Seychelles Biodiversity: Economic Assessment

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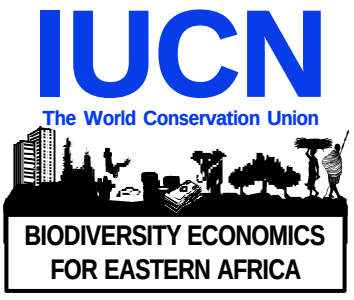

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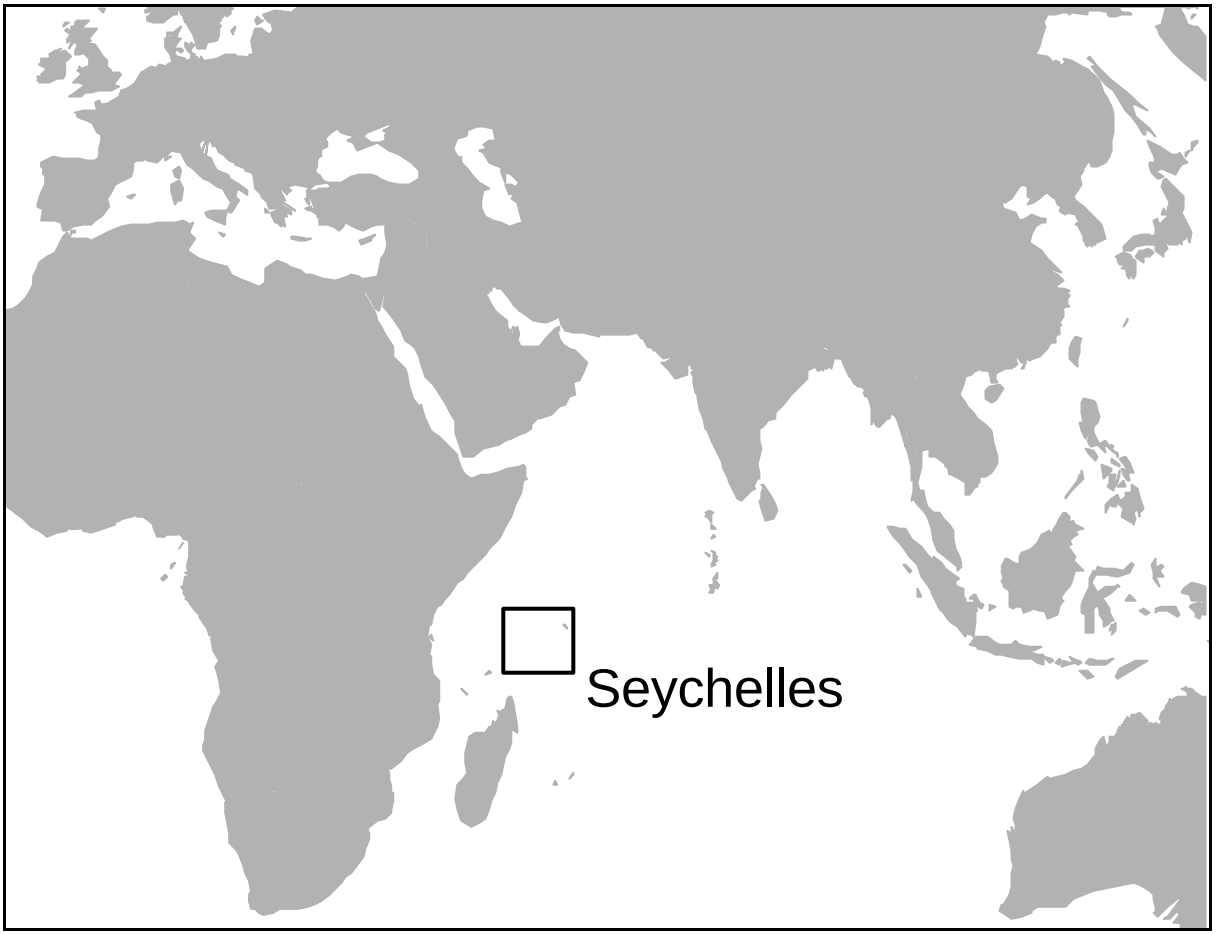

Seychelles

INTRODUCTION

Background

This document reports on an environmental economics consultancy carried out between April 7 and May 4 1997, comprising 19 days spent in the Seychelles and 6 days in IUCN EARO. The consultancy forms a part of the on-going *Seychelles National Biodiversity Strategy, Action Plan and First National Report to the Convention on Biodiversity Project.* The terms of reference for the environmental economist were to:

i) Assess the major impacts of current and planned national economic policies and strategies on biological resource use and conservation, especially taking into account the effects of macroeconomic liberalisation and reform;

ii) Assess the economic value of biodiversity in two of the main economic sectors, fisheries and tourism;

iii) Assess the possible economic impacts of biodiversity loss, including consideration of national and sectoral income, income distribution, foreign exchange earnings and employment;

iv) Assess the possible economic impacts of improved biodiversity conservation, especially in the main economic sectors, fisheries and tourism;

v) Provide recommendations for economic measures and instruments which may act as incentives for the conservation and sustainable use of biodiversity.

The consultancy benefited from wide consultation with government and non-governmental agencies in the Seychelles, and especially relied on the assistance of Mr. Peter Sinon, Director of Economic Planning, Ministry of Foreign Affairs, Planning and Environment and on the guidance and management of Mr. Nirmal Jivan Shah, Programme Co-ordinator of Seychelles National Biodiversity Strategy, Action Plan and First National Report to the Convention on Biodiversity Project. The Division of Environment of the Ministry of Foreign Affairs, Planning and Environment made available a wide range of unpublished data.

At the time of writing, U$1 was equivalent to Seychelles Rupees 4.7.

Biodiversity and economic activity in the Seychelles

Biodiversity depletion and degradation in the Seychelles are not just ecological issues. They are also economic issues – both because biological resources provide basic support to economic production and consumption, and because these economic activities in turn contribute to biodiversity loss.

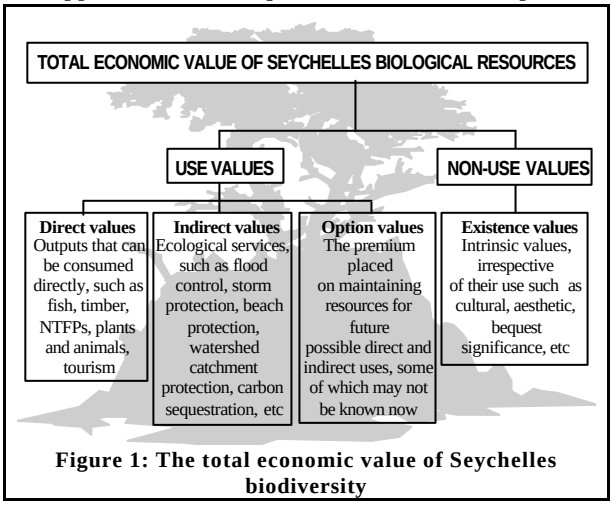


Figure 1: The total economic value of Seychelles biodiversity

Biodiversity provides multiple economic benefits to the Seychelles. The major sectors of the economy (including fisheries, forestry and tourism) directly depend on the raw materials provided from biological resources. Human and industrial production and consumption also indirectly rely on the ecological services that they provide as a sink for wastes and residues and in the protection that they provide to beaches and watersheds. The biodiversity of the Seychelles holds considerable intrinsic value, as evidenced by local, scientific and global tourism interest, and its components may provide a wide range of options for possible future economic activity, including recreational, pharmaceutical, industrial and agricultural applications, many of which are not known now. Together, as illustrated in Figure 1, these goods and services constitute the total economic value of biodiversity to the Seychelles.

Economic activities impact on the biological resource base of the Seychelles, and thus on their own means of production by using up renewable and non-renewable natural resources and converting them into other forms (for example in fisheries, agriculture, construction and land reclamation activities), and by adding wastes and effluents to the environment which in turn impacts on biodiversity (for example from tourism, urban settlement, industry and manufacturing).

Biodiversity loss and degradation lead to a wide range of costs to the Seychelles economy, both in biodiversity-dependent activities and as knock-on effects and externalities in other sectors. The economic costs of biodiversity loss include production and consumption opportunities foregone (for example loss of the direct use of biological resources such as fish, tree products and tourism), expenditures necessary to prevent or avert the effects of resource and ecosystem damage (for example purifying water, treating pollution-related diseases and illness and cleaning up wastes and effluents), costs of replacing lost or depleted biological goods and services (for example finding alternatives to resource-based sources of income and subsistence, instituting physical coastal protection or soil and water conservation structures) and costs in terms of future economic opportunities foregone (for example future tourism and industrial developments). These costs accrue both to the Government of the Seychelles as the agency responsible for providing basic services, including environmental quality, as well as to private Seychellois consumers and producers. Biodiversity costs are also felt as general costs to the Seychelles national economy, through such indicators as falling employment, declining income and decreased foreign exchange earnings.

If the Seychelles' biodiversity is conserved it will continue to provide economic benefits and support human production and consumption in the future. If it is destroyed or environmental quality declines, such goods and services will progressively decrease and the Seychelles economy will suffer as a result. This downward spiral of biodiversity degradation and economic loss, illustrated in Figure 2, has implications for both economic efficiency – the sound use and management of scarce resources to generate output, and equity – the access of different groups and individuals to secure livelihoods and economic opportunities. The Seychelles economy cannot afford to bear these costs over the long-term or to perpetuate a downward spiral of biodiversity loss and economic decline.

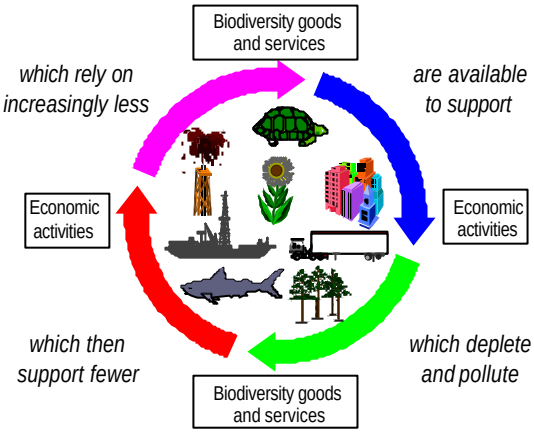


Figure 2: Spiral of biodiversity degradation and economic loss

Existing environmental economics information in the Seychelles

The Seychelles Government has excellent economic records. There has been a history of comprehensive data collection and there are easily accessible documentation centres within government ministries. The quality and coverage of information is also enhanced by the small size and relatively limited economic base of activity in the country. Statistics dealing with most economic activities are available for the last two decades, and there are many studies on the ecology and environment of the Seychelles. To date, no environmental economic work has however been carried out, and lack of information on the links between economic activity and biodiversity has been a major constraint to this assessment. Recommendations for future environmental economics work and data collection needs are provided below, Chapter 7.

The role and limits of economics in biodiversity assessment

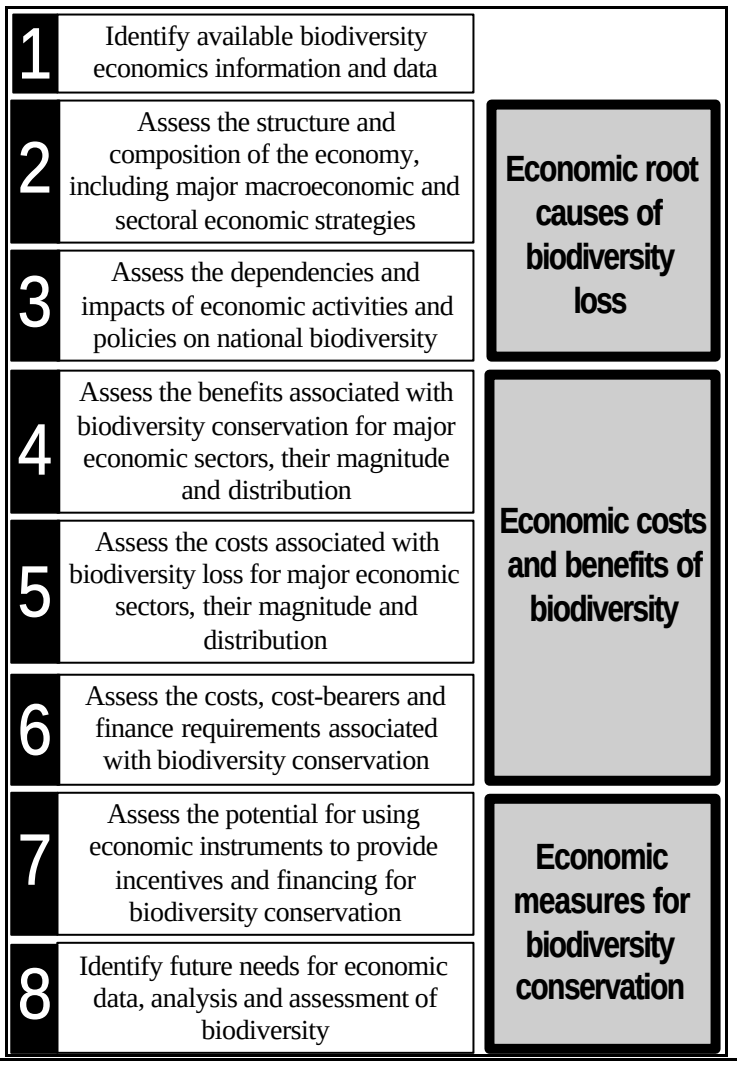
The on-going Seychelles biodiversity assessment will provide the information base from which a national biodiversity strategy and action plan can be developed. Together with biological, ecological, social, institutional and policy aspects, economics forms a key part of the process of planning and implementing biodiversity conservation.

The aim of an economic assessment of Seychelles biodiversity is to provide an estimate of the magnitude and distribution of the economic benefits associated with the biological resources of the Seychelles, and of the

economic costs of biodiversity loss. The economic assessment will provide some indication of the magnitude and distribution of the costs of biodiversity conservation to the Seychelles, and make recommendations for using economic instruments for financing and providing incentives for biodiversity conservation and sustainable use of biological resources. It will also explain the broader national economic context to the status, threats and conservation of Seychelles biodiversity.

This is a first effort to compile environmental and economic data for the Seychelles and a preliminary attempt to gauge the economic costs and benefits associated with biodiversity. A degree of caution should always be exercised in interpreting and using the results of environmental economic analysis. Because so many of the benefits associated with biodiversity have no price, or are undervalued in the market, and because available data are in most cases poor, economic valuation of biodiversity can only ever be partial. Quantified values inevitably omit a wide range of biodiversity benefits, most notably non-use and option values. The results of economic valuation should always be taken as a lower, incomplete estimate of the total economic value of biodiversity. Even where quantification is possible, analysis relies on a wide range of hypotheses and assumptions in order to generate data. The resulting figures are indicative values, to be used for planning and management purposes. They should never be seen as "real" or absolute values.

Figure 3: Stages of economic assessment of biodiversity



Steps for the economic assessment of Seychelles biodiversity

In order to generate information and recommendations which are consistent with other aspects of the Seychelles biodiversity assessment, and are useful for developing a national biodiversity strategy and action plan, economic assessment of biodiversity follows eight iterative steps, outlined in Figure 3. The layout of this report largely corresponds to these steps. The process of economic assessment aims to yield data on economic activities, costs and benefits associated with Seychelles biodiversity, and thus to present an understanding of the economic root causes of biodiversity loss and of economic measures which may be used for biodiversity conservation.

