2000. It is estimated that taken together, Government budgetary (recurrent and capital) flows into environmental management during the EMPS period of 1990-2000 totaled up to SR 1 billion (source EMPS 2000-2010)

This first Environmental Management Plan for Seychelles achieved some notable successes, which were noted in the introduction to the new EMPS. These included: (i) the strengthening of institutional capacity, particularly in the Ministry of Environment; (ii) the passage of important environmental acts, including the Environment Protection Act (1995), the Plant Protection Act and the Pesticides Control Act, as well as the review and amendment of other key acts and standards; (iii) the elaboration of management plans for various sites and sectors; (iv) abolition in trade in turtle shell; (v) implementation of a globally threatened species recovery programme, in partnership with a local NGO; (vi) greater protection of environmentally significant sites and habitats, including the promulgation of three new protected areas and designation of 370 sites as sensitive areas; (vii) improvements to solid waste management, which has included privatisation of operations within the sector; (viii) improvements in physical planning and development, through the implementation of an EIA process under the Environmental Protection Act; (ix) improvement in pollution controls, with the establishment of standards, laboratories and trained personnel; (x) increased public awareness of environmental issues, including through the media and through the introduction of environmental education in schools; (xi) increase in number of environmental NGOs, and some decentralization of environmental activities to the district level; and (xii) progress in the ratification and implementation of a number of international environmental programs (including the CBD and the Framework Convention on Climate Change).

At the same time, a number of limitations were identified, a number of which are consistent with the conclusions drawn from the Integrated Problem Analysis as a whole. In the first place, EMPS 1 did not contain objectively verifiable environmental criteria, which has made it difficult to analyse and quantify the impact of the various EMPS projects on environmental quality. Another general weakness was that the nature of the implementation process was such that it was not seen as a process whereby the "product" could be periodically reviewed in terms of costs, goals and objectives, or the incorporation of new projects. Thus, EMPS 1 became more of a project list, rather than a "master plan" to provide guidance. The fact that the plan was targeted to donors meant that it became susceptible to be donor-driven.

Other weakness highlighted in the introduction to EMPS 2 include a recognition that the overall state of the environment was not reported on, mainly due to financial constraints, and while government produced studies and reports increased, peer-reviewed papers and documents decreased. It was also recognised that few EMPS projects created an enabling environment for NGO and private sector participation, and government ministries or parastatal organizations implemented most projects, although the private sector did become involved in solid waste management.

It was also acknowledged that environmental decision-making had remained largely a government concern, although the EIA mechanism did provide opportunities for the public to comment on specific projects. Thus, although it was noted that there is a genuine public concern for the environment, public understanding of environmental issues remained limited, partly because environmental policy was generally not available in the public domain.

Another weakness was that although environmental legislation was developed in specific areas (i.e. biodiversity and natural resources), the process of developing such legislation has been slow and fragmented. Moreover, despite the implementation of legislation and EIA enforcement, land use management is still poorly linked to environmental protection, and impacts such as deforestation, erosion and inappropriate development continued during the plan period. Non-point sources of pollution in certain areas also remain a significant problem, mainly due to financial constraints. Finally, it was recognised that gaps in knowledge of Seychelles ecology and natural processes remain a concern, despite the existence of a substantial body of scientific knowledge. Poor data management is a particular problem.

It is notable that many of these observations were confirmed in the course of the Integrated Problem Analysis. The Environmental Management Plan 2000-2010 therefore seeks to address these shortcomings through interventions in the following thematic areas:

- society, population and health (including gender);
- land use, coastal zones and urbanisation, biodiversity, forestry and agriculture;
- energy and transport;
- fisheries and marine resources/processes;
- water, sanitation and waste;
- tourism and aesthetics;
- environmental economics, mainstreaming and sustainable financing;
- regulatory, policy and institutional mechanisms; and
- commerce, industry and production.

The Environmental Management Plan for Seychelles 2000-2010 represents an integrated approach that cuts across sectors that will be implemented nationally. The same applies to the National Biodiversity Strategy and Action Plan, and the Vision 21: Tourism Development in Seychelles policy document. The respective documents should be viewed as complementary to each other, and taken together will go a long way towards addressing the most pressing issues affecting the Seychelles' environment, including those highlighted in this Report.

#### **7.2.1.2 VISION 21 - Tourism Development in Seychelles 2001-2010**

The causal chain analysis clearly identifies socio-economic development, linked directly or indirectly with the tourism industry, as the major pressure on the coastal and marine environment. There is a particular link between tourism development and the modification of ecosystems.

As the income generated from the tourism industry is the main contributor to GDP, it is essential that all subsequent tourism development takes place within the framework of maintaining the ecological, social and economic sustainability of tourism, giving utmost consideration to continuing and expanding application of environmental protection measures to designated protected areas, and more generally to the environment, in order to maintain the overall environmental quality of the Seychelles.

To achieve these objectives, the tourism industry as a whole must view environmental management as a continuous process, with both government and private enterprises sharing responsibility for conservation of natural resources. In particular, planning, development and management of tourism projects must be undertaken in a way that avoids serious environmental impacts.

Specific tourism projects should be carefully planned to take account of the carrying capacities of respective sites. Tourism development should also be environmentally integrated, suitably designed, stress the conservation of electric power and water supply, and apply appropriate waste management techniques.

These requirements are acknowledged in the draft *VISION 21 Tourism Development 2001-2010* document, which is to be officially launched during the last quarter of 2001, which states: -

*“Tourism in Seychelles depends primarily on features of the natural environment, and it is therefore essential that the industry be nationally integrated so as to protect the natural environment from pollution and degradation, and also to ensure that the carrying capacity of the islands is not exceeded. The anticipated increased demands of the tourism sector must also be taken into account in improving infrastructure and waste management, as well as the conservation of resources such as energy and water”.*

**VISION 21** also highlights the need for co-management between the tourism industry and government and the need to foster more business ethics in environmental management.

Among the specific control measures that are identified in *VISION 21* to mitigate environmental impacts on both the land and marine environment as a result of physical alterations and habitat damage are:

- introduction of guidelines on sound land use and site development practices;
- determining and not exceeding carrying capacities;
- maintaining visitor use controls in sensitive ecosystems and vulnerable wildlife areas;
- proper construction of piers, jetties and groynes (or no development of these if negative impacts would be generated);
- prohibiting anchors being dropped indiscriminately in coral areas; and
- reducing sedimentation of the coastal coral area from land erosion and controlling visitor use in coastal areas.

Vision 21 also states that existing plans and programmes establishing guidelines to control development in coastal areas will be continued, including the Coastal Zone Management Programme and Marine Resources Management Programme, and that additional legislation will be developed wherever appropriate.

In order to protect the coastal zone, especially from storms and sea level rises, all tourism and other permanent development will be subject to a mandatory set back of 25 metres from the mean high tide line with a greater set back required in vulnerable areas. Existing mangrove and freshwater wetlands will be reserved and protected to act as hydrological sponges and function as important habitats for marine life and birds.

The further development of all tourism infrastructure will therefore be subject to comprehensive planning procedures and controls, with the aim of meeting standards and to ensure minimal environmental impact and sustainability. In this regard, there is a need to improve coordination between land use planning and development area planning, in order to reduce conflicts in tourism land-use patterns, so that all national plans reflect the same development policy and strategy. This will ensure that tourism development is well integrated into the overall development patterns of the country.

The present approach in reviewing tourism development proposals is to evaluate each proposal on its own merit. Thus, while some standards have been generally accepted and applied (including a minimum setback of buildings from the high tide line of 25 metres in coastal areas, a building height limit of below the tops of coconut trees in rural areas and four stories in Victoria, and use of Creole style architecture), there is a need to establish a comprehensive set of standards and design guidelines, including suitable building materials to be used. These standards and guidelines could then be given to each prospective developer to guide the planning and design of the project, and could also be used in reviewing proposed tourism projects.

One important standard should relate to the carrying capacity of the site in terms of the density of development proposed. Project proposals should also include landscape plans and the development standards. For eco-tourism facilities such as eco-lodges, a separate set of development standards and design guidelines may be prepared.

In addition to *VISION 21*, it is to be noted that the new Environmental Management Plan for Seychelles (EMPS): 2000-2010, includes a sector on tourism and aesthetics. Management plans have been prepared for the protected areas, indicating the conservation measures that will be applied, and the appropriate types and locations of visitor facilities and uses. The management plans incorporate both conservation measures and development of visitor facilities and visitor use controls, as important aspects of increasing opportunities for tourist activities. A National Biodiversity Strategy and Action Plan is also being implemented.

### **7.2.2 Specific Recommendations**

While these policy documents are concerned with much broader issues than have been dealt with in this report, if implemented successfully they will contribute greatly towards addressing the environmental threats to the marine and coastal environment that have been identified in the Integrated Problem Analysis. Moreover, small island developing states such as Seychelles faces severe constraints with respect to absorption capacity, due to very limited human resources. In developing project proposals to address issues identified in the integrated problem analysis, it is therefore important to identify complementarities with projects that have already been identified as part of the overall national environmental strategy, as contained in EMPS 2 and Vision 21.

It is also recommended that, as far as possible, project proposals should be developed from specific project components of EMPS 2 and Vision 21 where these address issues identified in the Integrated Problem Analysis. Among the critical issues to be addressed are the following:

- strengthening of institutional capacity to deal with land-use planning and management effectively, so as to minimise and mitigate negative environmental impacts, particularly those impacts arising from land use conversion;
- reducing impacts from tourism development, so that tourism can be developed in a sustainable manner and contribute to the long term social and economic development of the country;
- developing sustainable financing mechanisms, including sustainable tourism approaches, for sensitive marine areas, and particularly for some of the more remote islands that are currently under threat from poaching and illegal fishing activities; and
- improving the management and sustainable use of Marine National Parks by developing Standard Operational And Management Procedures.

Finally, it is also recommended that the implementation of both policy documents should be closely monitored, and that to this end broad-based monitoring and implementation committees should be established, with representation from major stakeholders.



## References

- Barbados Programme of Action, 1994.
- Burnett, W. and Johnson, M. *Initial assessment of mortality of Seychelles reef corals following the 1998 bleaching event and establishment of monitoring sites*. Unpublished report of the Shoals of Capricorn Seychelles Baseline Project, 1999.
- Byron, G. Reef Monitoring Program for Baie Ternay/Port Launay Marine National Parks, Seychelles, Division of Environment, Seychelles, 1996.
- Carlström, A. *Endemic and threatened plant species on the granitic Seychelles*. Report for Ministry of Environment, 1996.
- Carlstrom, A. *Areas of special conservation vValue for the plants of the granitic islands of Seychelles*. Division of Environment, Seychelles, 1996.
- Cazes-Duvat, V. *Les littoraux des Iles Seychelles*. L'Harmattan, 1999.
- Central Bank of Seychelles Quarterly Report* (Oct-Dec 2000).
- Atlas de Sensibilité et de Vulnérabilité de la Zone Cotière de Mahé, Seychelles*. Commission de L'Ocean Indien, 1998.
- De Georges, A.P. *An environmental appraisal of impacts from dredge fill and reclamation activities in East Coast Mahé, Seychelles*. USAID/REDSO/ESA, 1990.
- Port Launay and Baie Ternay Marine National Parks - proposed management plan*, CNP, Republic of Seychelles. Department of Environment, 1995.
- Environment management plan of Seychelles - EMPS 2000-2010* Republic of Seychelles. Department of Environment, 2000.
- Atlas des zones d'environnement sensible des Seychelles*. Government of Seychelles. Division of Environment, 1996.
- La Veuve special reserve - proposed management pPlan*, Seychelles. Division of Environment, 1995.
- Environmental management plan of Seychelles (EMPS)*, 1990-2000. Division of Environment.
- Environmental management plan of Seychelles (EMPS) 2001-2010*. Division of Environment.
- Emerton, L. *Seychelles biodiversity: economic assessment*. 1997.
- Engelhardt, U. *Fine scale survey of selected ecological characteristics of benthic communities on Seychelles coral reefs one year after the 1998 mass coral bleaching event*. (2000).
- Geographical Information System maps. Government of Seychelles, 1998.
- Maps of Seychelles Ordinance Survey (UK). Government of Seychelles (various dates).
- First national communication under the UN framework convention on climate change*. Government of Seychelles, 2000.
- Lane, P. and Associates Limited Environmental consultants, *Assessment of fish processing waste (offal) disposal in victoria harbour - Seychelles project No. E347*, 1991.

- Linden, O. and N. Sporrong. *Coral reef degradation in the Indian Ocean.* (1999).
- Lundin, C.G. and O. Linden (Eds.) *Proceedings of the national workshop on integrated coastal zone management in the Seychelles, Sida and the World Bank,* (1995).
- Mcarley and Lindberg. *Water resources evaluation - La Digue,* Public Utilities Corporation, 1987.
- Miccock, B. *Urban planning in Seychelles: A GIS approach.* MSc Dissertation University of Durham, 1998.
- Redesignation of the Morne Seychellois National Park boundaries.* Memorandum to the Natural Resources Inter-Ministerial Committee. Ministry of Environment & Transport, 2000.
- National population and housing census 1994.* Government of Seychelles. MISD, 1994.
- Seychelles population projections 1996-2019.* Government of Seychelles. MISD, 1997.
- Mortimer, J. *Rediscovery of the Turtle Dove (Streptopelia picturata) on Cosmoledo Atoll in the Seychelles.* Ibis 126:81-82. 1984.
- Mortimer, J. and A. Constance. *Observations on the birds of Cosmoledo Atoll, Seychelles.* Bull. B.O.C. 1999.
- Neueld, D. *Survey of habitats on La Digue - Reports from the Conservation and National Parks Service,* No 004. Division of Environment, 1992.
- Marine environmental baseline study for the greater Victoria sewerage project wastewater treatment and disposal facilities.* Ogden Environmental and Energy Services Co. Inc., 1993.
- Payet R.A. *Environmental impact assessment East Coast reclamation phase III* (Government of Seychelles), 1998.
- Payet, R. (Draft) *Environment cost benefit analysis of the phase III of the East Coast reclamation.*
- Payet, R. (Ed.) *Vulnerability assessment - enabling activities within the UN framework convention on climate change - Republic of Seychelles, National Climate Change Committee, Government of Seychelles,* 1999.
- Payet, R.A. and R. Lajoie. (In press). *Implications of sea-level rise and climate change for Seychelles.* Proceedings of SURVAS Workshop, Cairo, November, 2000.
- Payet, R.A. *Environment impact assessment for the phase III of the East Coast reclamation, Government of Seychelles,* 1998.
- Payet, R.A. (Ed.) *Seychelles: Vulnerability assessment to climate change, Government of Seychelles/UNFCCC,* 1998.
- Payet, R (Ed.) *Vulnerability assessment of Seychelles to climate change.* (ENVIRO), 1998.
- '*La Digue Water Supply Development, project memorandum*'. Public Utilities Corporation, Seychelles. PUC, 1988.
- Groundwater Vol.3, Hydrological Yearbook for Seychelles.* PUC, 1990.
- Reefcare International. Technical Report to WWF Sweden, 65pp.

Sauer, J.D. *Plants and man on the Seychelles coast: a study in historical biogeography.* University of Wisconsin Press, Madison, 1967.

Seychelles Biodiversity Strategy and Action Plan, 1997.

Seychelles Fishing Authority. *Seychelles artisanal fisheries statistics for 1999.* Seychelles Fishing Authority Technical Report, 2000.

Seychelles Fishing Authority: Annual Report 1999.

Shah, N.J. *Managing coastal areas in the Seychelles.* Nature and Resources 31 No 4. 1995a. 16-32.

Shah, N.J. Coastal Zone Management in the Seychelles. *Integrated coastal zone management in the Seychelles.* Eds. CG Lundin and O Lindén, World Bank and Sida. 1995b.

Shah, N.J., Payet, R. and K. Lowe-Henri, (Eds.) *Seychelles national biodiversity strategy and action plan, Republic of Seychelles.* UNEP and IUCN, 1997.

SIGMA Ove Arup et al. Ltd. Port Launay Beach Resort - *Environmental impact assessment, 2000.* Sun Resorts (Seychelles)

Sogreah. Praslin Island - Anse Volbert: *State of the marine environment.* Public Utilities Corporation. Seychelles, 1994.

Sogreah. Praslin Island - Anse Volbert: *Proposed land use plan.* Public Utilities Corporation. Seychelles, 1994.

*Statistical abstract 1999 and trade bulletin (Jan 2001).* Management and Information Systems Division (MISD)

Taylor J.D. *Coral reef and associated invertebrate communities (mainly molluscan) around Mahé, Seychelles.* 1968.

Thomasset, H.P. *Report on a visit of investigation to Astove Cosmoledo, Assumption and the Aldabra Group of the Seychelles Islands.* The Central Printing Establishment, Mauritius, 1907.

*UNDP human development index (2000 Edition).*

Seychelles Coral Reef Conservation Project - Baie Ternay Marine National Park and Baie Beau Vallon. *Report of the Universities of York and London expedition 1995.* Universities of York and London, 1996.

*Vision 21: Tourism development in Seychelles 2001-2010* (Draft Document). Ministry of Tourism and Civil Aviation, Seychelles, August 2001

Weaver, J. *Review of the Fregate Island hydrology and hydrogeology and the environmental implications of future water supply.* CSIR Environment Services, 1994.

Westmacott, S., Teleki, K., Wells, S. and J. West. *Management of bleached and severely damaged coral reef.* IUCN, 2000.



## Annex I

### **Identification Sheets for Hot Spots, Sensitive Areas and Overriding Issues**

#### **Identification Sheet: Hot Spot**

1. Title: The Flat Coastal Plateau of La Digue Island

2. Region (administrative) and location:

La Digue is the 4<sup>th</sup> largest island of granitic Seychelles. The flat coastal plateau is on the Western side of the island.

3. Surface area and definition:

La Digue is about 16km<sup>2</sup>, of which the plateau is about 200ha (165ha, depending on source of information).