THE ECONOMIC CONTEXT TO THE STATUS, THREATS AND CONSERVATION OF BIODIVERSITY

Background to the Seychelles economy

The Seychelles archipelago consists of an estimated 115 islands which occupy a land area of some 445 km^2 within an exclusive economic zone of 1.3 million km^2. The country's current population is estimated at 76 500, predicted to grow to 102 000 by the year 2019 (Republic of Seychelles 1996a). Nearly 90% of Seychellois inhabit the island of Mahé (Republic of Seychelles 1996c), most living in the coastal strip where the bulk of tourism, industrial and commercial activities are also concentrated. Seychelles has a per capita GDP of $6 500 (Republic of Seychelles 1996b), and can therefore be categorised as a middle-income country.

Prior to Independence in 1976, the Seychelles was primarily a subsistence agricultural-fishing economy with limited cash crop exports (Republic of Seychelles 1993). Since then the agricultural sector has stagnated and steadily declined in importance. Tourism was established as a major sector of the economy during the 1970s and 1980s, and over the same period manufacturing and industrial fishing activities were set in place, all under heavy state regulation. Tourism, fisheries and manufacturing have continued to form a focus of economic activities during the 1990s, accompanied by a gradual devolution of the role of the public sector and increasing liberalisation of the economy.

Today the Seychelles economy is dominated by tourism, fisheries and a growing industrial sector. Tourism was estimated to have generated one fifth of GDP and over 60% of foreign exchange earnings in 1995, fisheries produced some 90% of domestic exports and 10% of foreign exchange and industry accounted for approximately 19% of GDP (Republic of Seychelles 1996b, 1996c).

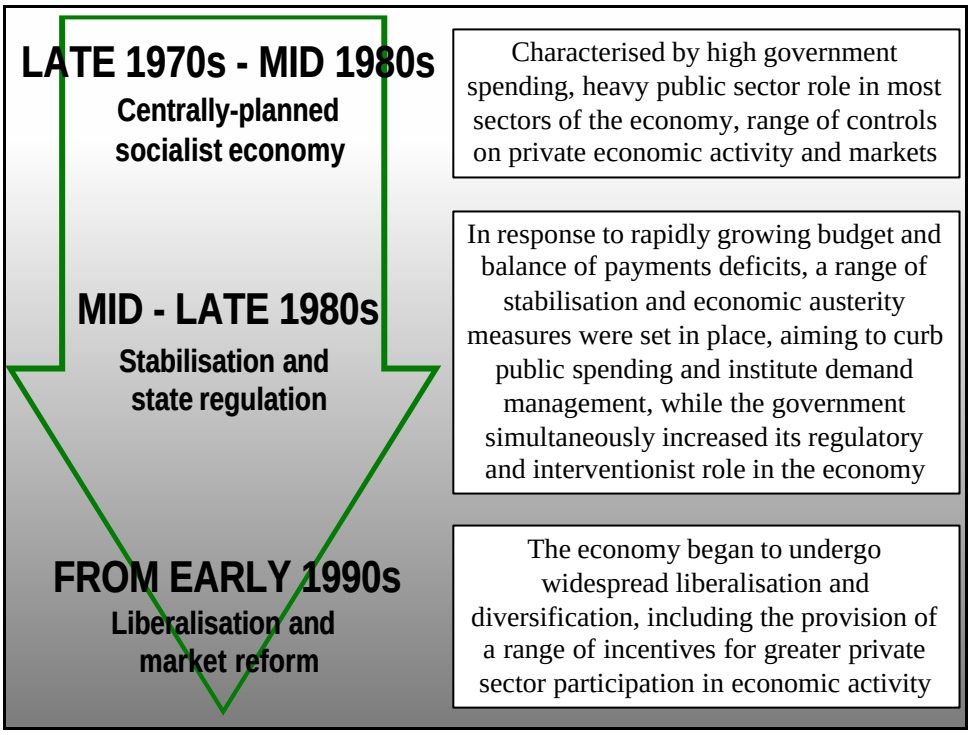
In line with its limited production base and geographical isolation, the Seychelles economy is characterised by a high level of openness and import dependence, and is vulnerable to external economic shocks. The oil crisis of the 1970s, world recession of the 1980s and Gulf War of the early 1990s all impacted heavily on the Seychelles by raising essential import prices, decreasing tourism and contributing to a decline in foreign exchange earnings. The country has consistently run a trade deficit with imports far outstripping exports, reflected in high import bills and severe foreign exchange shortage. In 1995, more than 90% of production inputs and consumption goods were imported, and imports accounted for nearly half of GDP (Republic of Seychelles 1996a). Over-reliance on tourism and imported goods has meant that macroeconomic and sectoral economic policy have since Independence primarily been oriented towards import substitution, export promotion and production diversification in order to achieve basic goals of employment, equitable income distribution and economic growth.

Macroeconomic and sectoral economic strategies and policies

Since 1978, macroeconomic and sectoral plans, objectives, strategies and policies which the Seychelles government is committed to pursue have been stated in five-year rolling National Development Plans. In 1996 these plans were replaced by a simpler and less ambitious 3 year Public Sector Investment Programme (PSIP). On paper, environmental preservation has always been a key stated objective in government economic growth strategies, reflected in the Seychelles Strategy for Sustainable Development (Republic of Seychelles 1992b), and is heavily emphasised in the current 1996-98 PSIP.

There have been three clear phases of macroeconomic and sectoral economic strategy and policy in the Seychelles, which provide the rationale and context for changes which have taken place in the structure and composition of the economy since Independence. These are outlined in Figure 4.

Figure 4: Macroeconomic and sectoral economic strategy and policy 1976-date



In common with many small island states, the Seychelles has always depended heavily on the government budget as a tool for economic management because it does not have the flexible use of alternative policy instruments to achieve macroeconomic objectives. Heavy public sector intervention has until recently also limited the autonomy of economic activities and thus minimised the effectiveness of economic instruments. Coinciding with the liberalisation of the economy, a range of fiscal, financial and market instruments have however increasingly been used as economic management tools during the 1990s.

Macroeconomic strategies

After the Seychelles gained independence in 1976 public sector investment was high, especially in basic services such as construction, education and health. The prices of most domestic, import and export goods were controlled by the government throughout the marketing chain, and heavy foreign exchange and import controls were in force. A major thrust of macroeconomic policy was the protection of domestic industries against imports.

Government intervention in markets and public investment in state-owned enterprises increased through the mid-1980s when a series of parastatals were formed, covering most sectors of the economy and including fisheries, tourism and agriculture. Heavy government spending, a large public sector and increasing import bills contributed to severe budgetary deficit and balance of payments problems over this period (Republic of Seychelles 1992). In response, a range of austerity and economic stabilisation measures were introduced in the mid-1980s, with the aim of dampening demand and narrowing the fiscal deficit (CBS 1993). These included cutbacks in public sector spending, demand management measures and increased private and commercial taxation. The exchange rate and import markets continued to be controlled, and a range of price controls were set on both domestic and traded goods.

The economic situation of the early and mid-1990s has been characterised by growing liberalisation together with continued financial austerity. A major aim has been economic diversification and devolution of the role of the public sector. Concern that government was crowding out the private sector and that the economy was over-regulated led to an economic reform programme emphasising continued fiscal and monetary prudence and greater reliance on market-driven and private sector growth. The government has made a stated aim to increase private sector participation in tourism, industry and agriculture (CBS 1994). In order to balance the high reliance of the economy on tourism, fiscal incentives have been provided for private investment in other manufacturing and value-added industries. In 1995 broad incentives were provided for private sector investment, including

reduction of the commercial tax burden, tax concessions on capital equipment, spare parts and finished products, the devolution of parastatals and a gradual dismantling of import controls and duties (CBS 1993).

Despite liberalisation of the economy, price and foreign exchange controls have continued to be in force and there is still public sector intervention in the Seychelles economy. Between 1979 and 1996 the Seychelles Rupee remained pegged to the SDR[1], and since May 1996 has been linked to a basket of currencies representing the Seychelles' most important trading and tourism partners. A range of other tools have also been employed to restrain demand for foreign exchange, such as the maintenance of a high interest rate floor and foreign exchange rationing. Some import prices are still set by government, although there has been a gradual liberalisation of tariff and non-tariff barriers and import restrictions. There has consistently been a strong import substitution thrust in government economic policy, more recently supplemented by export promotion measures. The public sector continues to dominate the economy, with the government employing two thirds of the labour force, absorbing over one third of GDP and controlling many economic activities, and some prices, in 1995 (Republic of Seychelles 1996b).

Tourism sectoral policy

Since Independence tourism has been promoted as a primary sector of the Seychelles economy. It is a major consumer of goods and services provided in other sectors of the economy, and been seen as a means of achieving broader economic growth and macroeconomic goals. Both the 1982-86 and 1985-89 National Development Plans highlight an intention to increase the integration of tourism and other sectors of the economy, aiming to stimulate the supply of local foodstuffs for supply to tourism establishments, to distribute income earned from tourism throughout the country and to promote Seychellois participation in tourism so as to generate broad income and employment. Increasing the supply of local goods and services to the tourism sector, and expanding tourism itself, is also seen as a way of increasing scarce foreign exchange earnings and decreasing the reliance of the sector on imported commodities.

The 1990 National Development Plan and Budgets of the early 1990s continue to recognise the economic importance of tourism, but express concern about over-dependence on tourism and over-regulation of the tourism industry by the public sector. Encouraging private sector participation in tourism is a major aim of current policy, at the same time as stimulating alternative sources of income, employment and foreign exchange. Although tourism has continued to be promoted as an economic activity through a range of fiscal concessions, the government has simultaneously pursued an industrial development policy which aims to encourage economic diversification.

Fisheries sectoral policy

Like tourism, fisheries has been consistently targeted as a major sector of the Seychelles economy, although until recently was heavily regulated by the government. Throughout the 1980s, National Development Plans focused on expanding both fisheries catches and processing capacity so as to increase domestic income and employment, promote exports and generate foreign exchange. The Fisheries Policy of 1986 aimed to maximise foreign exchange earnings and develop industrial fisheries, as well as to continue to create domestic income and employment (SFA 1986). Establishment of a tuna fishery and cannery in the mid-1980s significantly increased the role of the fisheries sector in both income and trade.

From the 1990s, the marine sector (including but not limited to fisheries) has been seen as the main potential counterbalance to the dominance of tourism in the Seychelles economy (Republic of Seychelles 1996c). Sectoral economic policy has continued to focus on increasing the volume and value of fisheries, but has increasingly relied on the private sector and on the diversification of fishery-related activities to achieve these goals. Mariculture (including prawn, clam and oyster farming and plans for commercial scallop, beche-de-mer and sea urchin production), and value-added processing activities (such as drying, canning, freezing and export) have been promoted. A range of incentives to the private sector to engage in fisheries activities have been provided, including the provision of credit on preferential terms.

[1] Special Drawing Right, a currency index used by the International Bank for Reconstruction and Development (World Bank).

Agriculture and forestry sectoral policy

The agricultural and forestry sectors, which before Independence were major sectors of the Seychelles economy, have steadily been stagnating during the 1980s and 1990s. Agriculture comprised 40% of GDP in 1970 (Moustache 1997) when cinnamon and copra were still important export crops, but its share had fallen to only 2.4% of GDP in 1994 (Republic of Seychelles 1996a).

Despite its low and falling contribution to national income, macroeconomic and sectoral policies have always viewed agriculture as a mainstay of the Seychelles economy. The Agricultural Strategies of 1982 and 1989 aimed for a strong and self-sufficient agricultural sector which would generate food and income and simultaneously substitute for imports and prove foreign exchange through exports (Republic of Seychelles 1982b). At the same time as establishing production targets and government pricing and marketing structures, assistance in credit, irrigation and agricultural intensification were provided throughout the 1980s and generous tax and price incentives were offered to farmers in an attempt to stimulate production. Over this period foreign investors were welcomed into the agricultural sector, land was acquired by the state and allocated to agriculture, and there were attempts at cash crop diversification into coffee, tea, vanilla, tobacco, herbs, spices and floriculture.

During the 1990s the agricultural sector has continued to be promoted, although the focus of activity has changed. Cash cropping has been de-emphasised in favour of national food crop self-sufficiency and value-added through processing. There has been a devolution of the government's role in marketing and price setting, and price incentives have been used in an attempt to attract the private sector to the agricultural sector. There is some evidence that the small farms sector, mainly producing meat, vegetables and fruit, is beginning to grow again, and agriculture is close to reaching goals of food self sufficiency in domestically-produced items (Moustache 1997). By April 1996 a total of 172 plots of between 0.5 and 1 hectare had been allocated by the government to new farmers (Moustache 1997), and land under greenhouses – enabling year-round cultivation of a wide range of crops – had increased rapidly.

There has been little policy focus on the forestry sector beyond a broad recognition of the need for tree planting to provide for domestic timber demands, the bulk of which are currently being met through imports. In recent years the ecological role of forests has increasingly been recognised, including their importance in supporting tourism interest, biodiversity, erosion control and watershed catchment protection (INDUFOR 1993). There is however still no coherent national forest policy and poor incentives for private forest development and conservation**.**

Industry, urban and construction sectoral policy

A manufacturing industry was established in the Seychelles during the 1970s (Republic of Seychelles 1993). During the 1980s the main thrust of industrial development policy was to increase import substitution and economic self-reliance, achieved through tariff protection to industries and the provision of finance to investors. Throughout this period a series of large industries were established, all under heavy state ownership and regulation, including a brewery and soft drinks factory, a tuna cannery, agro-industry, chemical products and animal feeds processing plant.

The industrial sector has continued to grow in importance and has formed a major focus of macroeconomic and sectoral policy. The 1993 Industrial Development Policy had the aim of economic diversification through industry, and sought to involve the private sector as a key player in industrial development. Although the major focus of industrial development is similar to the 1980s and stresses import substitution and export promotion, the envisaged means to these ends are different. Natural resource-based activities and small enterprise development are being encouraged, with fiscal incentives being provided for the establishment of both (Republic of Seychelles 1993). In direct contrast to former government intervention, the 1993 policy pays particular attention to the role of private investment in industrial development, and several formerly parastatal industries have been privatised since the early 1990s.

Economic policy impacts on biodiversity

The root causes of biodiversity loss in the Seychelles are multiple and include legislative, institutional, social and policy as well as economic factors. Economic policy to date, rooted in the need for rapid growth with poor considerations of sustainability, has promoted large-scale tourism and fisheries operations, industry and

urbanisation and increasing biological resource utilisation. By encouraging particular types, levels and forms of economic activity, it has provided a major stimulus for biodiversity loss and degradation.

The Seychelles has an extremely limited productive resource base from which to satisfy the rapidly growing economic needs and aspirations of its population. Most of the population, and the bulk of production and consumption activities, are concentrated in a small coastal area and impact on fragile ecosystems. The majority of economic activities directly affect the natural environment, and impact on biodiversity.