4. Definition:

The coastal plateau is flat land, sloping slightly downwards towards the back of the plateau, near the mountain slopes. The soil is sandy, derived originally from calcareous reef material. La Veuve Special Reserve (for the Seychelles Black Paradise Flycatcher) occupies 7.817ha (it is to be extended to 18ha).

5. Transboundary elements:

Adjacent mountainous area of the island influences the plateau (housing, agriculture, solid waste dump site), together with human activities offshore from the edge of the plateau (in particular, the jetty and harbour). There is also a Shell Reserve on the Northern coast of the island.

6. Relevant GIWA issues:

- freshwater shortage - changing water table and pollution/salination of existing supplies;
- pollution - microbiological, eutrophication, solid wastes;
- loss and/or modification of ecosystems - wetland, woodland, coastal fringe;
- global change - sea level change; and
- other - coral bleaching.

7. Context of the site:

a) main human activities related to the site:

- housing (the plateau has the main concentration of housing for a population of about 3500 - 505 households for a population of 1990 in 1994);
- tourism establishments (the plateau has 90% of all hotel developments and there has been rapid development in the last five years);
- tourism activities (mainly scuba diving and other marine activities);
- agriculture (including coconuts, vanilla, cattle, pigs, chickens and other livestock); and
- failure to maintain the sluice gates which control the entry of sea water into the freshwater marsh.

b) natural conditions/phenomena related to the site:

- originally covered with forest of native trees (takamaka *Calophyllum inophyllum*, bodanmyen *Terminalia catappa*, and bwa-d-nat *Mimusops sechellarum*), now much reduced in area and in scattered patches;
- extensive freshwater marsh around the back of the plateau at the base of the mountain slopes with rich biodiversity, now much modified. Also some mangrove, also much modified; and
- presence of the only breeding population of Seychelles Black Paradise Flycatcher (*Terpsiphone corvina*) in the world.

8. Nature of threats and extent of threats (human and natural):

- vulnerability of the one remaining breeding population of the Black Paradise Flycatcher, since it is found only on La Digue;
- rapid removal of remaining forest cover, which may affect the breeding success of the Black Paradise Flycatcher, and also affects the hydrology of the plateau;
- continued loss and modification of remaining wetlands (from drainage, invasive alien plants, and salination), leading to loss of wetland biodiversity (which affects the food sources of the Flycatcher), and changes in the hydrology of the plateau (flooding, shortage of ground water, etc.);
- development of tourism and other activities beyond the limits of acceptable change within the plateau area and surrounding coastal zone. Note that there is still no legally binding Land Use Plan. The La Digue plateau has been designated a sensitive area under the 1996 EPA Act;
- increased pollution from various sources, due to increased human activities without mitigation;
- sea surface temperature rises might produce further coral bleaching episodes, which would affect local fishermen as well as marine tourism activities;
- sea level rise would present a threat to all human activity on the plateau;
- takamaka wilt disease already affects the population of these trees - currently out of control; and
- accidental introduction of tenrec (*Tenrec ecaudatus*) could significantly affect the invertebrate biodiversity on the island.

9. If heavy incidence of pollution, list the type of source and identify the exact source:

So far, pollution is relatively low level and mostly diffuse or non-point from septic tank overflows, agricultural chemicals and fertilizers, etc.

<b>10. Value of the Site</b>	<b>Local</b>	<b>National</b>	<b>Regional/Global</b>
Environmental significance	<ul style="list-style-type: none"> <li>• only remaining population of Seychelles Black Paradise Flycatcher;</li> <li>• wetlands provide 60% of the treated water supply from freshwater table; and</li> <li>• wetlands provide many unseen ecological services.</li> </ul>	<ul style="list-style-type: none"> <li>• only remaining population of Seychelles Black Paradise Flycatcher; and</li> <li>• one of the few remaining remnants of coastal woodland.</li> </ul>	<ul style="list-style-type: none"> <li>• only remaining population of Seychelles Black Paradise Flycatcher.</li> </ul>

Socio-economic significance	<ul style="list-style-type: none"> <li>• tourism is the main economic activity on the plateau/island; and</li> <li>• the unique Flycatcher is an added attraction for visitors.</li> </ul>	<ul style="list-style-type: none"> <li>• although small, the island attracts 40,000 visitors annually, and provides a quieter environment; and</li> <li>• possibility of development of eco-sensitive tourism.</li> </ul>	
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11. List of available data sets:

Anon. Environment Management Plan of Seychelles - EMPS 2000-2010 Republic of Seychelles, 2000.

CNP. *La Veuve Special Reserve - Proposed management plan*. Division of Environment, Seychelles, 1995.

Lundin, C.G. and O. Linden (Eds.) *Proceedings of the national workshop on integrated coastal zone management in the Seychelles, Sida and the World Bank*, (1995).

*National population and housing census 1994*. Government of Seychelles. MISD, 1994.

*Seychelles population projections 1996-2019*. Government of Seychelles. MISD, 1997.

Neueld, D. *Survey of habitats on La Digue* - Reports from the Conservation and National Parks Service, No 004. Division of Environment, 1992.

Payet, R. (Ed.) *Vulnerability assessment - enabling activities within the UN framework convention on climate change* - Republic of Seychelles, National Climate Change Committee, Government of Seychelles, 1999.

### **Identification Sheet: Hot Spot**

1. Title: East Coast of Mahe Island, Seychelles.
2. Region (administrative) and location: City of Victoria, Mahe.
3. Surface area and definition.
4. Definition: 12-15 km<sup>2</sup>, est. population of 40-45,000.
5. Transboundary elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site: Most urbanized part on the island, and close to the Ste Anne Marine Park and Morne Seychelles National Park.
6. Relevant [GIWA] issue(s)<sup>52</sup>:

Pollution: microbiological, chemical, suspended solids, solid wastes, and spills, habitat and community modification, global change: sea level rise; other: coral bleaching, coastal erosion.

7. Context of the site:
  - 7a. Main human activity(ies) related to the site: urbanisation, fisheries, industrial fish processing, industries, ports, trading, petroleum bunkering, tourism - pleasure yachting/boating, cruise ships, power generation, wastewater treatment, solid waste dump site, land reclamation.
  - 7b. Natural conditions/phenomenon related to the site: coral reefs, seagrass beds, mangroves, and mud flats
8. Nature of threats and extent of threats (human and natural): reclamation of the entire east coast is possible, coastal pollution is increasing, air pollution in certain areas, leachates from landfill. Coral bleaching from sea warming, and flood form sea level rise likely to happen.
9. If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):
  - i. wastewater treatment plant outfall;
  - ii. discharge of effluents by industries;
  - iii. chemical poisoning from misuse of pesticides (not common); and
  - iv. oil spills in the harbour from purse seiners.

<b>10. Value of the Site:</b>	<b>Local</b>	<b>National</b>	<b>Regional/Global</b>
Environmental significance	Ste Anne MPA Fringing reef	Ste Anne MPA Coral Reefs	Ste Anne MPA Coral reefs
Socio-economic	Employment	Heart of Seychelles	Trade and commerce

<sup>52</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; overexploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached table 1.

significance	Service center Trading	Economy	links within the region
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11. List of available data sets:

*Marine environmental baseline study for the greater Victoria sewerage project wastewater treatment and disposal facilities.* Ogden Environmental and Energy Services Co. Inc., 1993.

Lane, P. and Associates Limited Environmental consultants, *Assessment of fish processing waste (offal) disposal in victoria harbour - Seychelles* project No. E347, 1991.

Taylor J.D. *Coral reef and associated invertebrate communities (mainly molluscan) around Mahé, Seychelles.* 1968.

Payet, R.A. *Environment impact assessment for the phase III of the East Coast reclamation, Government of Seychelles,* 1998.

### **Identification Sheet: Hot Spot**

1. Title: Anse Volbert, Praslin, Seychelles.
2. Region (administrative) and location: Anse Volbert, and extensive plateaux area on Praslin Island.
3. Surface area and definition.
4. Definition: 5 km<sup>2</sup>; est. pop. 1,400.
5. Transboundary elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site: Praslin (second largest granitic island) is the most developed island for tourism, and Anse Volbert is the most developed area in terms of hotels and other tourism services.
6. Relevant [GIWA] issue(s)<sup>53</sup>: Pollution: microbiological, suspended solids; Habitat and community modification; Global change: sea level rise; Other: coastal erosion and coral bleaching.
7. Context of the site:
  - 7a. Main human activity(ies) related to the site: high tourism development, artisanal fisheries, beach and coastal modification.
  - 7b. Natural conditions/phenomenon related to the site: beaches, coral reefs, seagrass beds, coastal plateau vegetation and wetlands.
8. Nature of threats and extent of threats (human and natural): Coastal erosion, discharge of wastewater, coral bleaching from sea warming.
9. If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):

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<sup>53</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; overexploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached table 1.

<b>10. Value of the Site</b>	<b>Local</b>	<b>National</b>	<b>Regional/Global</b>
Environmental significance	Coral reefs and beaches	Coral reefs and beaches	None
Socio-economic significance	Beach Tourism Casino Water activities	Beach Tourism Casino Water activities	None

11. List of available data sets:

Sogreah. Praslin Island - Anse Volbert: *Proposed land use plan*. Public Utilities Corporation. Seychelles, 1994.

Sogreah. Praslin Island - Anse Volbert: *State of the marine environment*. Public Utilities Corporation. Seychelles, 1994.

## **Identification Sheet: Sensitive Area**

1. Title: Port Launay and Baie Ternay Marine National Parks + Port Glaud Mangrove Area.

2. Region (administrative) and location:

Port Glaud district, in the North West of Mahé Island. Marine Parks Authority is responsible for the two Marine Parks.

3. Surface area and definition:

- Port Launay National Park - 158ha;
- Baie Ternay National Park - 80ha; and
- Port Glaud mangrove - approx. 20ha.

4. Definition:

Two adjacent bays with shallow marine habitats, sandy beaches, rocky shores and an adjacent area of mangrove. Port Launay is relatively enclosed (from the point of view of water circulation). Note that the mangrove is soon to be included in the Morne Seychellois National Park, through changes in the boundary of that Park.

5. Transboundary elements:

The area is a breeding place for marine organisms and a resting place for migrating birds. Much of the adjacent hilly land is part of the Morne Seychellois National Park. Developments on the surrounding flat land significantly influence the area.

6. Relevant GIWA issues:

- changes in the water flow;
- pollution - microbiological, eutrophication, chemical, solid wastes;
- modification of ecosystems - mangrove, coral reefs, seagrass beds;
- over exploitation of coral reef resources;
- global change - sea level change; and
- other - coral bleaching.

7. Context of the site:

a) Main human activities related to the site:

- tourism (diving, snorkelling, picnics);
- nearby residential area (which included agriculture in the past);
- proposed hotel developments; and
- some fishing.

b) Natural conditions/phenomena related to the site:

- area of outstanding natural beauty - sandy beach, rocky shore, mountains;
- marine biodiversity - coral, reef sand, sea grass; and
- the largest and most diverse mangrove area remaining on Mahé.

8. Nature of threats and extent of threats (human and natural):

- unknown future uses for buildings and land previously used by the NYS village at Cap Ternay, which would influence Baie Ternay;
- large proposed hotel development at Port Launay (400 beds), which would impact both Port Launay Marine National Park and the Port Glaud mangrove;
- over-use and damage by marine tourism activities;
- sea surface temperature rises might produce further coral bleaching episodes, which would affect tourism activities; and
- sea level rise would present a threat to all activity on the flat land between the two Marine National Parks.

9. If heavy incidence of pollution, list the type of source and identify the exact source:

None at present.

<b>10. Value of the Site</b>	<b>Local</b>	<b>National</b>	<b>Regional/Global</b>
Environmental significance	<ul style="list-style-type: none"> <li>• natural ecological processes.</li> </ul>	<ul style="list-style-type: none"> <li>• marine conservation area;</li> <li>• PL is one of the few remaining beautiful undeveloped beaches; and</li> <li>• largest remaining mangrove on Mahé.</li> </ul>	<ul style="list-style-type: none"> <li>• breeding area for marine organisms.</li> </ul>
Socio-economic significance	<ul style="list-style-type: none"> <li>• local beauty spot; and</li> <li>• source of income for local tourism operators.</li> </ul>	<ul style="list-style-type: none"> <li>• local beauty spot.</li> <li>• source of income for national tourism operators; and</li> <li>• could become significant area for employment if hotel development goes ahead.</li> </ul>	

11. List of available data sets:

Anon. Port Launay and Baie Ternay Marine National Parks - Proposed Management Plan. CNP, DOE. Republic of Seychelles.,1995.

Byron, G. *Reef monitoring program for Baie Ternay/Port Launay Marine National Parks, Seychelles.* Division of Environment, Seychelles, 1996.

Carlström, A. *Areas of special conservation value for the plants of the granitic islands of Seychelles.* Division of Environment, Seychelles, 1996.

*Atlas de Sensibilité et de Vulnérabilité de la Zone Cotière de Mahé, Seychelles.* Commission de L'Ocean Indien, 1998.

*Redesignation of the Morne Seychellois National Park boundaries.* Memorandum to the Natural Resources Inter-Ministerial Committee. Ministry of Environment & Transport, 2000.

*National population and housing census 1994.* Government of Seychelles. MISD, 1994.

SIGMA Ove Arup et al. Ltd. Port Launay Beach Resort - *Environmental impact assessment, 2000.* Sun Resorts (Seychelles).

Shah, N.J. Coastal Zone Management in the Seychelles. *Integrated coastal zone management in the Seychelles.* Eds. CG Lundin and O Lindén, World Bank and Sida. 1995b.

Shah, N.J., Payet, R. and K. Lowe-Henri, (Eds.) *Seychelles national biodiversity strategy and action plan, Republic of Seychelles.* UNEP and IUCN, 1997.

Seychelles Coral Reef Conservation Project - Baie Ternay Marine National Park and Baie Beau Vallon. *Report of the Universities of York and London expedition 1995.* Universities of York and London, 1996.

## Identification Sheet: Sensitive Areas

1. Title: Cosmoledo Atoll, Seychelles.
2. Region (administrative) and location: Outer island under the management of Seychelles Island Development Corporation.
3. Surface area and definition.
4. Definition: 5.2 km<sup>2</sup>, Atoll of 15 islands (lagoon and marine area exceed 10 km<sup>2</sup>).
5. Transboundary elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:

Close to Madagascar and Aldabra (World Heritage Site), far from Mahe (1,054 km) and isolated with no permanent human settlement.

6. Relevant [GIWA] issue(s)<sup>54</sup>: Habitat and community modification: Loss of Ecosystems or ecotones; Unsustainable exploitation of fisheries and other resources: over-exploitation, impact on biological and genetic biodiversity; Other: poaching (Illegal fishing, bird and turtle poaching from Seychelles and Madagascar); Global change: sea-level change.
7. Context of the site:
  - 7a. Main human activity(ies) related to the site: no permanent human settlement due to physical isolation, however poaching is increasing.
  - 7b. Natural conditions/phenomenon related to the site: largest grouping of some bird species in the region, prime turtle nesting area, endemic plant and insect species, extensive coral reefs, reef fish, lagoon fish, crustacea and sea cucumbers.
8. Nature of threats and extent of threats (human and natural): poaching, invasives, diseases, coral bleaching are increasing.
9. If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s): None.

<b>10. Value of the Site</b>	<b>Local</b>	<b>National</b>	<b>Regional/Global</b>
Environmental significance	Endemic and unique populations of several threatened species	Similar in status to Aldabra	Global biodiversity importance - migratory species: birds and turtles
Socio-economic significance	Eco-tourism potential	Eco-tourism potential	None

<sup>54</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; overexploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached table 1.

11. List of available data sets:

Mortimer, J. and A. Constance. *Observations on the birds of Cosmoledo Atoll, Seychelles*. Bull. B.O.C., 1999.

Mortimer, J. *Rediscovery of the Turtle Dove (Streptopelia picturata) on Cosmoledo Atoll in the Seychelles*. 1984. Ibis 126:81-82.

Thomasset, H.P. *Report on a visit of investigation to Astove Cosmoledo, Assumption and the Aldabra Group of the Seychelles Islands*. The Central Printing Establishment, Mauritius, 1907.

## **Identification Sheet: Sensitive Area**

1. Title: Mahé Wetlands/Mangroves

2. Region (administrative) and location:

Mahé Island. Scattered patches around the coastal plateau.

3. Surface area and definition:

Very approximately 130ha. There are 40 areas of freshwater marsh/mangrove and 98 small rivers on Mahé. The total area of freshwater marsh and mangrove is difficult to ascertain because of continuing modification. Some areas are only a few square metres, others several tens of hectares.

4. Definition:

Areas of permanent freshwater, and/or temporary accumulation of freshwater after heavy rainfall. Sometimes inundated by seawater, thereby becoming brackish. Mangroves are usually at river mouths or along shallow sheltered coastlines.

5. Transboundary elements:

Influenced by activities on the surrounding land and marine areas. Source of larval marine organisms for surrounding ocean. Resting/feeding place for migrating birds.

6. Relevant GIWA issues:

- changing water tables, due to excessive run-off, drought or sea level rise;
- pollution - microbiological; eutrophication; chemical; suspended solids; solid wastes;
- loss and modification (including species composition) of all wetland ecosystems; and
- global change - sea level change.

7. Context of the site:

7a. Main human activities related to the site:

- drainage or reclamation for housing, agriculture, roads, tourism developments.

7b. Natural conditions/phenomena related to the site:

- freshwater marsh acts as a sponge for rainwater;
- marsh and mangrove act as collectors of sediments and excess organic matter;
- specific biodiversity for these habitats, some not found elsewhere (e.g. caecilians, Seychelles moorhen, freshwater terrapins);
- migrating birds use these areas for feeding and resting; and
- mangrove is breeding ground for marine organisms.