Rapid economic growth

Since Independence national development strategies in the Seychelles have focused on rapid infrastructural and industrial growth, aiming to increase employment, per capita income and access to services, to achieve domestic self-sufficiency in food and manufactured items, generate foreign exchange and decrease reliance on imported goods. Development strategies have especially focused on establishing industrial-level operations in the manufacturing, tourism and fisheries sectors, on expanding natural resource sector activities to achieve maximum income and employment and on setting up a network of infrastructure to support these industries and to house an increasingly urbanised population.

Rapid economic growth has largely been achieved in the absence of proper environmental controls and standards on industrial and infrastructural activities, and there have been few private incentives for conservation. By encouraging large-scale, biological resource-dependent industries, and by failing to consider environmental issues within the context of broad economic planning, economic growth has impacted on biodiversity.

Public sector regulation

Over-regulation of the economy by the public sector has meant that environmental protection, in common with the provision of most goods and services, has been seen largely as a government responsibility, not the responsibility of private consumers and producers. The overburdened government sector has however not adequately provided for biodiversity conservation. Whereas high government spending on infrastructure and industry from the late 1970s to 1980s led to rapid expansion in economic activities which left little finance for conservation and undoubtedly hastened the process of biodiversity loss, recent cutbacks in public expenditure since austerity measures were instituted in the mid-1980s have subsequently decreased the amount of money available for environmental protection by the government.

Market failure and economic incentives

Biodiversity conservation, as is the case in wider macroeconomic management in the Seychelles, has mainly depended on government budget allocations and command and control measures to achieve its goals. Within the context of heavy price controls and market regulation, environmental and biological resources have largely been treated as free. The prices of most goods and services have failed to reflect the value of biological resources used or degraded in their production and consumption. The natural environment has been used as a cost-free dump for industrial wastes and residues and a limitless source of consumable biological resources, without the prices of resulting outputs incorporating the costs associated with biodiversity degradation and loss.

Environmental degradation and biodiversity loss have thus been allowed to occur in the course of economic expansion, but have not been counted as economic costs. Rather than appearing within the private consumption and production functions of the agents who give rise to biodiversity loss, these costs have been felt as externalities by other sectors of Seychelles society and economy. For example, marine pollution and reef destruction have, by leading to reef destruction and fisheries damage, imposed losses on fishing and tourism activities but have made little difference to the profits of industrial polluters. There have been few built-in incentives for the private or public sectors to carry out economic activities in ways which do not harm biodiversity, and few disincentives to them carrying out activities which contribute to biodiversity loss.

Current economic activities

The Seychelles economy is currently characterised by a high level of tourism, fisheries, industrial and manufacturing activities, which continue to expand and diversify. The infrastructure network is also growing rapidly, providing housing, roads and construction to support other productive sectors of the economy. All

these economic sectors are linked to biodiversity either through their dependence on biological resources or their impact on the natural environment. Current major economic activities in the Seychelles can be categorised according to their links with biodiversity as follows:

- **Economic activities which depend directly on biological resources** – including tourism, fisheries, forestry and other wild plant and animal-based industries – rely on biological resources for their production. They directly impact on biodiversity by consuming biological resources, some of which are scarce or fragile. They also affect biodiversity, and thus their own means of production, through requiring infrastructure and support services which alter ambient, terrestrial and marine environments and use these environments as sinks for the disposal of wastes, effluents and residues. Impacts on Seychelles biodiversity from these economic activities include:

    - Unsustainable harvesting of biological resources including fish, trees, corals, shells, plants and animals, and consequent biodiversity loss;
    - Direct damage to biological resources in the course of economic activities such as reef destruction and destruction of vegetation;
    - Degradation of environmental quality, and thus depletion of biodiversity, through the activities of primary and secondary industries and infrastructural and support services, including the disposal of wastes, effluents and residues into the land and sea.

- **Economic activities which impact on biodiversity through their effects on environmental quality** – such as manufacturing, shipping, infrastructure, urban settlement and construction – are largely unreliant on the biological resources of the Seychelles as primary inputs for production. They however indirectly impact on biodiversity through requiring infrastructure and support services which alter ambient, terrestrial and marine environments, and use these environments as sinks for the disposal of wastes, effluents and residues. Impacts on Seychelles biodiversity from these economic activities include:

    - Uncontrolled pollution of air, land, water, coast and seas from urban, industrial and shipping wastes and effluents;
    - Clearance of natural vegetation for construction of houses, roads and waste disposal sites, leading to loss of watershed catchment protection, soil erosion and downstream siltation and sedimentation;
    - Land reclamation for settlement, leading to marine degradation and siltation from dredging.

THE ECONOMIC VALUE OF BIODIVERSITY

Background: the total economic value of biodiversity

A range of economic benefits are associated with Seychelles biodiversity, some of which can be at least partially valued. The total economic value of Seychelles biodiversity includes:

- Seychelles biological resources provide **direct use values** from goods such as fish, birds' eggs, timber, wild meat, fibres, shells, coral and sand which are consumed in their original state or used as raw materials for other production processes such as animal feeds, dried marine products, tuna canning, button-making and construction. Through tourism and scientific research activities, biodiversity also supports non-extractive industries. These direct uses have an economic value which is to some extent revealed through market expenditures and sales;

- The presence of terrestrial and marine biological resources, and their diversity, supports a range of **ecological services**. These include watershed catchment protection, beach protection, soil erosion control and provision of sink for wastes and residues. Although these services have no market price, their economic benefits can be quantified by looking at the costs of replacing them with artificial alternatives, which represents the expenditure saved by their existence and can be used as a partial proxy of their economic value;

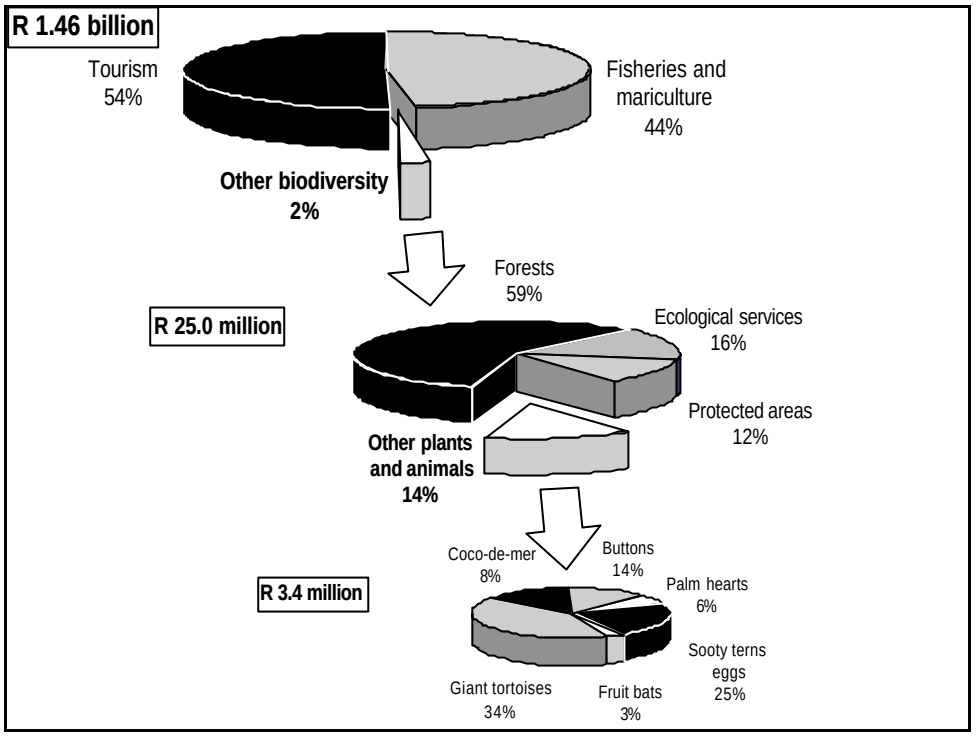
- Calculating **option and existence values** – the premium placed on maintaining biodiversity for possible future uses, and the intrinsic significance that biodiversity holds regardless of its use – typically requires a large volume of data on people's perceptions of value and stated willingness to pay for goods and services. These data are not available for the Seychelles, and so it is impossible to present any quantified estimates of these values. Both option and existence benefits are however likely to be significant components of the total economic value of biodiversity. It should also be noted that they are partly captured in tourism and scientific revenues and in donor and government expenditures on biodiversity conservation, which reflect the perceived value of conserving Seychelles biodiversity for its own sake, and for the possibility of its support to economic activity in the future.

A range of activities are to a greater or lesser extent supported by the presence of biodiversity. This chapter looks at the gross value of all the major economic activities in the Seychelles economy which have some link to biodiversity. It includes consideration of tourism, fisheries, protected areas, forests, other plants and animals and ecological services associated with biodiversity. Although the major focus is on indigenous biodiversity, some exotic tree species have been included in analysis as they form a part of mixed forest areas. Prawn mariculture, although depending on imported fry, is included as it utilises prawn species which can also be found in the Seychelles.

Many components of the economic value of biodiversity are omitted due to data constraints, so estimates should be taken as minimum values. All values are gross values unless otherwise stated, they do not take account of the physical costs incurred in biodiversity-related production and consumption (such as inputs, transport, equipment and maintenance) or the biodiversity costs that are associated with activities (the negative impacts that they may simultaneously have on biodiversity and environmental quality). In order to highlight the full range of biodiversity benefits, some values are disaggregated (for example into government revenues, private income, employment earnings, domestic and import sales). To avoid double counting these values are not repeated, they are netted out of other revenues and earnings (for example industrial fisheries earnings are net of license revenues and port expenditure, hotel receipts are net of tourism wages).

As illustrated in Figure 5 below, the total quantifiable annual value of economic activities supported by the presence of Seychelles biodiversity is nearly R 1.5 billion. Although tourism and fisheries account for the major proportion of this value – 98% of the total – because they are the most commercialised activities, the absolute value of ecological services, forests, protected areas and other plant and animal products is high at R 25 million. The economic benefits associated with fisheries and tourism also depend on the continued existence of these other sectors.

Figure 5: Summary of quantified biodiversity values



Direct values

Tourism and scientific expeditions

Throughout the 1980s and 1990s tourism has consistently – and increasingly – been a primary sector of the Seychelles economy. Its share of GDP rose from 11% in 1982 (Republic of Seychelles 1985a) to 17% in 1993 (Republic of Seychelles 1996b). Nearly 121 000 overseas visitors, 84% of whom were tourists, came to the Seychelles in 1995, staying a total of 1.15 million nights (Republic of Seychelles 1996c). In 1995 seven research ships passed through the Seychelles (Republic of Seychelles 1996a) and a range of other research activities were carried out by foreign individuals and international agencies. Tourism generates a wide range of economic benefits, including hotel and restaurant earnings, earnings to transport and other support and leisure sectors, government revenues, foreign exchange and employment.

Tourism in the Seychelles is predominantly beach-based and thus directly depends on coastal and marine biological resources and diversity. Other aspects of biodiversity, including the wild fauna and flora of the Seychelles, the presence of protected marine and terrestrial areas and good general environmental quality, also undoubtedly provide important support to the tourism industry, as well as to scientific research activities.

As illustrated in Table 1 below, the annual quantifiable value of tourism is in excess of R 794 million, the bulk of which is accounted for by expenditure made on hotels and other purchases.

Table 1: Annual tourism values

	R '000
Hotel and restaurant receipts[1]	301212
Car hire[2]	25200
Taxi and bus[2]	14400
Excursions[2]	61600
Handicraft[2]	23800
Other shopping[2]	7600
Miscellaneous tourist expenditures[2]	8100
Other local tourist expenditures[2]	189700
Pre-paid tourist services[2]	9500
Cruise and transit passengers expenditures[3]	6100
Commercial banks' mark up on foreign exchange[4]	23300
Government bednight levy[5]	11500
Government airport tax[6]	9700
Employment[7]	102888
Total	**794600**

[1] From Republic of Seychelles 1996a, less government levies and wages; [2] From Republic of Seychelles 1996a; [3] From Republic of Seychelles 1996a , includes scientific expeditions; [4] Assumed to be 0.5% of total volume of transactions; [5] Levy is R 10 per bednight, total bednights 1.15 million (from Republic of Seychelles 1996c); [6] R 100 per passenger, total tourists arriving by air 97 000 (from Republic of Seychelles 1996c);
[7] Average wage, including tourism sector and 50% of hotels and restaurants sector, all from Republic of Seychelles 1996a

Protected areas

There are some 19 760 ha of protected terrestrial areas and 23 000 ha of reef and marine areas on the Seychelles (Shah 1995), managed by government as well as by NGOs. These protected areas generate earnings, including charges for entry, sales of souvenirs and other products and land rental to enterprises such as hotels and restaurants.

As illustrated in Table 2 below, the annual quantifiable value of protected areas is in excess of R 3 million, spread over 5 protected areas.

Table 2: Annual protected area values

	R '000
Government entry fees Curieuse and Ste. Anne Marine Parks[1]	1253
Government rents Praslin and Botanical Gardens[1]	10
Seychelles Island Foundation revenues Aldabra[2]	469
Seychelles Island Foundation revenues Vallée de Mai[2]	1133
Royal Society for Nature Conservation entry fees Aride[3]	153
Total	**3018**

Note: revenues from Cousin Island, managed by BirdLife, are unavailable. [1] From DoE 1997 figures; [2] From SIF figures 1997; [3] From Carty and Carty 1996

Fisheries and mariculture

The fisheries sector includes demersal and pelagic fisheries, mariculture and fish-based processing and industry. Both the absolute value of fisheries to the Seychelles economy and its relative economic importance have grown over recent years. The share of fisheries in GDP is currently 4% (Payet *et al* 1997), as compared to 2% in 1985 (Republic of Seychelles 1985b). Diversification and expansion of the fisheries sector since the mid-1980s has resulted in greater value-added, exports, employment and income. The contribution of fisheries to total domestic exports rose from 14% in 1978 to 36% in 1982 (Republic of Seychelles 1985b) and 85% in 1987 (Republic of Seychelles 1994), and generates some 90% of export earnings today (Republic of Seychelles 1996b).

Artisanal fish catches are estimated at 4 500 tonnes per annum (Republic of Seychelles 1996a) and industrial tuna catches at 307 000 tonnes (SFA 1995). Both primary and secondary fishing industries depend directly on

biological resources as primary inputs. They also depend on marine environmental quality for their continued existence. Fisheries and mariculture generate a wide range of economic benefits, including direct sales, inputs to industry, foreign exchange and export earnings, government revenues and employment.

As illustrated in Table 3 below, the annual quantifiable value of fisheries and mariculture is in excess of R 644 million, a large part of which is comprised of exports and expenditures related to industrial fisheries and shipping activities.