8. Nature of threats and extent of threats(human and natural):

- no official protection or Land Use Plan means that wetlands continue to be modified by human activities;

- wetlands have usually been considered wasteland - solid waste and waste water continue to be dumped;
- non-point pollution from agriculture run-off, septic tanks etc;
- excess siltation because of clearing of uplands for development purposes;
- invasive alien species are present already in freshwater marshes;
- less throughput of water into wetlands because of extraction upriver for human use; and
- sea level rise will produce salination of freshwater marsh.

9. If heavy incidence of pollution, list the type of source and identify the exact source:

Mostly diffuse or non-point from septic tank overflows, agriculture, surface run-off, or direct deposition of solid wastes, although there are occasional spills of chemicals or leakage from dumped solid waste.

<b>10. Value of the site</b>	<b>Local</b>	<b>National</b>	<b>Regional/global</b>
Environmental significance	<ul style="list-style-type: none"> <li>• important in the hydrology of the coastal plateau land; and</li> <li>• unique biodiversity.</li> </ul>	<ul style="list-style-type: none"> <li>• important in the hydrology of the coastal plateau land; and</li> <li>• unique biodiversity.</li> </ul>	<ul style="list-style-type: none"> <li>• unique species;</li> <li>• breeding area for marine organisms; and</li> <li>• resting place for migrating birds.</li> </ul>
Socio-economic significance	<ul style="list-style-type: none"> <li>• unseen ecological services; and</li> <li>• interest for tourists if maintained in good shape.</li> </ul>	<ul style="list-style-type: none"> <li>• eco-tourism possibilities can be expanded.</li> </ul>	

11. List of available data sets:

*Atlas de Sensibilité et de Vulnérabilité de la Zone Cotière de Mahé, Seychelles.* Commission de L'Océan Indien, 1998.

*Atlas des zones d'environnement sensible des Seychelles.* Government of Seychelles. Division of Environment, 1996.

Sauer, J.D. *Plants and man on the Seychelles coast: a study in historical biogeography.* University of Wisconsin Press, Madison, 1967.

Shah, N.J. *Managing coastal areas in the Seychelles.* Nature and Resources 31 No 4. 1995a. 16-32.

Shah, N.J. Coastal Zone Management in the Seychelles. *Integrated coastal zone management in the Seychelles.* Eds. CG Lundin and O Lindén, World Bank and Sida. 1995b.

Shah, N.J., Payet, R. and K. Lowe-Henri, (Eds.) *Seychelles national biodiversity strategy and action plan, Republic of Seychelles.* UNEP and IUCN, 1997.

**Annex II****Summary tables for hot spots, sensitive areas and overriding issues****Table 1. Aggregated table for hot spot**

	<b>Criteria/Hot Spot</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
1	Size of affected area.	2	2	1	2	2	2			
2	Affected population.	3	2	1	2	2	2			
3	Extent to which the natural coastal and marine resources of the site support the livelihood of local communities (for instance, in the case of fisheries, tourism).	4	5	5	5	4	5			
4	Extent to which the natural coastal and marine resources of the site support the national development (for instance, in the case of fisheries, tourism).	5	5	3	5	4	5			
5	Extent to which the site is a government priority (refer to NEAP or other strategic environmental action programme).	4	4	4	4	4	5			
6	Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, etc.).	3	3	5	3	3	4			
7	Degree of Degradation at the site ( <i>e.g.</i> type of degradation).	4	2	3	3	3	4			
8	Extent of degradation on coastal and marine resources and systems.	4	2	4	3	3	3			
	TOTAL SCORE	29	25	26	27	24	30			
	NORMALISED SCORE	74	66	69	71	65	79			
	Key issues relevant to the hot spots:	1 - Pollution 2 - Habitat Modification 3 - Global Change	II III V	II III V	II III VI	II III VI	II I III			

**Table 2. Aggregated table for sensitive area**

	<b>Criteria/Sensitive Area</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
1	Biodiversity value of the site.	4	5	4	3	4	5			
2	Cultural value of the site.	3	3	2	3	4	4			
3	Size of area at risk.	1	2	1	1	2	2			
4	Population at risk (please define the population).	2	2	3	1	1	1			
5	Extent to which the natural coastal and marine resources of the site support the livelihood of local communities (for instance, in the case of fisheries, tourism).	4	4	4	3	4	-			
6	Extent to which the natural coastal and marine resources of the site support the national development (for instance, in the case of fisheries, tourism).	4	4	4	3	4	-			
7	Extent of involvement of communities in local management.	3	3	3	3	3	-			
8	Extent to which the site is a government priority (refer to NEAP or other strategic environmental action programme).	2	4	4	3	4	-4			
9	Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, etc.).	2	4	4	3	4	5			
	TOTAL SCORE	25	31	29	23	30	19			
	NORMALISED SCORE	74	89	85	65	85	52			

	Key issues relevant to the sensitive area.	1 - Pollution 2 - Habitat Modification 3 - Global Change 4 - Unsustainable exploitation	II III IV	II III IV	II III V	II III V	III IV II	III IV V		
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**Table 3. Summary Table of Prioritised Hot spots and Sensitive Areas**

Country: SEYCHELLES

Total population: 78,846 (1998)

Coastal population: 78,846

Issues	Identification								
	Selected Hot spots			Selected Sensitive Areas			Overriding Issues		
	1	2	3	1	2	3	1	2	3
Issue 1	II.4	II.5	II.4	II.5	III.12	II.5	Modification of ecosystems  III.13	Pollution  II.4 and II.5	Global Change  V.20
Issue 2	I.3	II.11	III.13	III.13	IV.14	III.12			
Issue 3	III.13	III.12	V.20	IV.14	V.20	V.19			



### Annex III

#### Reporting and calculation tables for Scoping Exercises

**Table 1a. Reporting and Calculation Tables for Scoping Exercises for Hot Spots: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities on the Selected Hot Spot**

IMPACTS TABLE		Country: SEYCHELLES				Date: 29 JANUARY 2001				
Major concern	Issue	Hot Spot 1: La Digue (West Coast Plateaux)		Hot Spot 2: East Coast, Mahe			Hot Spot 3: Anse Volbert, Praslin			
		Scores 0 - 3		Total for issue	Scores 0 - 3		Total for issue	Scores 0 - 3		
		(a) Environ- mental	(b) Socio- economic	(a+b) max=6	(a) Environ- mental	(b) Socio- economic	(a+b) max=6	(a) Environ- mental	(b) Socio- economic	(a+b) max=6
I: Freshwater shortage	Lowering of water table	2	3	5	0	0	0	0	0	0
II: Pollution	Microbiological	1	1	2	1	2	3	1	3	4
	Chemical	0	0	0	1	2	3	0	0	0
	Suspended solids	1	1	2	2	2	4	1	3	4
	Solid wastes	1	3	4	1	3	4	1	3	4
	Spills	0	0	0	1	2	3	0	0	0
	Eutrophication	1	2	3	1	2	3	1	2	3
III: Habitat and community modification	Modification of ecosystems or ecotones	2	2	4	3	2	5	1	1	2
	Loss of Habitat	2	2	4	3	3	6	1	2	3
IV: Unsustainable exploitation of fisheries & other living resources.										
V: Global change	Sea level rise	2	3	5	2	2	4	2	2	4
VI: Other	Coral bleaching	3	3	6	3	3	6	3	3	6
	Coastal erosion	3	3	6	2	3	5	2	3	5

\*The habitats and communities suffering most significant damage will be reported on Table 2.

**Table 1b. Reporting and Calculation Tables for Scoping Exercises for Sensitive Areas: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities of the Selected Sensitive Areas**

IMPACTS TABLE		Country: SEYCHELLES	Date: 29 JANUARY 2001										
Major concern	Issue	Sensitive Area 1: Port Launay/Baie Ternay, Mahe	Sensitive Area 2: Cosmoledo Atoll	Sensitive Area 3: Mahe Wetlands									
		Scores 0 - 3	Total for issue	Scores 0 - 3	Total for issue	Scores 0 - 3	Total for issue						
		(a) Environ-mental	(b) Socio- economic	(a+b) max=6	(a) Environ- mental	(b) Socio- economic	(a+b) max=6	(a)	(b)	(a+b)	Environmental	Socio- economic	max=6
I: Freshwater shortage													
II: Pollution	Eutrophication	1	1	2	0	0	0	1	1	2			
III: Habitat and community modification	Loss of Ecosystems or ecotones	1	2	3	3	2	5	2	2	4			
	Modification of ecosystems	3	2	5	3	2	5	3	2	5			
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	2	2	4	2	2	4	1	1	2			
	Impact on biological and genetic biodiversity	1	1	2	3	1	4	1	2	3			

V: Global change	Sea level rise	2	2	4	3	2	5	2	2	4
	Changes in hydrological cycle	1	2	3	1	3	4	2	2	4
VI: Other	Poaching	2	2	4	3	2	5	0	0	0

\*The habitats and communities suffering most significant damage will be reported on Table 2.

**Table 1c. Reporting and Calculation Tables for Scoping Exercises for Overriding Issues: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities of the Country or National Ecosystem as a Whole**

<b>IMPACTS TABLE</b>		<b>Country: SEYCHELLES</b>		<b>Date: 29 JANUARY 2001</b>
<b>Major concern</b>	<b>Issue</b>	<b>Scores 0 - 3</b>		<b>Total for issue</b>
		<b>(a) Environ-mental</b>	<b>(b) Socio-economic</b>	<b>(a+b) max=6</b>
I: Freshwater shortage				
II: Pollution	Eutrophication	1	2	3
III: Habitat and community modification	Modification of habitats and ecotones	3	2	5
IV: Unsustainable exploitation of fisheries & other living resources				
V: Global change	Sea level rise	2	2	4
VI: Other				

\*The habitats and communities suffering most significant damage will be reported on Table 2

## Annex IV

### **Habitats and communities suffering significant loss**

The table below will be used in order to indicate those habitat or community types that have suffered most significant loss. These would be listed in priority order. The term 'priority' refers to:

1. the highest aggregate score for environmental and social and economic criteria (Table 1), as applied to each major habitat and community type in the system;
2. the transboundary nature of the habitat/community or its transboundary ecological significance; and
3. additional site/national/regional considerations that should be indicated in the space provided.

**Table 2. Issue: Habitats and Communities Suffering Significant Loss**

	<b>Habitat/Community type</b>	<b>Reason for selection of priority</b>
1	Coral Reefs	Suffered from both direct human impact such as fisheries and reclamation, as well as from global change (increased sea surface temperatures)
2	Lagoons	Over-exploitation by fisheries, especially shell, conch, crustacea, reef fish, and pollution from land-based sources
3	Coastal marshes	Reclaimed for agriculture and construction, and future sea level rise
4	Sandy foreshores	Tourism development and coastal erosion
5	Mangroves	Reclaimed for agriculture and as dump sites, and future sea level rise.
6	Sea grass meadows	Siltation and sedimentation
7	Fast flowing, stony bottom rivers	Deforestation and encroachment, as well as global effects of El Niño/La Niña
8	Ocean Fisheries	Threat of overfishing and global change
9		
10		



**Annex V****Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change****Table 3a. Rporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Issues Affecting Hot Spots**

FUTURE CHANGES TABLE		Country: SEYCHELLES	Date: 29 January 2001	
Major concern	Issue	Hot Spot 1: La Digue -West Coast Plateaux	Hot Spot 2: East Coast, Mahe	Hot Spot 3: Anse Volbert, Praslin
		Scores -3 to 3	Scores -3 to 3	Scores -3 to 3
		Perceived future changes	Perceived future changes	Perceived future changes
I: Freshwater shortage	Lowering of water table	+2	0	0
II: Pollution	Microbiological	+1	-3	+1
	Chemical	0	0	0
	Suspended solids	+3	+2	+2
	Solid wastes	+2	+2	+2
	Spills	+1	+3	0
	Eutrophication	+1	+2	+2
III: Habitat and community modification	Modification of ecosystems or ecotones	+3	+3	+3
	Loss of habitats or ecotones	+3	+1	+1
IV: Unsustainable exploitation of fisheries & other living resources				
V: Global change	Sea level rise	+3	+3	+3
VI:Other	Coral bleaching	+3	+3	+3
	Coastal erosion	+3	+3	+3

**Table 3b. Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Issues Affecting Sensitive Areas**

<b>FUTURE CHANGES TABLE</b>		<b>Country: SEYCHELLES</b>	<b>Date: 31 January 2001</b>	
<b>Major concern</b>	<b>Issue</b>	<b>Sensitive Area 1: Port Launay/Baie Ternay, Mahe</b>	<b>Sensitive Area 2: Cosmoledo Atoll</b>	<b>Sensitive Area 3: Mahe Wetlands</b>
		<b>Scores -3 to 3</b>	<b>Scores -3 to 3</b>	<b>Scores -3 to 3</b>
		<b>Perceived future changes</b>	<b>Perceived future changes</b>	<b>Perceived future changes</b>
I: Freshwater shortage				
II: Pollution	Eutrophication	+2	0	+2
III: Habitat and community modification	Loss of Ecosystems or ecotones	+1	+2	+2
	Modification of Ecosystems or ecotones	+3	+4	+3
IV: Unsustainable exploitation of fisheries & other living resources	Over-exploitation	+2	+4	0
	Impact on biological and genetic biodiversity	+2	+4	+1
V: Global change	Sea level rise	+3	+3	+3
	Changes in the hydrological cycle	+3	+3	+3
VI: Other	Poaching	-2	+4	0

**Table 3c. Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Overriding Issues**

<b>FUTURE CHANGES TABLE</b>		<b>Country: SEYCHELLES</b>	<b>Date: 31 January 2001</b>
<b>Major concern</b>	<b>Issue</b>	<b>Scores -3 to 3</b>	
		<b>Perceived future changes</b>	
I: Freshwater shortage			
II: Pollution	Eutrophication		+2
III: Habitat and community modification	Modification of Habitats or ecotones		+3
IV: Unsustainable exploitation of fisheries & other living resources			
V: Global change	Sea Level rise		+3
VI: Other			

### Summary Table for the Scoping Exercises

		Country: SEYCHELLES	Date: 1 Feb 2001		
Major concern	Issues	Average total score per issue	Average score of perceived future change		Final Ranking of the issues
I: Freshwater shortage	Lowering of water table	5	+2	7	12 <sup>th</sup> =
II: Pollution	Microbiological	9	-1	8	11 <sup>th</sup>
	Chemical	3	0	3	13 <sup>th</sup>
	Suspended solids	10	+7	17	8 <sup>th</sup>
	Solid wastes	12	+6	18	7 <sup>th</sup>
	Spills	3	+4	7	12 <sup>th</sup> =
	Eutrophication	13	+9	22	6 <sup>th</sup>
III: Habitat and community modification	Modification of ecosystems or ecotones	26	+19	45	1 <sup>st</sup>
	Loss of Ecosystems or ecotones	25	+10	35	3 <sup>rd</sup>
IV: Unsustainable exploitation of fisheries & other living resources	Over-exploitation	10	+6	16	9 <sup>th</sup> =
	Impact on biological and genetic biodiversity	9	+7	16	9 <sup>th</sup> =
V: Global change	Sea level rise	26	+18	44	2 <sup>nd</sup>
VI: Other	Coral bleaching	18	+9	27	4 <sup>th</sup>
	Coastal erosion	16	+9	25	5 <sup>th</sup>
	Poaching	9	+2	11	10 <sup>th</sup>

**Annex VI****Socioeconomic exposure and summary tables****Exposure Table E1. Loss of Ecosystems****For habitat type: \_\_\_\_\_ Coastal\_\_\_\_\_**

Sub-Region: \_\_\_\_\_ Aquatic System: Coastal marine ecotones Country: Seychelles  
 No. Name  
 Prepared by : \_\_\_\_\_ Organisation/Department Name

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Tourism/recreation and aesthetic values <sup>55</sup>	Decrease in number of international and national tourist visits	K				
	Decrease in average time of visit	K				
	Decrease in time spent on water based activities (person days)	K				
	Number of complaints to authorities about visual disamenity	K				
Resources for subsistence of local population <sup>56</sup>	Increase in travel distance (km/person/week) to gather food	Not Applicable				
	Increase in travel distance (km/person/week) to gather fuel	Not Applicable				
	Number of persons forced to relocate due to inadequacy of local resources to support subsistence livelihood	Not Applicable				
Fish sales <sup>57</sup>	Decrease in harvest of fish target species (metric tons)	K				
	Decrease in aggregate fishery revenues from all local stocks (currency units)	K				

<sup>55</sup> Data exists for tourism arrivals, but trends are not linked directly to these issues at the present time

<sup>56</sup> The impact measures are not relevant / applicable in Seychelles

<sup>57</sup> Data available on landings only, which cannot be assigned to a particular issue

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Fish sales (cont.)	Increase in average fishery revenues from all local stocks (currency unit per metric ton)	K				
	Decrease in harvest of non-fish target species (metric tons)	K				
	Decrease on aggregate revenues from all local non-fish stocks	K				
Employment and other exploitation opportunities <sup>58</sup>	Number of job losses resulting from loss/modification of habitat	Not Applicable				
	Future employment opportunities lost through loss/modification of habitat	Not Applicable				
	Decrease in number of locally extant plant species	K				
Cultural heritage	Loss of identified areas of significance to indigenous people (number of sites and [percentage as proportion of total])	Not Applicable				
Human conflict	Increase in number of disputes/legal cases connected with habitat exploitation	-				
Scientific/educational value	Decrease in number of published academic articles concerning the ecology of the habitat	-				
Land use, physical capital and human safety	Increase in number of dwellings and businesses inundated by flood or storm surge	K				
	Forced relocations due to flooding or storm surge events	Not yet an issue				
Physical protection measures	Increase in costs of construction of preventative structures (walls, barriers, etc.) (currency units)	K				

<sup>58</sup> In the context of Seychelles, where land is in very short supply, habitat modification (including reclamation) has led to increased job opportunities (i.e. construction, establishment of industries, tourism development, etc.)