Table 3: Annual fisheries and mariculture values

	R '000
Frozen and fresh fish exports[1]	10140
Sharks fin exports[1]	2896
Government licence revenues[1]	36200
Port expenditure[2]	153834
Domestic fish sales from artisanal fisheries[3]	21785
Prawn exports[1]	6889
Prawn domestic revenues[4]	8111
Canned tuna exports[5]	87993
Other tuna revenues[6]	196817
Animal feeds revenues[7]	22000
Employment in fisheries sector[8]	59388
Employment in secondary fisheries industries[9]	35495
Employment in mariculture sector[10]	3064
Total	**644612**

[1] From Republic of Seychelles 1996a; [2] From SFA 1995, includes expenditures on stevedores, bunkering, port dues, in-port expenditure, etc, includes scientific expeditions; [3] Catch from Republic of Seychelles 1996a net of employment, exports and fish trap purchase; [4] From MFAPE, less employment and exports; [5] From Republic of Seychelles 1996a; [6] From Swedmar 1994, less employment and exports, 1985 production figures; [7] From MFAPE, less employment; [8] Average wage from Republic of Seychelles 1996a, employment figures from Payet *et al* 1997, MFAPE; [9] From MFAPE, average wage from Republic of Seychelles 1996a; [10] From MFAPE, average wage from Republic of Seychelles 1996a

Forestry

Total forest cover on the Seychelles has been estimated at 40 600 ha, of which productive plantation forests comprise about 4 800 ha (INDUFOR 1993). Although the forestry sector is marginal in terms of recorded income and employment, contributing only 0.1% to GDP in 1994 (Republic of Seychelles 1996a), it supports a wide range of other economic values.

Forest areas and species contribute to tourism interest in the Seychelles, they also play an important biodiversity conservation, watershed catchment protection and erosion control role. As well as recorded harvesting, forests also support significant illegal timber felling (INDUFOR 1993) and yield a range of non-timber products including fruits, fibres and medicines. Forestry generates a wide range of economic benefits, including direct sales, inputs to industry, foreign exchange and export earnings, government revenues and employment.

As illustrated in Table 4 below, the annual quantifiable value of forestry is nearly R 15 million, mainly accounted for by employment, domestic sales of timber and forest produce.

Table 4: Annual forestry values

	R '000
Coconut exports[1]	1
Copra exports[1]	335
Coconut oil[1]	1
Government sales of forest produce[2]	630
Government tree felling permits[3]	32
Private timber sales round logs[4]	654
Private timber sales sawn timber[5]	980
Employment[6]	12050
Total	**14683**

[1] From Republic of Seychelles 1996a; [2] From DoE 1997 figures, includes sales of round logs from state forests, excludes palmistes and coco-de-mers; [3] From DoE 1997 figures; [4] From DoE 1997 figures, excludes state forest timber, less tree felling permits; [5] From DoE 1997 figures, less round log purchases and tree felling permits; [6] From Republic of Seychelles 1996d

Other plant and animal products

Seychelles biological resources support a wide range of other direct uses. Plant and animal species are routinely harvested for consumption and sale, including:

- Live trade in tortoises;
- Domestic consumption and trade in meat from fruit bats;
- Trade in coco-de-mer nuts;
- Manufacture of wood, shell and mother-of pearl buttons;
- Trade in palm hearts;
- Trade in eggs of the sooty tern;
- Trade in marine souvenirs including corals and shells;
- Plant and animal raw materials for crafts.

These products generate economic benefits in terms of direct sales as well as government revenues to a total value in excess of R 3 million, as illustrated in Table 5 below.

Table 5: Annual plant and animal product values

	R '000
Government sales of palm hearts[1]	2
Private sales of palm hearts[2]	200
Sooty tern eggs[3]	852
Fruit bat meat[4]	118
Government revenues from giant tortoise[5]	90
Government sales of giant tortoise[5]	1050
Sales to government of coco-de-mer[6]	61
Government sales of coco-de-mer[7]	341
Private sales of coco-de-mer[8]	201
Button exports[9]	479
Total	**3394**

[1] From DoE 1997 figures; [2] From DoE *pers comm*; [3] From Collie 1992; [4] From Shah *pers comm*; [5] From DoE CITES certificates 1994, sale price R 3 500, government tax R 300 from Shah *pers comm*; [6] From DoE 1997 figures, sale price R 70 symmetrical R 30 asymmetrical from INDUFOR 1993; [7] From DoE 1997 figures, sale price R 400, net of purchase price; [8] From DoE 1997 figures, sale price R 600, net of purchase price; [9] From Republic of Seychelles 1996a

Indirect values

Beach protection, storm and flood control

Both reefs from the sea direction, and coastal vegetation from the land side, protect against storms and beach erosion in the Seychelles. The wetland marsh and mangrove areas around the coastal zone of the Seychelles

additionally act as flood and storm barriers. Beach erosion, increased floods and storms impose a range of economic costs on human settlements and infrastructure as well as to natural habitats and species.

The replacement cost and avertive expenditure saved of artificial groyne and flood barrier construction, and works to prevent coastal erosion of reclaimed land forms a component of the economic value of beach protection, storm and flood control provided by the presence of terrestrial and marine biological resources. As illustrated in Table 6 below, this has an annual quantifiable value of nearly R 4 million.

Table 6: Costs of physical protection against coastal erosion

Eroded beach areas	Length (km)	Total cost of construction (R '000)	Annualised cost of construction (R '000)
Beach erosion[1]			
Mahé[2]	8.75	6125	613
Praslin[2]	3.5	2450	245
La Digue[2]	0.5	350	35
Navigation channels[3]	-	5000	500
Reclaimed land[4]			
Mahé	1	-	2480
Total	**13.75**	**13925**	**3873**

[1] Using groynes, estimated requirements and costs from DoE *pers comm*; [2] Eroded beach lengths from Shah *pers comm*, 35m groynes placed every 100 m; [3] 25 navigation channels each requiring 2 groynes of 50 m each; [4] Using rock armouring protection, ratio of reclaimed area to coastline length 16 ha: 1 km, average annual rate of reclamation 16 ha, requirements and costs from d'Offay and Savy Associates 1991

Watershed catchment protection and erosion control

Most of the water catchment areas serving human populations in the Seychelles lie in the forested hills of central areas of the granitic islands. Downstream domestic and commercial consumers and plant and animal species depend on this water, which is an increasingly scarce resource. Undisturbed natural vegetation and forest provide ground cover and soil holding capacity and, by minimising soil and water runoff, protect against erosion. In turn, this maintains soil fertility, regulates downstream waterflow, decreases the risk of flooding and maintains low silt and sediment loads in watercourses, protecting terrestrial and marine environments.

The mitigative and avertive expenditure saved by the watershed catchment protection and erosion control provided by biological resources is equivalent to the cost of purifying, desilting and desedimenting downstream water supplies. As data for these costs are unavailable, no quantified estimate has been made of the benefits of watershed protection and erosion control provided by biodiversity.

Waste and residue sink

Natural ecosystems in the Seychelles, including soil, wetlands and seas, and the biodiversity they contain, act as a sink for human wastes and residues and to some extent absorb and purify their contents. Large volumes of human, shipping and industrial wastes are disposed of in the land, water and marine environment of the Seychelles. Because of the devastating effects on biodiversity of these activities, the waste and residue sink services provided by biological resources cannot be considered a viable or sustainable service. Their replacement is therefore considered below in Chapter 5 as a component of the cost of biodiversity conservation.

The biodiversity of the Seychelles additionally provides a carbon sink. The capacity of Seychelles forests as a sink is estimated at 830 Gg of CO_2 annually (SBS 1997). In addition, reefs, through calcification processes, contribute to carbon sequestration and seagrass beds also fix carbon. There are insufficient data to assess the economic value of these services in terms of their contribution to mitigating global climate change.

THE DISTRIBUTION OF BIODIVERSITY BENEFITS AND COSTS OF BIODIVERSITY LOSS

Background: the distribution of biodiversity benefits

As illustrated in Chapter 3, biodiversity supports multiple economic activities and benefits. Without the presence of biodiversity many of the activities would no longer be possible, others would progressively decline and eventually disappear as biodiversity is degraded and lost. Costs of biodiversity loss include:

- **Production and consumption opportunities foregone.** As biological resources decline in quantity and diversity, especially if they are non-renewable or the rate at which they are used exceeds natural regeneration, the amount of raw materials available to generate output will grow less. Outputs based on fisheries, tourism, forestry and other plant and animal species will decline, affecting current production and consumption as well as precluding future economic opportunities;

- **Replacement, preventive or avertive expenditures.** As biodiversity is degraded or lost, so the ecological services it supports decline, including watershed catchment protection, beach protection, storm, flood and erosion control. Direct economic costs are implied in terms of the expenditure necessary to prevent or avert the effects of damage resulting from the loss of these services, or the costs of replacing them by artificial means.

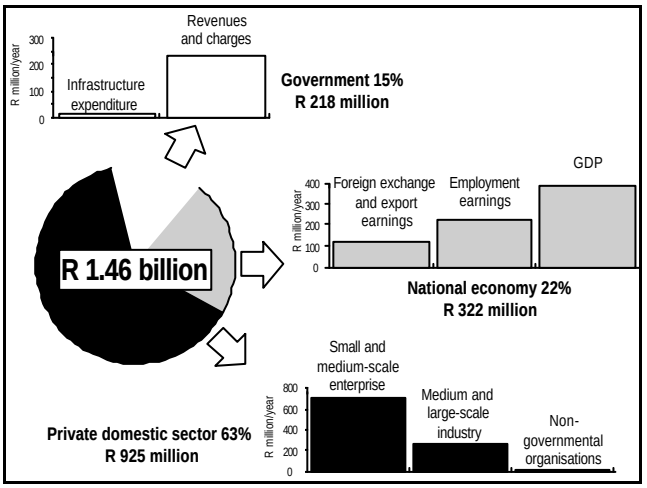
Biodiversity benefits accrue to a wide range of producers and consumers in the Seychelles economy, in the public and private sectors and within and outside biodiversity-dependent industries, as illustrated in Figures 6 and 7. These groups will all be affected by biodiversity loss, including:

- **Losses to biological resource producers and consumers**, including those who depend on biodiversity for income and subsistence, as inputs into other industrial processes and for consumption goods;

- **Decline in national economic indicators**, including falling national income and employment and decreased foreign exchange and export earnings in biological resource-dependent sectors of the economy and, through multiplier effects, in other sectors of the economy and in broader indicators such as economic growth and security, food self-sufficiency and standard of living;

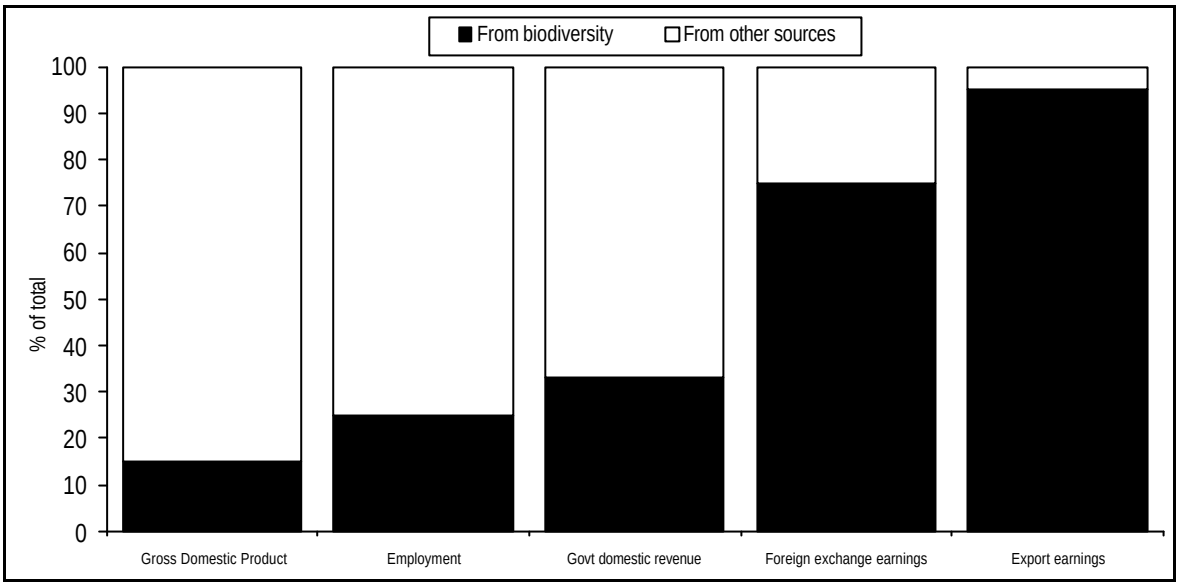
- **Budgetary costs to the government**, who, as the agency responsible for providing basic goods and services to the Seychelles economy, including environmental services and maintaining living standards, will be responsible for much of the expenditure necessary to offset the economic effects of biodiversity loss, as well as losing a range of revenues and charges generated through biological resources.

Figure 6: The distribution of biodiversity benefits



Note: GDP not included in cost totals because represented by other earnings

Figure 7: Biodiversity contributions to the national economy



Biodiversity loss would significantly decrease these values. Given a high dependence on the natural resource sector, on the use and consumption of biological resources and on continued environmental quality, the cost of permanently destroying the base of the Seychelles economy can never be fully quantified. Many biodiversity-related losses represent irreversible losses. The knock-on effects of biodiversity loss in terms of broader economic welfare and indicators, and on wider sectors of the economy, is also impossible to predict or accurately quantify.

The government budget

The presence of biodiversity supports a range of revenues and avoided expenditures for the Seychelles government. Government revenues, taxes and fees associated with biodiversity represent one third of current government revenues from domestic sources of R 644 million (Republic of Seychelles 1996a). Biodiversity loss would imply losing some or all of these revenues, outlined in Table 7. In addition to quantified values, taxes on income, including export earnings, will decline.

Table 7: Annual government revenues and biodiversity

	R '000
Bednight levies	11500
Airport taxes	9700
Protected areas revenues[1]	1263
Fish licences	36200
Port expenditures	153834
Forest produce sales[2]	973
Tree felling permit revenues	32
Giant tortoise revenues	90
Total	**213592**

[1] Includes rents and entry fees; [2] Includes coco-de-mer and palmistes

The government is the main agency responsible for major infrastructural developments in the Seychelles. The replacement, avertive and mitigative costs avoided by biodiversity-related ecological services are in excess of nearly of R 4 million, as described in Chapter 3 and outlined in Table 8. This represents 2% of current annual government expenditure on capital projects of R 200 million (Republic of Seychelles 1996a). Biodiversity loss would imply making some or all of this replacement, avertive and mitigative expenditure.

Table 8: Annual government budget expenditure and biodiversity

	R '000
Beach protection, storm and flood control	3 873

Includes groynes and rock armouring

Although not quantified, decline in two major biodiversity-dependent sectors of the economy – fisheries and tourism, and in a major sector of the economy where many activities rely on biological resources as primary or secondary inputs – industry and manufacturing, will necessitate the development of alternative industry and sources of income. Much of the associated research, development and promotion costs are likely to be borne by government.

The national economy

The presence of biodiversity supports a range of national economic indicators including GDP, employment, foreign exchange and export earnings. Although values accrue primarily within biodiversity-dependent activities, it is likely that a multiplier effect spreads these benefits into other sectors of the economy. Over R 387 million of recorded national income comes from biodiversity-related sources, outlined in Table 9. This represents nearly one sixth of current GDP (Republic of Seychelles 1996a). Biodiversity loss would imply losing some or all of these earnings.

Table 9: Annual national income and biodiversity

Item	R million
Forestry	1.8
Fishing	44.0
Tourism-related	341.7
Total	**387.5**

Over 6 000 people are employed in biodiversity-related activities, to a total value in excess of R 212 million, outlined in Table 10. This represents nearly a quarter of the total formal labour force of 25 761 persons (Republic of Seychelles 1996a). Biodiversity loss would imply losing some or all of this employment. Employment opportunities in other sectors of the economy also provide support and services to biodiversity-dependent activities. For example, it has been estimated that the expenditure of 18.7 tourists creates one direct job as well as maintaining an additional 1.38 secondary jobs in other sectors of the economy (Payet 1995).

Table 10: Annual employment values and biodiversity

	Number	Value R '000
Fisheries[1]	2845	97947
Tourism-related[2]	2989	102888
Forestry	350	12050
Total	**6184**	**212885**

[1] Includes mariculture, fisheries and secondary fisheries industries; [2] Tourism-related and 50% of hotels and restaurants

Export and foreign exchange earnings in biodiversity-dependent sectors of the economy have a total value in excess of R 108 million, outlined in Table 11. This represents approximately three quarters of total foreign exchange earnings and 95% of total export earnings (Republic of Seychelles 1996a). Biodiversity loss would imply losing some or all of these earnings.

Table 11: Annual export and foreign exchange values and biodiversity

	R '000
Fisheries	107918
Tree products[1]	337
Buttons	479
Total	**108734**

[1] Coconut oil and copra

Private producers and consumers

Private production and consumption values associated with biodiversity have a total value in excess of R 925 million, most of it accruing to small and medium-scale enterprises. Biodiversity loss will result in the loss of some or all of these values, including a decline in income as well as a decrease in the availability of biodiversity-based consumption goods.

Table 12: Annual private domestic production and consumption values and biodiversity

	R '000
Small and medium-scale enterprises	
Hotels and restaurants	301212
Small and medium-scale retailers of tourism goods and services	346000
Commercial banks	23300
Artisanal fishermen	21785
Timber merchants and private sales	1634
Plant and animal users	2482
Non-governmental organisations	
Conservation NGO receipts	1755
Medium and large-scale industry	
Medium and large-scale fish-based industries	226928
Total	**925096**

Note: excluding employment and export values

THE COSTS OF BIODIVERSITY CONSERVATION

Background: the total economic cost of biodiversity conservation

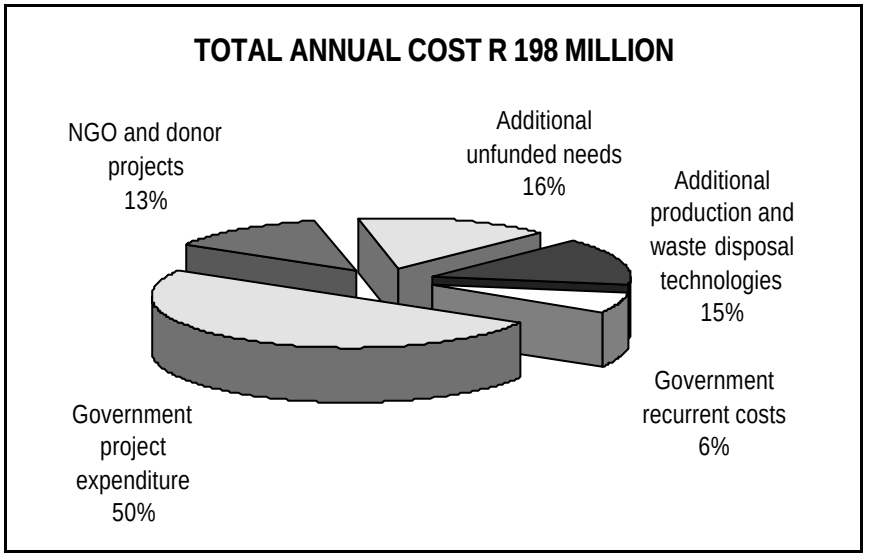
Biodiversity conservation incurs economic costs, both in terms of direct expenditure and through limiting particular production and consumption activities. Each individually is a necessary, but not sufficient, condition for biodiversity conservation. The total economic cost of biodiversity conservation to the Seychelles includes:

- The **costs of unsustainable activities foregone or diminished** – limiting extractive use of biological resources to sustainable levels in the tourism, fisheries, forestry and other plant and animal products sectors, and curtailing activities which impact on threatened and important species and areas;

- The **costs of replacing or adapting technologies which are harmful to biodiversity** – the introduction of environmentally-friendly production and waste disposal technologies in the tourism, infrastructural and industrial sectors;

- The **direct physical costs associated with biodiversity management and protection** – the capital and recurrent expenditures required by government and other agencies to improve biological resource conservation and protected area management, including projects, programmes, membership fees to conservation agencies, expenditures to meet the obligations of international conventions and contributions to various environmental funds.

Figure 8: Summary of quantified costs of biodiversity conservation



Note: some government and donor projects concerned with production and waste disposal technologies

Direct production and consumption losses

A variety of biological resources are harvested illegally, despite bans and restrictions governing their use. They include the harvesting of turtles for meat and shell, live trade in protected plants and animal species, exploitation of marine mammals and sales of unworked marine souvenirs. All these activities are leading to biodiversity loss. As there are no estimates of the volume or value of this utilisation, it is impossible to quantify the economic costs associated with its curtailment. Other activities which in the past have led to biodiversity loss, such as phosphate mining and coral-based road and house construction, have stopped of their own accord because they are no longer economically viable.

Biological resources which continue to be legally utilised include fish (including sharks), timber, non-timber forest products (including coco-de-mer and palm hearts), birds eggs, giant tortoises and fruit bats. It is likely that some of these activities are unsustainable, although lack of detailed data prevents any estimate being made of the economic costs of bringing utilisation in line with biodiversity conservation goals. For example, it is believed that harvesting of coco-de-mer is unsustainable due to the restricted and rapidly decreasing range of the species,

its long growing period, and because nearly all fallen nuts are harvested. Current level of offtake of giant tortoise are also probably unsustainable, for similar reasons, in the absence of a planned captive breeding programme. Recorded annual offtake represents a high proportion of the total population of fruit bats, and may well exceed natural regeneration. Although tuna fisheries are broadly sustainable (Payet 1997), it is widely argued that inshore demersal catches in excess of 1 200 tonnes per annum exceed sustainable yields estimated at approximately 400 tonnes (Mees 1994), and that offshore catches may also be unsustainable in some locations.

Linked to the production and consumption losses associated with biodiversity conservation are the opportunity costs of protecting important biodiversity areas (for example recommended protection of key catchment and biodiversity forests (INDUFOR 1993) and of sensitive coastal and marine areas (Republic of Seychelles 1995a)). The opportunity cost of marine or terrestrial protection is the cost of productive activities and opportunities foregone in these areas. Costs include limiting housing development in biodiversity protection areas and watershed forests, curtailing beach developments and reclamation in sensitive coastal zones and reducing or stopping fisheries, tourism and industrial activities in other protected land and sea areas.

Changes in production and waste disposal technologies

Industry, construction and manufacturing have been among the fastest growing sectors of the Seychelles economy in the last decade. Their share of GDP rose from 7% in 1985 (Republic of Seychelles 1985b) to 14% in 1990 and 19% in 1994 (Republic of Seychelles 1996b). Simultaneously the urban population has increased and a range of new industries have been established.

Industry, manufacturing, urbanisation and construction have all impacted heavily on biodiversity by changing the natural landscape and adding wastes, residues and effluents to the land, water and sea. In upland areas, vegetation destruction and watershed degradation has led to soil erosion, affecting downstream waterflow and quality and leading to marine siltation and reef damage. It is estimated that about 200 acres of land are allocated annually for housing, involving the clearance of over 300 m^3 of vegetation (Republic of Seychelles 1996c).

Within the coastal zone there has been destruction of vegetation, wetlands and beaches for construction, including land reclamation. Over 200 ha of land have been reclaimed on Mahé over the last 15 years (Republic of Seychelles 1996c). Together with vegetation clearance, dredging for land reclamation has resulted in increased sediment loads in watercourses flowing into the sea, discolouring beaches and killing coral. There are dead reefs at Curieuse, perhaps linked to siltation, and plumes of silt at Anse Royale and Beau Vallon are damaging coral reefs (INDUFOR 1993). Removal of coastal vegetation and inappropriate infrastructural developments including roads, sea walls, piers, breakwaters, artificial lagoons and excavation of rocks and coral have resulted in beach erosion, exacerbated by offshore reef degradation (Shah 1995). All these changes have impacts on coastal and marine biodiversity.

The coastal zone of Mahé contains the majority of human settlement and industry, which discharge wastes and effluents into the land, water and sea. Urban and construction wastes are estimated at between 7 500 tonnes (Tebodin 1994) and 12 000 tonnes (ITW 1995) a year, port shipping wastes at 22 500 tonnes (Tebodin 1995) and industrial wastes at between 8 500 tonnes (Tebodin 1994) and 12 000 tonnes (ITW 1995). All these wastes include land, water and air pollutants, some of which are toxic or otherwise hazardous (Radegonde 1992). Most solid wastes are disposed in a landfill, which is leached out by rainwater, polluting the sea around the landfill site (Tebodin 1994). Industrial wastes are often discharged directly into the harbour, including fisheries wastes and by-products, offal, oils, dirty water, spent solvents and other chemicals. Although a central sewerage system serves Victoria, most other areas use septic tanks or pit latrines. Sewerage systems are often inadequate, sometimes leading to raw sewage being discharged into the sea. Organic and inorganic pollution from domestic and industrial wastes has negative effects on near shore coral reefs and on marine life.

Within the marine ecosystem itself a range of waste and effluents from ships and boats are routinely discharged into the ocean, with consequent effects on reef and marine biodiversity. Reef destruction is also occurring as a result of tourist boats and watersports activities, including damage recorded around both Ste. Anne and Ste. Pierre islands (Shah 1995).

Minimising onshore destruction of natural vegetation and ecosystems, and limiting the flow of pollutants into the sea, requires changes in current forms of production and waste disposal technologies. Although impossible to quantify, an important economic cost of biodiversity conservation is limiting further housing expansion in

upland, coastal and reclaimed areas. Major action is also required in the industrial and urban sectors in terms of the establishment of proper wastes and effluent disposal mechanisms and in the provision of alternatives to beach sand construction materials. The annual costs of these changes, some of which have been identified in the projects necessary for biodiversity conservation outlined in Section 5.4 below, are estimated to be approximately R 150 million.

Table 13: Annual costs of industrial and urban wastes disposal and pollution control

Already funded or identified

	Average annual cost (R '000/)
Solid waste treatment plant[1]	35333
Greater Victoria sewerage project[1]	49667
Contingency plan for marine pollution[2]	927
La Digue Solid Waste[2]	300
Le Niol treatment works[2]	3567
MARPOL[2]	440
Pollution monitoring, control and advisory service[2]	340
Control of toxic or potentially hazardous chemicals[3]	103
Anse aux Pins-Anse Royale sewerage project[3]	1167
Anse Volbert sewerage project[3]	4300
Beau Vallon Bay sewerage project[3]	9160
Greater Victoria sewerage projects[3]	11667
Feasibility study on introduction of lead-free gas[3]	60
Roche Caiman sewerage project[3]	2250
Standards for air and water quality and noise pollution[3]	46
Total	**119327**

[1] Funded by government, covered below; [2] Donor funded, covered below; [3] Identified but not yet funded, covered below

Additional projects not yet identified or funded

	Annualised capital cost (R '000/year)	Operating costs (R '000/year)	Total annual cost (R '000/year)
Ships treatment unit[1]	163	720	883
Sewage from port[1]	50	195	245
Port garbage[1]	375	2250	2625
Urban wastes collection, cleaning and transport[2]	870	9300	10170
Urban waste treatment and disposal[2]	4455	10800	15255
Total	**5913**	**23265**	**29178**

[1] From Tebodin 1994; [2] From ITW 1995

Direct management and conservation costs

The Government of Seychelles funds projects and programmes which are directly concerned with biodiversity, or indirectly support its conservation. In addition to these project expenditures, made by various ministries, the recurrent budgets of the Division of Environment of the Ministry of Foreign Affairs, Planning and Environment and of the Marine Park Authority are wholly allocated to biodiversity conservation. In total, the Government of Seychelles spends over R 111 million on biodiversity conservation a year. Data are unavailable on Seychelles membership fees to conservation agencies and expenditures to meet the obligations of international conventions.

Table 14: Annual biodiversity-related government budgets and projects 1996

	R '000
Marine Park Authority recurrent expenditure[1]	869
Division of Environment recurrent expenditure[1]	11699
Government Environmental Trust Fund[2]	3208
Ministry of Agriculture and Marine Resources projects[3]	2035
Ministry of Community Development projects[3]	2902
Ministry of Foreign Affairs, Planning and Environment projects[3]	5517
Ministry of Industry projects[3]	433
Public Utilities Corporation projects[3]	85000
Total	**111663**

[1] DoE figures 1995, 1996; [2] Total ETF projects over 2 year period 1994-to 31/8/96, includes administration expenses, projects assumed to have run for 2 years; [3] From Republic of Seychelles 1996b

Various donor and NGO projects, some carried out in partnership with the Government of Seychelles, are concerned with biodiversity conservation. Together these projects account for expenditure of over R 25 million.

Table 15: Annual biodiversity-related project expenditure by donors and NGOs 1996

Organisation	R'000
Non-Governmental Organisations[1]	1159
Bilateral and multilateral donors[2]	25180
Total	**26 339**

Note: [1] Seychelles Island Foundation, BirdLife and Royal Society for Nature Conservation costs for Cousin and Aride Islands unavailable; [2] From Republic of Seychelles 1996b, includes a range of donors.

A range of projects and expenditures necessary for biodiversity conservation have been identified in the Seychelles but not yet funded. These represent the costs of conserving biodiversity in addition to existing expenditures, and are in excess of R 31 million.