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Restoration and response to catastrophic events	Increase in cost of habitat protection or restoration (currency units)	K <sup>59</sup>				
	Increased cost of emergency service responses to floods/surges	K <sup>60</sup>				
Control of invasive species	Increase in costs of controlling invasive species (e.g. monitoring/culling) (currency units)	K				
Wildlife	Sanctuary/Biodiversity: Decrease in number of locally extant animal species	K				
Proportion of impacts arising from economic activities outside the country in which the impact is suffered						
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Impact: _____	Other impact measure: _____					
Impact: _____	Other impact measure: _____					

<sup>59</sup> Might be possible to obtain data on cost of restoring beach front vegetation

<sup>60</sup> To obtain data on costs associated with the “1997 Weather Event”

**Exposure Table E2. Modification of Ecosystems****For habitat type: \_\_\_\_\_ Coastal \_\_\_\_\_**Sub-Region: \_\_\_\_\_ Aquatic System: Coastal marine ecotones Country: Seychelles

No. Name

Prepared by : \_\_\_\_\_

Organisation/ Department Name

<b>IMPACTS</b>	<b>IMPACT MEASURE</b>	<b>AMOUNT</b>	<b>VALUE OF UNDERLYING MEASURE</b>	<b>GEOGRAPHIC COVERAGE</b>	<b>SOURCE PUBLICATION</b>	<b>SOURCE ORGANISATION</b>
Tourism/recreation and aesthetic values <sup>61</sup>	Decrease in number of international and national tourist visits	K				
	Decrease in average time of visit	K				
	Decrease in time spent on water based activities (person days)	K				
	Number of complaints to authorities about visual disamenity	K				
Resources for subsistence of local population <sup>62</sup>	Increase in travel distance (km/person/week) to gather food	Not Applicable				
	Increase in travel distance (km/person/week) to gather fuel	Not Applicable				
	Number of persons forced to relocate due to inadequacy of local resources to support subsistence livelihood	Not Applicable				
Fish sales <sup>63</sup>	Decrease in harvest of fish target species (metric tons)	K				
	Decrease in aggregate fishery revenues from all local stocks (currency units)	K				

<sup>61</sup> Data exists for tourism arrivals, but trends are not linked directly to these issues at the present time<sup>62</sup> The impact measures are not relevant / applicable in Seychelles<sup>63</sup> Data available on landings only, which cannot be assigned to a particular issue

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Fish sales (cont.)	Increase in average fishery revenues from all local stocks (currency unit per metric ton)	K				
	Decrease in harvest of non-fish target species (metric tons)	K				
	Decrease on aggregate revenues from all local non-fish stocks	K				
Employment and other exploitation opportunities <sup>64</sup>	Number of job losses resulting from loss/modification of habitat	Not Applicable				
	Future employment opportunities lost through loss/modification of habitat	Not Applicable				
	Decrease in number of locally extant plant species	K				
Cultural heritage	Loss of identified areas of significance to indigenous people (number of sites and [percentage as proportion of total])	Not Applicable				
Human conflict	Increase in number of disputes/legal cases connected with habitat exploitation	-				
Scientific/educational value	Decrease in number of published academic articles concerning the ecology of the habitat	-				
Land use, physical capital and human safety	Increase in number of dwellings and businesses inundated by flood or storm surge	K				
	Forced relocations due to flooding or storm surge events	Not yet an issue				
Physical protection measures	Increase in costs of construction of preventative structures (walls, barriers, etc.) (currency units)	K <sup>65</sup>				

<sup>64</sup> In the context of Seychelles, where land is in very short supply, habitat modification (including reclamation) has led to increased job opportunities (i.e. construction, establishment of industries, tourism development, etc.)

<sup>65</sup> It may be possible to estimate the additional costs associated construction of preventative barriers, although this is not readily available.

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Restoration and response to catastrophic events	Increase in cost of habitat protection or restoration (currency units)	K <sup>66</sup>				
	Increased cost of emergency service responses to floods/surges	K <sup>67</sup>				
Control of invasive species	Increase in costs of controlling invasive species (e.g. monitoring/culling) (currency units)	K <sup>68</sup>				
Wildlife	Sanctuary/Biodiversity: Decrease in number of locally extant animal species	K				
Proportion of impacts arising from economic activities outside the country in which the impact is suffered						
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Impact: _____	Other impact measure: _____					
Impact: _____	Other impact measure: _____					

<sup>66</sup> Could refer to cost of restoring beach front vegetation.

<sup>67</sup> Could give figures from the “1997 Weather Event”

<sup>68</sup> Some data might be available with respect to establishment of “Marsh Unit” / water hyacinth infestation & Control of *albezia* and other exotic species

**Exposure Table E3. Sea Level Change (Storm Surges)****For habitat type: \_\_\_\_\_ Coastal \_\_\_\_\_**Sub-Region: \_\_\_\_\_ Aquatic System: Coastal marine ecotones Country: Seychelles

No. Name

Prepared by : \_\_\_\_\_

Organisation/ Department Name

<b>IMPACTS</b>	<b>IMPACT MEASURE</b>	<b>AMOUNT</b>	<b>VALUE OF UNDERLYING MEASURE</b>	<b>GEOGRAPHIC COVERAGE</b>	<b>SOURCE PUBLICATION</b>	<b>SOURCE ORGANISATION</b>
Tourism and recreation	Decrease in number of international and national tourist visits	K				
	Decrease in average time of visit (hours)	K				
	Decrease in time spent on water based activities (person days)	K				
Water supply	Decrease in volume of useable water (e.g. for drinking, agricultural purposes) m <sup>3</sup>	K				
	Decrease in fish catch (metric tons)	K				
	Average value of fish catch before decrease (sate currency units per metric tons)	K				
	Decrease in harvest of non-fish species (metric tons)	K				
	Average value of harvest before decrease (currency units per metric ton)	K				
Property value	Decrease in average land price (currency units m <sup>-2</sup> )	K				
	Land area affected (km <sup>2</sup> )	K				
	Fall in residential and commercial building price (currency units m <sup>-2</sup> floor area)	K				
Aesthetic value	Number of complaints to authorities about visual disamenity	K				
Development opportunities	Number of future employment opportunities lost	K				

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Human health (impacts attributable to diminution in water quality due to pollution)	Increase in morbidity rate (number of illnesses per 100,000 population)	K				
	Increase in average length of illness (days)	K				
	Increase in morbidity rate (number of deaths per 100,000 population)	K				
Water treatment	Increase in costs to maintain quality (currency units)	K				
Weed control	Costs of maintaining navigable channels (currency units)	K				
Monitoring fish quality	Increased inspection costs on landing/first sale (currency units)	K				
Wildlife Sanctuary/habitat	Decrease in number of locally extant animal species	K				
Proportion of impacts arising from economic activities outside the country in which the impact is measured						
Other Impacts: <u>Infrastructure</u>	Specify appropriate measure: Cost to repairs to roads & bridges	K				
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Impact: _____	Other impact measure:- _____					
Impact: _____	Other impact measure:- _____					

**Exposure Table E4. Sea Level Change (Beach Coastal Erosion)****For habitat type: \_\_\_\_\_Coastal\_\_\_\_\_**Sub-Region: \_\_\_\_\_ Aquatic System: Coastal marine ecotones Country: Seychelles

No. Name

Prepared by : \_\_\_\_\_

Organisation/ Department Name

<b>IMPACTS</b>	<b>IMPACT MEASURE</b>	<b>AMOUNT</b>	<b>VALUE OF UNDERLYING MEASURE</b>	<b>GEOGRAPHIC COVERAGE</b>	<b>SOURCE PUBLICATION</b>	<b>SOURCE ORGANISATION</b>
Tourism and recreation	Decrease in number of international and national tourist visits	K				
	Decrease in average time of visit (hours)	K				
	Decrease in time spent on water based activities (person days)	K				
Water supply	Decrease in volume of useable water (e.g. for drinking, agricultural purposes) m <sup>3</sup>	K				
	Decrease in fish catch (metric tons)	K				
	Average value of fish catch before decrease (sate currency units per metric tons)	K				
	Decrease in harvest of non-fish species (metric tons)	K				
	Average value of harvest before decrease (currency units per metric ton)	K				
Property value	Decrease in average land price (currency units m <sup>-2</sup> )	K				
	Land area affected (km <sup>2</sup> )	K				
	Fall in residential and commercial building price (currency units m <sup>-2</sup> floor area)	K				
Aesthetic value	Number of complaints to authorities about visual disamenity					
Development opportunities	Number of future employment opportunities lost					

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Human health (impacts attributable to diminution in water quality due to pollution)	Increase in morbidity rate (number of illnesses per 100,000 population)					
	Increase in average length of illness (days)					
	Increase in morbidity rate (number of deaths per 100,000 population)					
Water treatment	Increase in costs to maintain quality (currency units)					
Weed control	Costs of maintaining navigable channels (currency units)					
Monitoring fish quality	Increased inspection costs on landing/first sale (currency units)					
Wildlife Sanctuary/habitat	Decrease in number of locally extant animal species					
Proportion of impacts arising from economic activities outside the country in which the impact is measured						
Other Impacts: <u>Infrastructure</u>	Specify appropriate measure: Loss of roads, coastal structures	K				
Other Impacts: _____	Specify appropriate measure:					
Other Impacts: _____	Specify appropriate measure:					
Impact: _____	Other impact measure:- _____					
Impact: _____	Other impact measure:- _____					