Table 16: Annual costs of identified but not yet implemented biodiversity-related projects 1996

	R '000
Proposed biodiversity authority budget[1]	(595)
Projects identified in EMPS but not implemented[2]	31820
Total	**31225**

[1] From Republic of Seychelles 1995, less projected receipts; [2] From Republic of Seychelles 1990b

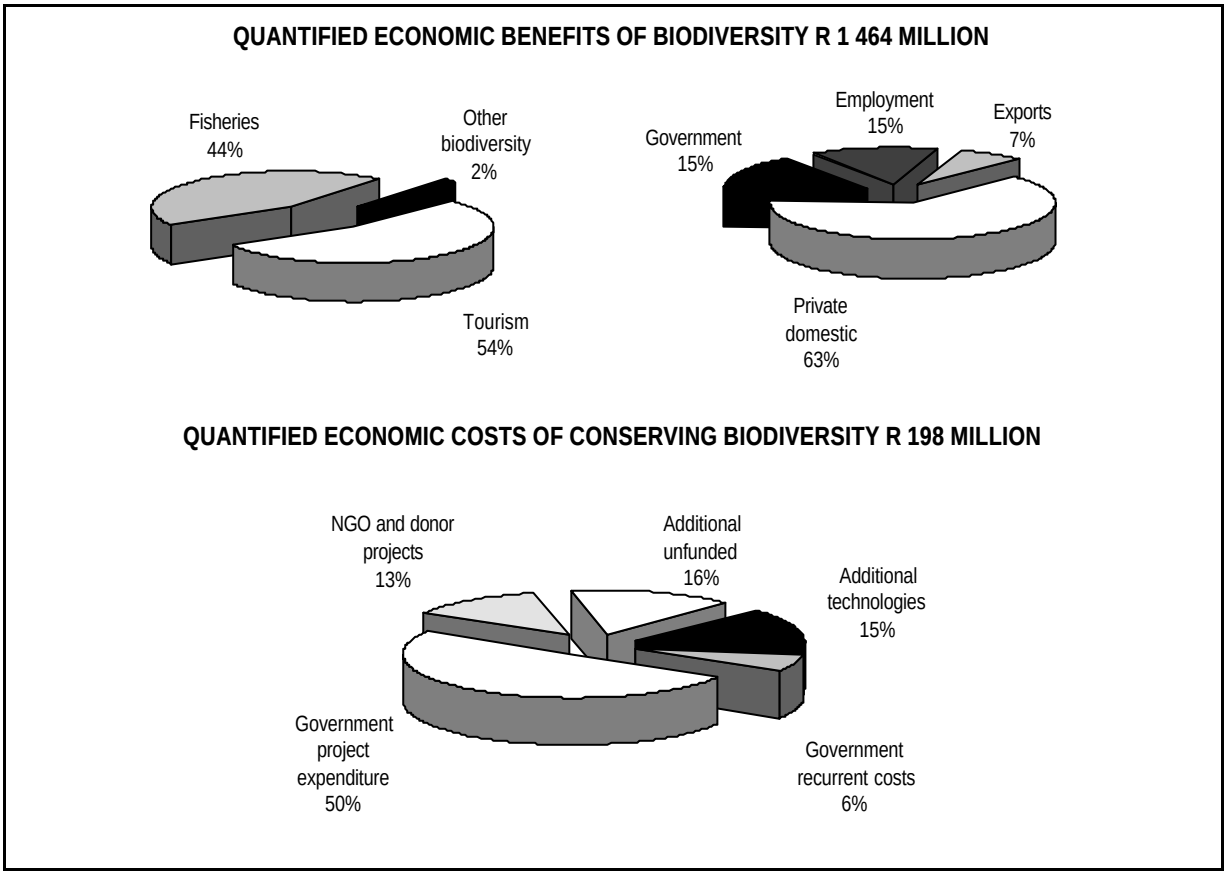
CONCLUSIONS: BIODIVERSITY COSTS, BENEFITS AND ECONOMIC INCENTIVES

The economic costs and benefits of Seychelles biodiversity

This assessment has demonstrated that biodiversity yields substantial benefits, which accrue throughout the Seychelles economy and population. Biodiversity, by generating income, employment and foreign exchange, makes an important contribution to national development goals and contributes to economic growth. It also supports a range of ecological functions which sustain human and economic activities. Loss or degradation of biodiversity implies significant costs to the government and the private sector, and will erode the productive base of the most important sectors of the Seychelles economy.

Major root causes of biodiversity loss include the unsustainable exploitation of biological resources as well as the modification, degradation and pollution of marine and terrestrial environments by industry and human settlements. Costs associated with biodiversity conservation, in addition to direct expenditures on protection and management, include foregoing unsustainable biological resource utilisation and modifying production and waste disposal technologies.

Figure 9: Summary of biodiversity costs and benefits



There is a clear economic benefit to biodiversity. The dependence of the Seychelles economy on biodiversity goods and services and the lack of alternative sources of income and employment present a strong justification for conservation. The costs of conservation represent only a small proportion of the economic value of biodiversity, and biodiversity conservation will imply considerable long-term economic savings and benefits to most sectors of the economy. Considering unquantified direct, indirect, option and existence values strengthens still further the economic case for biodiversity conservation. The major challenge, examined below, is how to maintain biodiversity benefits and apportion the costs of biodiversity conservation in the most efficient and equitable way and, given financial constraints within the Government of Seychelles, how to generate revenues to finance biodiversity conservation.

Market failure, externalities and biodiversity loss

In addition to policy, legislative and institutional factors, market failure is a major root cause of biodiversity loss in the Seychelles. Biodiversity has largely been treated as a free set of goods and services which can be mined, modified and degraded at no cost in order to generate economic output. This is reflected in the development of biological resource-based activities in the Seychelles – such as fisheries, tourism and harvesting of other plant and animal species – which have focused on progressively increasing levels of exploitation so as to generate income and employment with poor considerations of sustainability. It is also illustrated by urban and industrial expansion, which have modified and changed the natural landscape and its ecological functions – such as through land reclamation and vegetation clearance in watershed and beach areas – and discharged wastes and effluents into the terrestrial and marine environment, regardless of their impacts on biodiversity. Because the market price of goods and services do not incorporate the full costs of biodiversity loss there is a tendency for biodiversity-related goods and services to be over-produced, over-consumed and under-priced, and there are few incentives to utilise biodiversity sustainably.

Many of the costs of biodiversity loss appear as externalities. Instead of the producers and consumers whose demands for commodities and economic activities deplete biodiversity paying for the damage they cause, the costs are felt by the government, by other producers and consumers or by future generations. For example it is the government who bear many of the costs of cleaning up water and marine pollution caused by industrial effluents, income and health effects accrue to fishermen and local dwellers. The impacts of deforestation and beach erosion resulting from urban expansion can be felt through decreased downstream water quality and falling tourist revenues. This inequity acts as a further disincentive for producers to conserve biodiversity in the course of their economic activity, because they do not bear the costs of the biodiversity loss they incur.

It is clear that the Seychelles population and economy cannot afford to bear the costs associated with biodiversity loss over the long term. Although considerable public expenditure is made on conserving biodiversity and there exist a range of laws and penalties for biodiversity-damaging activities, laws are costly and difficult to enforce and government funds are limited. Economic instruments provide the potential to strengthen existing mechanisms for biodiversity conservation in the Seychelles, both by giving producers and consumers incentives to avoid biodiversity loss in the course of their activities and by generating finance for biodiversity conservation.

Economic instruments for biodiversity conservation

Economic instruments include a range of measures aiming to overcome market failures and to internalise externalities. Although their main aim is to change consumers' and producers' behaviour and encourage them to conserve biodiversity in the course of their economic activities, they can also raise revenues (see Section 6.4). They change the prices people pay for goods and services to reflect the costs of biodiversity used or degraded in their production and make sure that these costs accrue to the producer or consumer who is responsible for biodiversity degradation. By affecting private profits, they present economic incentives for biodiversity conservation, and disincentives to biodiversity degradation.

Below we consider five major categories of economic instruments:

- **Market creation** can deal with both on and off-site biodiversity benefits and costs. Creating a market in biodiversity goods and services where none exists allows them to be assigned, priced and traded. It encourages consumers to use biodiversity goods and services in a way which maintains environmental quality and recognises that biodiversity consumption has a cost. Markets can be created directly – such as by instituting the purchase and sale of biological resources and value-added products where there is an existing demand and willingness to pay by consumers. They can also be established via tradeable rights, shares and quotas in biological resources and environmental quality – for example tradeable fishing quotas, pollution permits or development rights.

- **Charge systems** are payments for the use of biodiversity goods and services. They can be instituted where biodiversity benefits are enjoyed at low or zero cost and aim to manage the demand for biological resources and to encourage consumers to take the costs associated with this consumption into account in their economic activities. For example, charges can be set or rationalised for entry into protected areas, use of biological resources and environmental pollution and waste treatment and clean up.

- **Fiscal instruments** include taxes and subsidies. They are used to bridge the gap between the private and social benefits and costs associated with biodiversity and its loss. Instituting differential tax rates of different products, resource uses and production methods can all ensure that the full costs of biological resources are incorporated into market prices, and alter producers' and consumers' demand patterns so as to encourage them to act in a way which consumes less biodiversity and maintains environmental quality. For example, the price of biological resources can be manipulated in absolute terms and relative to other alternative goods and services through imposing differential tax rates on biodiversity-depleting and biodiversity-conserving industrial equipment, technologies, inputs and products, on different land uses and on effluents, wastes and pollution. Biodiversity-conserving activities can also be encouraged through a range of subsidies to environmentally benign or biodiversity-replacing technologies, land uses and enterprises.

- **Financial instruments** include the creation of special funds, loans and subsidies earmarked for biodiversity conservation purposes. They provide instruments for encouraging investment in biodiversity. Such financial instruments as green funds, trust funds and preferential loans for biodiversity-conserving activities can all mobilise funds and promote investment in biodiversity.

- **Bonds and deposits** are economic instruments which shift the responsibility for biodiversity-depleting or environmentally-damaging activities to individual producers and consumers. By charging producers and consumers a refundable bond or deposit in advance for such damage, they provide them with an incentive to avoid causing damage in order to recoup their deposit, or ensure that sufficient funds are available to mitigate or reverse such damage if it occurs. Deposits and bonds levied on such activities and products as waste clean up, mooring at assigned sites and land restoration can all encourage producers and consumers to avoid damage to biodiversity.

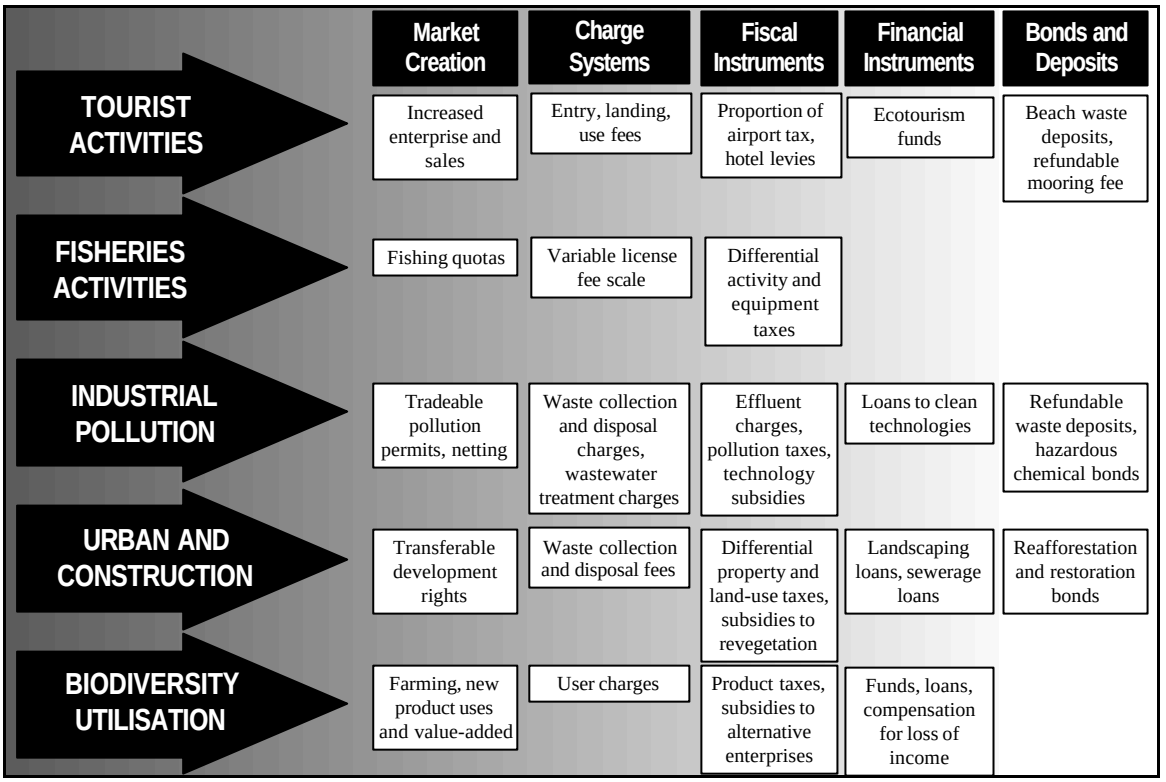
Economic instruments are relatively easy to apply and enforce in a small economy like the Seychelles. There are however a number of characteristics of the Seychelles economy which influence the choice of economic instruments and their appropriateness to goals of biodiversity conservation. Due to a high dependence on imported inputs and products, and because of the high costs of exporting Seychelles products overseas, a major concern is not to pass too many costs onto consumers and make goods produced in the Seychelles uncompetitive on world or domestic markets. Similarly, already high direct and implicit taxation rates in the Seychelles mean that there is only a limited capacity for increasing taxes, and government budgetary constraints limit the degree to which subsidies can be applied. It is more appropriate for the case of the Seychelles to focus on redistributive and cost-effective measures which encourage more efficient production techniques and present potential savings or alternatives to producers who damage biodiversity, rather than to look at instruments which will directly raise production costs and consumer prices.

Economic instruments must be politically acceptable and consistent with wider national economic goals. Given the domination of the economy by the public sector and important role of the budget in economic management, successful implementation of economic instruments in the Seychelles depends to a large extent on recognition by the government that the use of economic instruments can generate fiscal revenues and savings on public expenditure. There must also be a realisation that biodiversity conservation will constitute long-term savings to the national economy and should therefore form a part of development and economic growth strategies. Even where economic instruments through subsidies increase government expenditure in some sectors, or through reduced tax revenues cut government earnings, many of these losses are balanced by transferring a part of the burden of conservation expenditure away from the government to the private sector, and saving on conservation or cleanup costs which have to date been borne by the state.

A wide range of economic instruments, summarised in Figure 10, have potential application as incentives for biodiversity conservation in the Seychelles. They target the major root causes of biodiversity loss, including unsustainable activities in the fisheries and other biological resource utilisation sectors, urban, infrastructural and tourism developments which are harming biological species, habitats and ecologically sensitive areas, and the uncontrolled disposal of industrial wastes and effluents into terrestrial and marine ecosystems. Most instruments are not direct charges or taxes, rather they encourage producers and consumers to follow a particular course of action because it will save them money or increase production over the long-term (such as through allowing tax relief or preferential credit rates for alternative technologies, by subsidising particular activities or by

instituting refundable deposit requirements). They present positive incentives for conservation, rather than penalising for biodiversity loss.

Figure 10: Economic instruments for biodiversity conservation



Tourist activities

Deposit systems have some potential for minimising biodiversity degradation, for example the refundable deposit currently levied on the organisers of all public events for waste disposal and clean up. These measures could be further extended and targeted to the tourist industry, including refundable beach waste deposits which can be offset against beach cleanup costs. In order to minimise on reef damage from boats, a refundable mooring fee could be set against mooring at designated buoys and anchoring points.

Charge and fee systems also provide a means of generating increased revenues from tourism which can be used for biodiversity conservation, as well as potentially minimising congestion. Several charges – including airport taxes and park entry fees – are already levied on tourists, and hotels have to pay a bednight levy to government. Although there is only limited potential for raising direct fees and user charges, tourists may be willing to increase payments if they were assured that revenues were being used for conservation purposes. Several areas of outstanding natural beauty and tourism interest do not currently charge for entry. A range of other revenue-generating opportunities could be further developed in these areas through increased enterprise and sales, examined below in Section 6.4.

Unsustainable fishing activities

Regulating marine fisheries is notoriously hard because they typically cover a large and remote area, and the fisheries resource is mobile and to some extent an open access good. Fishing quotas, although difficult to enforce, can limit catches to sustainable yields. Quotas can additionally be traded or auctioned in order to generate revenues and allow the market acquisition and disposal of fishing rights. Differential taxes on inshore and offshore fishing equipment, and a variable scale for license fees, can help to encourage or discourage particular types of fishing in different areas and take pressure off stocks.

Polluting industrial production and waste disposal technologies

Waste collection, disposal and treatment charges, bonds, deposits, effluents charges and pollution taxes all aim to generate funds for cleanup, or, by imposing costs on industries, to encourage them to limit and treat wastes internally. Pollution permits, by setting a maximum level of discharge or effluent production, limit emissions and effluents. In order to allow firms some flexibility, these permits can be tradeable, or netting – allowing an increase in effluents if matched by a decrease elsewhere – can be instituted.

Additional incentives for industry to minimise wastes and discharges can be provided by lowering the relative cost of clean technologies and waste disposal mechanisms. This includes measures such as differential taxes or tariff scales, or by providing tax relief or subsidies to clean technologies. Improved technologies which also increase production efficiency reinforce incentives for firms to modify their production and waste disposal techniques.

Construction of infrastructure and disposal of urban wastes in ecologically sensitive areas

A range of economic instruments provide the potential for minimising or avoiding the damage to biodiversity caused by construction. The imposition of differential land use or property taxes or taxation zones can discourage construction in ecologically sensitive areas. Tradeable development rights have been used with some success to limit construction in wetland, coastal and montane zones in other parts of the world to shift developments to less sensitive areas. Reafforestation or beach restoration bonds, landscaping loans and subsidies to afforestation can be imposed at the same time as construction takes place to guarantee that sensitive areas are protected or returned to their original state.

Better waste management and disposal can be encouraged by providing loans on preferential terms or tax relief for the installation of proper sewerage facilities by property owners, especially hotels or settlements in remote areas. Treatment charges can raise revenues for centralised provision of these services.

Overexploitation of biological resources

Increased user charges and product taxes may limit to some extent the exploitation of biological resources, although it is likely that illegal harvesting will continue. Providing biodiversity users with subsidies, loans or other funds for alternative enterprise development can help to shift activities away from sensitive areas and species, as in the on-going turtle shell compensation programme. Other measures to increase the value of existing activities, rather than the volume of wild species exploited, include initiating commercial farming or captive breeding activities and instituting additional product uses and value-added to activities. These are examined further in Section 6.4, below.

Financing mechanisms for biodiversity conservation

Although economic instruments can internalise biodiversity costs in private production and consumption processes, transfer the financial burden of conservation from government to the private sector and generate funds, they are unlikely to ever cover the full economic costs associated with biodiversity conservation. The current capacity of the government to finance conservation is also limited. Despite the high domestic and global benefits of biodiversity, there remains a resource gap in terms of unmet finance needs for biodiversity conservation in the Seychelles, as described above in Chapter 5. It is necessary to consider additional financing mechanisms for biodiversity conservation in order to fill this gap. Consideration of additional financing to cover these unmet needs for biodiversity conservation covers three major areas:

- Improved financial management and revenue-generation by **government biodiversity agencies**;
- **Private sector and NGO** financing of biodiversity conservation;
- **Global** funding mechanisms and financial transfers.

Increasing biodiversity revenues

The Division of Environment and the Marine Parks Authority are the main government agencies responsible for biodiversity conservation in the Seychelles. Both have a limited revenue base, and largely depend on budget

allocations from central government. Budget allocations are not related to their earnings. They are also not linked to the role of biodiversity in the wider economy. For example both fisheries and tourism sectors, which depend on biodiversity and on marine and terrestrial environmental quality, generate high revenues but return no proportion of these to the Division of Environment or Marine Parks Authority. Other means of raising revenues for biodiversity conservation described above in Section 6.3 – including budgetary instruments such as taxes and levies imposed on biodiversity depleting, polluting or dependent goods and industries as well as extra-budgetary funds and trusts – could be expanded. For the case of the Division of Environment, all revenues (currently comprised mainly of forestry earnings) flow directly to central Treasury. Increasing financial autonomy at the same time as expanding the revenue base of government biodiversity agencies, could generate more funds for biodiversity conservation (Republic of Seychelles 1995a).

Although biodiversity enterprise can generate substantial income, government-managed species and areas currently yield low financial returns and much of the value of biodiversity remains uncaptured. Few protected areas incorporate commercial concerns or business management into their operation. Aside from park entry fees and limited forest revenues, government biodiversity agencies generate few earnings. There is scope for increasing the income-earning base of both the Division of Environment and Marine Parks Authority. The major potential for increased revenue generation lies in the tourism sector. Although there may be limited room for increasing existing entry fees for marine parks, charges could be instituted in government-managed biodiversity areas which are visited by tourists but currently charge no fees. Within protected areas the range of tourism activities could be expanded (for example to trails, nature walks, guided tours and visitor interpretation centres) and increased revenue could also be generated through developing enterprises such as shops, restaurants, and other retail outlets. For plant and animal species which have a high market value, including Giant Tortoises, palm hearts and birds eggs, commercial farming or captive breeding may be viable income-generating enterprises. Many of these activities could be developed in collaboration with the private sector, discussed below.

Private sector investment

Biodiversity conservation is largely seen as the monopoly of government, there are few opportunities or incentives for the private sector to become involved. A greater role for the private sector, including sponsorship as well as direct involvement in enterprise, could undoubtedly enhance revenues generated from government protected areas. Permitting private sector commercial management of biodiversity, including conservancies, captive breeding and private reserves, could also increase the area under protection.

There is already an environmental trust fund in the Seychelles which includes tax deductible contributions from the private sector. Private sector investment in biodiversity conservation could be further increased through additional mechanisms such as endowments and foundations. Providing direct incentives for private sector involvement in biodiversity conservation, through tax relief, profit-sharing and joint venture enterprises could generate increased revenues for government at the same time as spreading the financial cost of biodiversity conservation.

Global financial transfers

Although there are multiple domestic economic benefits, many of the benefits of Seychelles biodiversity accrue globally, especially ecological, scientific, option and existence values. This presents a strong justification for a proportion of the costs of conserving Seychelles biodiversity being borne by the global community. Financial transfers both act as incentives for the Seychelles to co-operate in preserving global biodiversity benefits as well as compensating for foregoing economic activities and technologies which are inconsistent with biodiversity conservation.

The global donor community already provides a range of financial support to the Seychelles, some of which is targeted to biodiversity conservation. These sources of financing could be increased still further, especially to meet currently unmet needs for biodiversity conservation. In addition to existing financial transfers such as grants, loans and technical assistance, more innovative funding mechanisms could be made available, including trust funds, technology transfer and direct investment in biodiversity conservation.

FURTHER BIODIVERSITY AND ECONOMICS NEEDS

There is a dearth of environmental economics information in the Seychelles, including basic data about the value of biological resources and ecological services, and the impacts of their loss or degradation on other economic activities. Such data could provide important information for national and sectoral economic planning as well as strengthening the economic case for biodiversity conservation.

Economic and environmental planning are in general poorly integrated. Increasing the information base on environment-economy linkages and linking economic planning tools with environmental management would undoubtedly improve national biodiversity conservation strategies in the Seychelles.

A priority activity is to **strengthen institutional capacity to integrate biodiversity and economic concerns within the context of national conservation and economic planning**. Although environmental and economic planning activities are combined within a single agency, the Ministry of Foreign Affairs, Planning and Environment, economists have little role in conservation planning, and similarly environment has little role in national economic policy and development planning. There are no economists within the Division of Environment and little capacity to carry out environmental economics exists in the Ministry of Foreign Affairs, Planning and Environment. An environmental economics awareness creation workshop has been proposed for senior policy-makers and planners. It is strongly recommended that this workshop should take place, and followed up with targeted training in environmental economics techniques for key economists and biologists within the Ministry of Foreign Affairs, Planning and Environment.

Integrating biodiversity and economics in turn requires a **range of basic environmental economic information** which can be incorporated both into sectoral and national economic planning as well as forming a part of biodiversity conservation activities. At the most basic level, this information includes:

- **Assessment of economic aspects of biodiversity utilisation and services.**
  Aside from tourism and fisheries, little is currently known about biodiversity-related activities in the Seychelles. Information is scarce on the volumes of biological resources used, value of production and marketing for fruit bats, marine products and other wild plants and animals which are both legitimately harvested as well as illegally used. Similarly, the economic benefits of the ecological services provided by biological resources, including forests, reefs and wetlands are largely unquantified.

  Until the volume, value and distribution of income from these activities is known it will be difficult to identify threats to biodiversity, to recommend strategies for halting unsustainable utilisation or to recognise the wider role of biodiversity in sectoral and national income, employment and development.

  An exercise to identify, and where possible quantify, these benefits would provide valuable information as to the likely sustainability of biodiversity exploitation, its contribution to income and employment, and the necessary conditions for replacing unsustainable biodiversity utilisation with alternative economic activities.

- **Assessment of improved funding and incentives for biodiversity conservation.** There are insufficient funds available for biodiversity conservation in the Seychelles as well as poor incentives for Seychellois to conserve biodiversity in the course of their economic activity. In order to provide a sound economic and financial base for biodiversity conservation, as well as to increase the attractiveness of biodiversity conservation for private actors and non-environmental government ministries, a range of assessments and pilot activities could provide models and recommendations for future conservation activities, including:

  - The economics of sustainable utilisation, captive breeding and value-added biodiversity activities;
  - Business planning of protected areas;
  - Analysis of economic instruments for biodiversity conservation;
  - Mechanisms for private investment in biodiversity conservation.

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ANNEX: DATA TABLES

Biodiversity values in the national economy

Table 17: The role of biodiversity in national income 1995

Item	R million	% GDP
Forestry	1.8	0.1
Fisheries	44.0	1.8
Tourism-related	317.3	13
Total	**363.1**	**14.9**
Total GDP	**2 440.4**	**100.0**

From Republic of Seychelles 1996a

Table 18: The role of biodiversity in export earnings 1995

Item	R '000
Fresh and frozen fish	10 140
Canned tuna	87 993
Sharks' fins	2 896
Prawns	6 889
Buttons[1]	479
Coconuts	1
Copra	335
Coconut oil	1
Total	**3839**
Total exports	**113 889**

From Republic of Seychelles 1996a; [1] Wood, mother of pearl and shell

Table 19: Employment in tourism and fisheries industries 1995

		No. employees
Fisheries		
Artisanal fishermen[1]		1 200
SFA staff[2]		95
Industrial vessels workers[2]		80
Port fisheries workers[2]		350
Tuna cannery workers[1]		935
Animal feeds factory workers[1]		60
Prawn farm workers[1]		89
	Total	**1810**
Forestry[3]		**350**
Tourism		
Hotels and restaurants[4]		1 866
Tourism-related transport and communications[5]		1 123
	Total	**2 989**
	Total	**6 148**
	Total employees[4]	**25 761**

Note: using average national wage (from Republic of Seychelles 199a); [1] From MFAPE 1997; [2] From Payet *et al* 1997; [3] From Republic of Seychelles 1996d; [4] From Republic of Seychelles 1996a, 50% of total employment assumed to be tourism-related; [5] From Republic of Seychelles 1996a

Prices of biological resources

Table 20: Retail plant and animal products prices 1996

	Price
Dried and trimmed shark fin[1]	R 263/kg
Sales to government of coco-de-mer [2]	R 30/nut asymmetrical R 70/nut symmetrical
Government sales of coco-de-mer[3]	R 400/nut
Retail price coco-de-mer[4]	R 600/nut
Sooty tern eggs[6]	R 1/egg
Live giant tortoises[7]	R 3 500/tortoise
Government price palm hearts[8]	R 100/palm heart
Retail price palm hearts[9]	R 40/palm heart
Fish traps[10]	R 100/trap
Fruit bats[11]	R 15-25/bat

[1] From Republic of Seychelles 1995b; [2] From DoE 1997 figures; [3] From DoE 1997 figures; [4] From Shah *pers comm*; [6] From Shah *pers comm*; [7] From Shah *pers comm*; [8] From DoE 1997 figures; [9] DoE *pers comm*; [10] From DoE 1997 figures; [11] From Uzice 1997

Table 21: Timber prices 1996

	Government price (R/m^3 round log)	Thickness (mm)	Width (mm)	Market price (R/sawn metre)
Grade A	1 000			
Mahogany		50	250	60
Bois noire		50	250	60
Sandragon		50	300	75
Jak				
Grade B	625			
Calice de pape		50	175	21
Takamaka		50	200	27
Lilas		50	300	54
Pomme		50	200	39
Grade C	455			
Badamier		50	200	27
Santol		50	200	21
Bois de table		50	200	24
Casuarina				
Agati				
Breadfruit				
Eucalyptus				
Bois jaune				
Grade D	95			
Albizia		50	300	12

From DoE 1997 figures

Table 22: Retail fish prices 1997

	Fresh price (R/kg)
Carangue	10.50
Becune	15.00
Bonito	27.00
Bourgeois	21.00
Capitaine	15.50
Cordonnier	15.00
Crabs	16.00
Job	16.75
Maconde	21.00
Macquereau Doux	10.00
Octopus	16.00
Other Macquereau	10.00
Other Pelagic	9.00
Other Trap	15.00
Other Vielle	17.86
Others	12.00
Red Snapper	21.00
Shark and Ray	10.25

From Oceana 1997 figures

Biological resource use

Table 23: Volumes of biological resource use

Industrial fisheries catch[1] (tonnes)	
Purse seiners	305 717
Longliners	1 415
Artisanal fisheries catch[2] (tonnes)	4 314
Shark fisheries	
Dried and trimmed shark fins[3] (tonnes)	11
Sharks[4] (no.)	7 500
Tuna production[5]	
Canned tuna (containers)	647
Tuna loins (containers)	804
Fish exports (tonnes)[6]	370
Prawn production (tonnes)[7]	174
Timber (m^3 round logs)[8]	1 431
Timber (m sawn timber)[8]	53 209
Palm hearts (no.)[9]	5 000
Sooty terns eggs (no.)[10]	852 471
Fruit bats (no.)[11]	5 900
Giant tortoise live export (no.)[12]	300

[1] From SFA 1995, Western Indian Ocean area; [2] From Republic of Seychelles 1995b; [3] Weight from Republic of Seychelles 199; [4] Weight of dried fin to wet shark from ENVI.R.O. 1994; [5] From Swedmar 1994; [6] From Payet *et al* 1997; [7] From Moustache 1997; [8] From DoE 1997 figures; [9] From DoE 1997 *pers comm*; [10] From Collie 1992; [11] From Uzice 1997; [12] DoE CITES certificates 1994

Table 24: Timber volumes and revenues 1996

	No trees	Round log volume (m^3)	Sawn timber volume (m)[1]	Round log income (R)	Sawn timber income (R)[2]
Albizia	85	208.9	5 570.5	19 845	314 382
Agathi	17	31.8	1 271.8	14 467	16 057
Sandragon	43	67.1	1 790.6	67 147	67 147
Takamaka*	96	115.6	4 625.0	72 266	52 609
Santol	93	82.6	3 303.2	37 574	31 793
Breadfruit	181	239.6	9 583.5	109 013	120 992
Calice du pape	1 110	276.7	12 649.8	172 946	92 699
Bois noire	56	60.3	1 929.2	60 288	55 465
Jackfruit	30	33.2	1 061.9	33 184	37 962
Badamier*	31	50.3	2 011.3	22 879	31 427
Casuarina[*]	94	49.5	1 981.2	22 537	25 013
Eucalyptus	20	30.7	1 228.9	19 202	17 666
Bois jaune	33	12.8	510.1	5 802	6 440
Pomme gouv.	8	6.9	276.4	4 318	6 460
Bois de table*	13	25.0	999.5	11 370	12 619
Bois blanche	6	6.7	269.6	3 067	3 404
Lilas	11	21.8	582.4	13 650	17 800
Mahogany*[3]	223	111.4	3 564.3	111 385	102 474
Total	**2 150**	**1 431.0**	**53 209.3**	**800 938**	**1 012 410**