**Exposure Table E5. Sea Level Rise (Coral Bleaching)****For habitat type: \_\_\_\_\_ Coastal \_\_\_\_\_**Sub-Region: \_\_\_\_\_ Aquatic System: Coastal marine ecotones Country: Seychelles

No. Name

Prepared by : \_\_\_\_\_

Organisation/ Department Name

<b>IMPACTS</b>	<b>IMPACT MEASURE</b>	<b>AMOUNT</b>	<b>VALUE OF UNDERLYING MEASURE</b>	<b>GEOGRAPHIC COVERAGE</b>	<b>SOURCE PUBLICATION</b>	<b>SOURCE ORGANISATION</b>
Tourism and recreation	Decrease in number of international and national tourist visits	K				
	Decrease in average time of visit (hours)	K				
	Decrease in time spent on water based activities (person days)	K				
Water supply	Decrease in volume of useable water (e.g. for drinking, agricultural purposes) m <sup>3</sup>	K				
	Decrease in fish catch (metric tons)	K				
	Average value of fish catch before decrease (sate currency units per metric tons)	K				
	Decrease in harvest of non-fish species (metric tons)	K				
	Average value of harvest before decrease (currency units per metric ton)	K				
Property value	Decrease in average land price (currency units m <sup>-2</sup> )	K				
	Land area affected (km <sup>2</sup> )	36,100 km <sup>2</sup>		Indian Ocean	Linden & Sporrong 1999	CORDIO
	Fall in residential and commercial building price (currency units m <sup>-2</sup> floor area)					
Aesthetic value	Number of complaints to authorities about visual disamenity					
Development opportunities	Number of future employment opportunities lost					

IMPACTS	IMPACT MEASURE	AMOUNT	VALUE OF UNDERLYING MEASURE	GEOGRAPHIC COVERAGE	SOURCE PUBLICATION	SOURCE ORGANISATION
Human health (impacts attributable to diminution in water quality due to pollution)	Increase in morbidity rate (number of illnesses per 100,000 population)	K				
	Increase in average length of illness (days)	K				
	Increase in morbidity rate (number of deaths per 100,000 population)	K				
Water treatment	Increase in costs to maintain quality (currency units)	K				
Weed control	Costs of maintaining navigable channels (currency units)	K				
Monitoring fish quality	Increased inspection costs on landing/first sale (currency units)	K				
Wildlife Sanctuary/habitat	Decrease in number of locally extant animal species	K				
Proportion of impacts arising from economic activities outside the country in which the impact is measured						
Other Impacts: <u>Biodiversity</u>	Specify appropriate measure: Value of loss of Biodiversity	K				
Other Impacts: <u>Food Production</u>	Specify appropriate measure:	US\$ 1,361 million	Pessimistic scenario	Indian Ocean	Linden & Sporrong, 1999	CORDIO
Other Impacts: <u>Tourism</u>	Specify appropriate measure:	US\$ 3,477 million	Pessimistic scenario	Indian Ocean	Linden & Sporrong, 1999	CORDIO
Impact: <u>Disturbance Regulation</u>	Other impact measure:- _____	US\$ 2,152 million	Pessimistic scenario	Indian Ocean	Linden & Sporrong, 1999	CORDIO

## References

- Cesar, H. (1999) Socio-economic aspects of the 1998 Coral Bleaching Event in the Indian Ocean (in *Coral Reef Degradation in the Indian Ocean*, Eds. Linden, O. & Sporrong).

**Sub-Region:** \_\_\_\_\_ **Aquatic System:** **COASTAL** **Country:** **SEYCHELLES**

<b>Ref.</b>	<b>ISSUES ? IMPACT ?</b>	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>
	<b>Loss of human use</b>				
Ai.	Tourism, recreation and aesthetic values	<b>E1</b>	<b>E2</b>		
Aii.	Resources for subsistence of local populations	<b>N</b>	<b>N</b>		
Aii.	Fish sales	<b>E1</b>	<b>E2</b>		
Aiv.	Employment/Employment opportunities	<b>E1</b>	<b>E2</b>		
Av.	Other exploitation opportunities	<b>E1</b>	<b>N</b>		
Avi.	Cultural heritage	<b>N</b>	<b>N</b>		
Avii.	Human conflict (due to loss of resource)	<b>N</b>	<b>N</b>		
Aviii.	Scientific/Educational value	<b>N</b>	<b>N</b>		
Aix.	Land use, physical capital & human safety	<b>E1</b>	<b>E2</b>		
Ax.	Other				
	<b>Costs of Management</b>				
Bi.	Physical protection measures	<b>E1</b>	<b>E2</b>		
Bii.	Restoration of modified systems	<b>E1</b>	<b>E2</b>		
Biii.	Response to catastrophic events	<b>E1</b>	<b>E2</b>		
Biv.	Control of invasive species	<b>E1</b>	<b>E2</b>		
Bv.	Other				

	<b>Loss to Wildlife</b>				
Ci.	Sanctuary	<b>E1</b>	<b>E2</b>		
Cii.	Biodiversity	<b>E1</b>	<b>E2</b>		
Ciii.	Other				
D	<b>TOTAL</b>				

V(x) = Valuation data available, See Data Table Imp/Hab/DTx.

R(y) = Not separately valued but included in an aggregate valuation, see Data Table Imp/Hab/Dty.

E = Impact is a *significant impact* but no valuation data available, Exposure Table Imp/Hab/ET

N = Impact is not a *significant impact*.

Sub-Region: SOMALI CURRENT Aquatic System: COASTAL  
 Country: SEYCHELLES

Ref.	ISSUES ? IMPACT ?	a Beach/Coastal Erosion	b Storm Surges	c Salt Water Intrusion	d Siltation	F Coral Bleaching	d TOTAL
	<b>Loss of human use</b>						
Ai.	Tourism	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Aii.	Recreation	<b>E3</b>	<b>N</b>			<b>E5</b>	
Aii.	Agriculture	<b>N</b>	<b>E4</b>			<b>N</b>	
Aiv.	Water supply	<b>N</b>	<b>N</b>			<b>N</b>	
Av.	Fish sales and aquaculture	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Avi.	Other loss of income/jobs	<b>E3</b>	<b>N</b>			<b>N</b>	
Avii.	Private property value	<b>E3</b>	<b>E4</b>			<b>N</b>	
Aiii.	Public infrastructure	<b>E3</b>	<b>E4</b>			<b>N</b>	
Aix.	Aesthetic value	<b>E3</b>	<b>N</b>			<b>N</b>	
Ax.	Development opportunities	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Axi.	Other						
	<b>Costs of Management</b>						
Bi.	Flood protection measures	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Bii.	Flood Damage	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Biii.	Rescue services	<b>N</b>	<b>E4</b>			<b>N</b>	
Bv.	Other						
	<b>Loss to Wildlife</b>						
Ci.	Sanctuary	<b>N</b>	<b>E4</b>			<b>E5</b>	
Cii.	Habitat/protected areas	<b>E3</b>	<b>E4</b>			<b>E5</b>	
Ciii.	Other (other impacts)	<b>See Table -----&gt; E5</b>				<b>X</b>	
D	<b>TOTAL</b>						

V(x) = Valuation data available, See Data Table Imp/Hab/DTx.

R(y) = Not separately valued but included in an aggregate valuation, see Data Table Imp/Hab/Dty.

E = Impact is a *significant impact* but no valuation data available, Exposure Table Imp/Hab/ET

N = Impact is not a *significant impact*.



## Annex VII

### Detailed environmental assessment

**Major concern:** Habitat and Community Modification

**Issue:** Modification of ecosystems or ecotones, including community structure and/or species composition.

**Table. Environmental Impact Indicators for Habitats and Community Modification**

<b>Environmental impact</b>	<b>Indicator</b>
1. Modification of biodiversity including loss of species and genetic diversity	BIO8: Relative number and distribution (or occurrence) of native species or families compared with historic and current baselines. PROD1: Relative abundance of selected native species or families compared with historic and current baselines.
2. Modification in natural storm barriers and reduced protection from erosion.	SAT2: Changes in the extent and condition of ecosystem types compared with historic and current baselines.

### **Detailed Environment Assessment**

**Major Concern:** Global Change

**Issue:** Sea Level Change

**Table. Environment Impact Indicators for Global Change**

<b>Environment Impact</b>	<b>Indicators</b>
1. Intrusion of seawater to freshwater	HYD3: Saltwater intrusion into aquifers revealed through information from boreholes
2. Modification of aquatic habitats	CR2: % bleaching of coral
3. Loss of land, damage to coastal zones including productive land	HYD13:Loss of habitat due to water erosion (coastal erosion)