From DoE 1997 figures; * Indigenous species; [1] Conversion rate of 40% (from INDUFOR 1993); [2] Less round log purchase; [3] From State forests

Table 25: Artisanal fisheries catches and revenues 1996

	Catch (tonnes)	Income (R mill)
Carangue	1 284	13.5
Becune	163	2.4
Bonito	100	2.7
Bourgeois	358	7.5
Capitaine	294	4.6
Cordonnier	293	4.4
Crabs	9	0.1
Job	572	9.6
Maconde	71	1.5
Macquereau Doux	322	3.2
Octopus	20	0.3
Other Macquereau	205	2.1
Other Pelagic	42	0.4
Other Trap	123	1.8
Other Vielle	93	1.7
Others	66	0.8
Red Snapper	183	3.8
Shark and Ray	116	1.2
Total	**4 314**	**61.6**

Volumes from Republic of Seychelles 1996a, prices from Oceana 1997 figures

Table 26: Visitors and revenues for Ste. Anne Marine Park, 1996

	Visitors	Revenues (R)
Jan	2 810	70 250
Feb	2 245	56 125
Mar	2 222	55 550
Apr	5 202	130 050
May	2 100	52 500
Jun	2 200	55 000
Jul	3 050	76 250
Aug	2 430	60 750
Sep	373	9 325
Oct	3 567	89 175
Nov	2 460	61 500
Dec	1 212	30 300
Total	**29 871**	**746 775**

From DoE 1997 figures

Table 27: Visitors and revenues for Curieuse Marine Park, 1996

	Visitors	Revenues (R)
Jan	675	33 750
Feb	482	24 100
Mar	942	47 100
Apr	1 282	64 100
May	786	39 300
Jun	631	31 550
Jul	1 142	57 100
Aug	860	43 000
Sep	750	37 500
Oct	908	45 400
Nov	908	45 400
Dec	766	38 300
Total	**10 132**	**506 600**

From DoE 1997 figures. Some tickets bought at discount, so number of visitors underestimated

Table 28: Forest produce revenues 1996

	Praslin (R)	Mahe (R)
Jan	17 066	30 593
Feb	26 895	33 746
Mar	24 332	32 296
Apr	27 717	62 725
May	12 348	63 073
Jun	22 683	16 744
Jul	35 646	33 340
Aug	12 752	26 457
Sep	4 868	35 432
Oct	11 774	18 439
Nov	19 881	22 497
Dec	13 558	26 912
Total	**229 520**	**402 254**

From DoE 1997 figures

Table 29: Tree felling revenues 1996

	La Digue (R)	Mahé (R)	Praslin (R)
Jan	250	1 450	600
Feb	250	2 150	450
Mar	650	250	1 050
Apr	400	3 100	1 650
May	450	2 200	500
Jun	200	1 150	550
Jul	450	1 900	1 200
Aug	150	2 050	300
Sep	50	1 800	550
Oct	750	1 050	700
Nov	150	1 400	550
Dec	150	500	700
Total	**3 900**	**19 000**	**8 800**

From DoE 1997 figures

Table 30: Coco-de-mer collections, Fond B'Offay 1996

	Shaped no.	Mis-shaped no.	Total no.
Jan	23	-	23
Feb	67	-	67
Mar	61	-	61
Apr	46	-	46
May	25	64	89
Jun	54	6	60
Jul	55	16	71
Aug	12	4	16
Sep	-	-	-
Oct	23	-	23
Nov	26	-	26
Dec	23	-	23
Total	**415**	**90**	**505**

From DoE 1997 figures

Table 31: Coco-de-mer collections, TCU/Mahé 1996

	Shaped no.	Mis-shaped no.	Total no.
Jan	32	8	40
Feb	53	10	63
Mar	37	10	47
Apr	15	-	15
May	74	37	111
Jun	9	6	15
Jul	31	12	43
Aug	8	4	12
Sep	6	6	12
Oct	46	7	53
Nov	12	-	12
Dec	39	39	78
Total	**362**	**139**	**501**

From DoE 1997 figures

Table 32: Visitors and revenues for Aride Island 1994/5

	Non-cruise visitors	Cruise visitors	Total visitors	Revenues (R)
Oct	199	-	199	9 950
Nov	130	72	202	10 100
Dec	85	155	240	12 000
Jan	151	386	537	26 850
Feb	95	441	536	26 800
Mar	144	432	576	28 800
Apr	215	80	295	14 750
May	162	-	162	8 100
Jun	72	-	72	3 600
Jul	129	-	129	6 450
Aug	44	-	44	2 200
Sep	69	-	69	3 450
Total	**1 495**	**1 566**	**3 061**	**153 050**

From Carty and Carty 1996

Table 33: Visitors to Vallée de Mai 1996

	Individuals	Group	Resident	Total
Jan	2 204	2 834	12	5 050
Feb	2 238	2 790	10	5 038
Mar	2 414	3 773	13	6 200
Apr	2 224	3 345	32	5 601
May	1 844	2 192	20	4 056
Jun	1 457	1 649	10	3 116
Jul	1 771	1 793	17	3 581
Aug	3 128	2 347	19	5 494
Sep	2 223	2 300	5	4 528
Oct	2 361	2 422	29	4 812
Nov	2 215	2 974	23	5 212
Total	**24 079**	**28 419**	**190**	**52 688**

From SIF records, Note: December figures unavailable

Table 34: Vallée de Mai revenues 1996

	R
Visitor revenues	1 056 889
Coco-de-mer	62 463
Rent	14 000
Total	**1 133 352**

From SIF records

Table 35: Aldabra revenues 1996

	R
Film rights	7 775
Landing fees	247 964
First day cover	8 950
Accommodation	2 000
Shop	79 276
Exchange	70
Interest	15 169
Sale of focus	11 900
Sale of books	91 762
Airport collections	4 029
Total	**468 895**

From SIF records

Expenditure on biodiversity conservation

Table 36: Government project expenditure on biodiversity 1996

	R '000[1]	R '000 total
Agriculture and Marine Resources		**1036**
Animal and plant quarantine	150	
Coconut replanting	1 000	
Fish inspection laboratory	885	
Industry		**433**
SBS laboratory	433	
Community Development		**2 902**
Ancillary works East Coast	1 750	
Maritime boundary delimitation	785	
Coastal erosion	250	
District land use plans	117	
Public Utilities Corporation		**85 000**
Solid waste treatment plant	35 333	
Greater Victoria sewerage project	49 667	
Foreign Affairs, Planning and Environment		**5 517**
Coastal environmental management	414	
Environmental equipment	2 400	
Biodiversity and national parks	1 450	
Protection of endangered sea turtle	485	
Integrated biodiversity, marine and coastal centre	67	
Rehabilitation of Curieuse National Park	175	
Increase of information on environment	335	
Environmental legislation	119	
Environmental guidelines	72	
Total	**5188**	**982**

[1] From Republic of Seychelles 1996b, average annual cost of project over PSIP period, includes foreign loans to government

Table 37: Government recurrent expenditure on biodiversity conservation 1996

	R	R total
Marine Park Authority[1]		**868 673**
Fuel, Ste. Anne	33 843	
Fuel, Curieuse	83 683	
Boat repair	15 195	
Airfares	406	
Diving equipment	535	
Subsistence allowances	8 662	
Electricity	10 291	
Water	8 523	
Telephone	4 287	
Salaries	703 248	
Division of Environment[2]		**11 698 500**
Staff costs and insurance	7 694 209	
Office running costs	1 406 016	
Transport and communications	1 124 085	
Fuel and vehicles	643 853	
Equipment	74 677	
Other consumables	304 885	
Repairs and maintenance	126 996	
Publications and advertisements	39 400	
Miscellaneous	284 379	
Total		**12 567 173**

[1] From DoE figures 1996; [2] From DoE figures 1995, less Marine Parks expenditure

Table 38: Expenditure on biodiversity conservation by Seychelles Island Foundation 1996

Agency	Activity	R	R total
Seychelles Island Foundation	**Vallée de Mai**[1]		**214 172**
	Staff expenses	175 016	
	Repairs and maintenance	6 581	
	Travel and fuel	6 027	
	Cleaning and refuse collection	4 038	
	Stationery and advertisements	21 281	
	Miscellaneous	1 229	
Seychelles Island Foundation	**Aldabra**[1]		**945 141**
	Staff expenses	268 250	
	Repairs and maintenance	100 180	
	Travel and fuel	113 896	
	Shop and book purchases	135 021	
	Royalties	1 740	
	Miscellaneous	326 054	

[1] From SIF records

Table 39: Donor biodiversity projects 1996

	Annual cost (R'000)
Alternatives to reduce sand in construction[1]	330
Biodiversity and national parks[2]	500
Coastal and plateau fisheries management plan[2]	83
Coastal environmental management[2]	1 656
Coastal fisheries development project[2]	8 000
Conservation strategy and national parks management plans[1]	400
Contingency plan for marine pollution[2]	927
Environmental assessment procedures[1]	80
Environmental legislation[2]	476
Forest fire contingency plan[1]	480
Improvement of national marine parks[1]	200
Integrated biodiversity, marine and coastal centre[2]	1 283
La Digue Solid Waste[2]	300
Le Niol treatment works[2]	3 567
MARPOL[1]	440
Medicinal and aromatic plants[2]	200
National forest management plan[2]	73
Pollution monitoring, control and advisory service[1]	340
Protection of endangered sea turtle[2]	1 012
Rehabilitation of Curieuse National Park[2]	753
Restoration and preservation of Aldabra[2]	693
Review of coastal zone management plans[1]	320
State of environment report[2]	52
Upgrading national botanical garden[1]	350
Wildlife inventories and protection of species[2]	1 315
Total	**8845**

[1] From COI, average annual cost of project; [2] From Republic of Seychelles 1996b, average annual cost of project over PSIP period

Table 40: Identified but not yet implemented biodiversity projects

	Annual cost (R'000)
Annual sustainable development audits	130
Anse aux Pins-Anse Royale sewerage project	1 167
Anse Volbert sewerage project	4 300
Beau Vallon Bay sewerage project	9 160
Control of pesticides	213
Control of toxic or potentially hazardous chemicals	103
Control on import and export of plants and animals	104
Control programme for offshore drilling	210
Disposal of sludge from Victoria power station	60
Expand environmental education	660
Expand environmental training	420
Feasibility study on introduction of lead-free gas	60
Greater Victoria sewerage projects	11 667
Impact assessment of climate warming and sea level rise	65
Improvement of vehicle tests and testing facility	750
Marine resource management plans	455
Roche Caiman sewerage project	2 250
Set standards for air and water quality and noise pollution	46
Total	**4847**

From Republic of Seychelles 1990b, average annual cost of project

Urban, shipping and industrial wastes, effluents and pollution

Table 41: Current and predicted ship and industrial wastes from Mahé

	(tonnes)	
	1993	**2005**
Ship generated waste		
Spent lubricating oil	900	900
Bilges	1 100	1 400
Oily sludge	350	460
Sewage	18 790	19 514
Garbage	1 299	1 498
Fish waste	81	75
Total	**2459**	**2793**
Land generated waste		
Lubricating oil	540	675
Other oily waste	25	25
Green waste	3 100	3 100
Abattoirs and fish waste	215	215
Cannery oily waste	85	
Electric plant and paint waste	25	25
Inert waste	4 654	5 900
Total	**993**	**1043**
Total ship and land		

From Tebodin 1994

	(tonnes)	
	1994	**2016**
Industrial and bulky waste	3 500	4 000
Yard waste and seaweed	2 500	3 000
Port solid waste	1 300	1 700
Tuna cannery and fish waste	400	400
Hazardous waste	1 500	3 000
Waste oil	1 200	1 700
Scrap	1 500	2 000
Total		

From ITW 1995

Table 42: Waste generated by selected industrial establishments

	Commercial (tonnes)	**Packaging (tonnes)**	**Other (tonnes)**	**Oil (tonnes)**	**Hazardous (tonnes)**	**Wastewater (m3'000)**
Conserveries de l'Ocean Indien	550			3 713		138
Seybrew	250	20	275			120
Seychelles International Airport	100	1000		3		
Port Services	1 040		180	1 000	760	

From ITW 1995

Table 43: Current and predicted volume of domestic and infrastructural wastes generated in Mahé

	(tonnes)	
	1993	**2005**
Domestic waste	6771	7 500
Sewage sludge	440	
Hospital waste	180	180
Total	**9204**	**2512**

From Tebodin 1994

	(tonnes)	
	1994	**2016**
Domestic waste	8 000	11 000
Sewage sludge	1 200	3 400
Hospital waste	200	300
Construction waste	2 700	3 500
Total	**2403**	**2730**

From ITW 1995

Table 44: Water pollution and waste loads generated in Mahé

	(tonnes)				
	BOD_5	**SS**	**Oil**	**N**	**P**
Fisheries industry	97.42	59.44	39.94	3.57	-
Other foods industry	3 393.10	17 345.74	6.20	6 514.77	5 438.63
Manufacturing industry	1.64	2.78	0.19	-	-
Urban settlement and construction	0.54	0.74	-	0.22	0.03
Natural processes	1.25	12.91	-	0.18	0.02
Total	**3 493.95**	**17421.61**	**46.34**	**6 518.73**	**5 438.68**

From Radegonde 1992

Table 45: Solid waste generated in Mahé

	(tonnes)			
	Putrid waste	**Non-hazardous solid waste**	**Non-hazardous sludge**	**Hazardous sludge**
Fisheries industry	476.00	-	-	-
Other foods industry	34 770.76	-	-	-
Manufacturing industry	-	-	-	0.00
Urban settlement and construction	-	16.88	0.46	-
Total	**35 246.76**	**16.88**	**0.46**	**0.00**

From Radegonde 1992

Table 46: Air pollution emissions generated in Mahé

	(kg)				
	Particulates	**SO_2**	**NO_x**	**CO**	**VOC**
Foods industry	50.29	-	-	-	-
Manufacturing industry	4.70	-	10.29	-	-
Energy and transport	22.05	82.23	777.29	4912.93	875.62
Urban settlement and construction	133.66	-	-	-	-
Total	**210.69**	**82.23**	**787.57**	**4 912.93**	**875.62**

From Radegonde 1992

Table 47: Greenhouse gas inventory of the Seychelles

	(GG)						
	CO_2 emissions	**CO_2 removals**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**
Fuel combustion	132.500		0.008	0.002	0.431	3.401	0.400
Industrial processes							
Solvent and other product use	0.011						0.001
Agriculture			0.202	0.075			0.011
Land use change and forestry		834.130					
Waste			2.210				
Other							
International bunkers	357.300		0.001	0.008	8.586	0.264	0.012
Total	**489.811**	**834.130**	**2.421**	**0.085**	**9.017**	**3.665**	**0.424**

From SBS 1997