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STATUS AND TRENDS OF, AND MAJOR THREATS TO, ISLAND BIODIVERSITY

Note by the Executive Secretary

EXECUTIVE SUMMARY

1. One of the tasks given the Ad Hoc Technical Expert Group in decision VII/31 of the Conference of the Parties is to review the status and trends, and major threats to, island biodiversity and to identify island ecosystems characteristics, based on material provided by the Secretariat. The present note contains information intended to facilitate the work of the Expert Group in this respect.

2. At the outset, the paper provides an overview of the main characteristics of island ecosystems. It explains how the extreme fragility of such ecosystems is conducive to a series of evolutionary processes as well as the interplay of a number of different threats and pressures, which have an unsustainable impact on island territories. The note elaborates on the common denominators of island ecosystems, their uniqueness, their high level of specialization and the high susceptibility to natural and human-related hazards. The geographical circumstances and their distance from the mainland are identified as the root causes of unique evolutionary dynamics, which have made island biota particularly fragile.

3. The document also elaborates on the principal causes of habitat loss and pressures on island ecosystems. As a result of the interaction and the cumulative effects of these pressures, a significant number of plant and animal species are threatened with extinction or have become extinct. One of the first impacts experienced by islands, which has now become a chronic problem of islands, is the spread of invasive alien species. The phenomenon is most probably the primary cause of extinction in island ecosystems. Islands are indeed more susceptible than mainland areas to invaders, as species populations tend to be small, localized, highly specialized and tend not to have developed defence mechanisms against a broad range of predators or competitors.

4. The introduction of invasive alien species is also facilitated by economic growth, and the expansion of the tourism sector in particular, another increasing stress imposed on biodiversity and the natural environment. Growth has generally taken place with little emphasis on urban planning, resulting in patterns of disorganized spatial development. Tourists have added pressure on energy, fuel demands

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for imported food and raw material and have contributed to solid waste, clogged drainage, roads and telephone lines, and are party to polluted air and beaches. Although considered one of the major direct and indirect threats to island biodiversity, tourism is also being recognized has having a high potential for biodiversity conservation and sustainable use, given its dependency on, and therefore its need to preserve, the natural environment.

5. Small islands are also particularly vulnerable to the effects of climate change and climate variability, since they have no or little control over the underlying causes of the phenomenon. Most small islands are low-lying, and have a larger exposure of coasts in relation to land mass, as well as a high concentration of population in coastal zones. They are therefore extremely susceptible to sea-level rise. Areas under most threats have been identified as marine ecosystems, coastal systems, tourism assets, human settlements and infrastructures. Sea-level rise will cause loss of coastal systems due to inundation; increased salinity due to encroachment of the sea and salt water intrusion into freshwater lenses; increased pressures on forest reserves and migration or loss of wildlife species.

6. Linked to the aforementioned phenomena are natural and environmental disasters. Of the 25 most disaster-prone countries, 13 are small island developing States. As many of their economies are still subsistence-based, many island populations are dependent on local biological and other natural resources for survival and have a limited capacity to respond and recover from disasters. It should also be noted that the traditional resilience of island communities to natural disasters is under threat from unsustainable practices and various economic and social pressures. The quick recovery of ecosystems can no longer be assured: poor farming and logging practices are creating massive erosion during storms; over-harvesting of coastal fish and invertebrates remove important sources of nutrients from coral reefs and sewage from urban areas have destabilized near-shore coral communities making these vital ecosystems less able to withstand and recover from the waves and rain of hurricanes.

7. Over-exploitation of resources is a major cause of biodiversity not only when natural events occur. Over-fishing is a major cause of coral reef degradation in many islands. Hunting is also a threat to some species. Unsustainable harvesting, overgrazing by livestock and the use of destructive practices, as well as unsustainable mining, are all unsustainable uses of biodiversity in small islands. Pollution and waste disposal have also impacted on sound conservation and management of biodiversity. The effects of the pollution and waste are such that emissions or uncontrolled disposal eventually end up in the water courses and in the coastal and marine environment.

8. The pressure and threats to the conservation and sustainable use of biodiversity in islands are often exacerbated by the lack of public awareness and appreciation by decision makers of environmental issues, a lack of knowledge of the current status of biodiversity, a lack of capacity especially in terms of the paucity of trained staff and resources to deal with environmental problems and the poor interaction of environment and development in decision making. A serious constraint to the development of effective management strategies is also the taxonomic data deficiency on island biodiversity and the lack of consolidation of the biodiversity information that does exist.

9. The note subsequently explores the status and trends of a series of biomes present on islands. For each biome described, the note provides information on ecosystem services offered, the status of health or degradation of the ecosystem, a short reference to the causes of change and information on developments in the management and restoration of the ecosystems under consideration.

10. Marine and coastal areas are identified as key ecosystems for islands, given their functions and services provided, and as important source of income. The continental shelves and costal ecosystems of many small island developing States are of major economic significance for settlement, subsistence and commercial agriculture, fisheries and tourism. Coastal ecosystems are also considered essential for their many ecological roles played, ranging from shorelines protections to buffer zones from land-based activities and pollution, to feeding, breeding and nursery grounds to many marine species. Therefore, habitat destruction, alteration and coastal degradation, given islands characteristics and their limitations, have serious repercussions on the ecological, social and economic well being of insular regions.

Dramatic changes have been experienced in most coastal areas and coral reefs of islands worldwide, threatening not only the ecosystems but also the livelihood of island people.

11. In addition to the degradation of marine and coastal environments, islanders face another threat that can seriously compromise the ecological balance and the socio-economic security of their territories: the unavailability of freshwater. In most SIDS, wetlands, in the form of swamps and mires, are small in extent and often ephemeral. In general, small islands depend heavily on groundwater resources which typically exist as freshwater lenses, containing limited quantity of water. Given the pressure imposed by fast growing developments in such small territories, island water ecosystems are critical for their functioning and services provided. Indeed, freshwaters and associated habitats have a series of essential functions, as they provide for freshwater fish production, provide breeding grounds for large number of waterfowl and supply freshwater for different human activities. The increased pressure for land development continues to have a negative impact on wetlands, which have to supply larger populations, developing industries and tourism activities.

12. Strictly associated with inland water ecosystems are forests, as the latter are critical regulators of freshwater supply. Although forest cover of small islands may be insignificant in global terms, forest resources are of global importance for the conservation of biodiversity and the loss of forest in SIDS may have serious impacts due to intensified interactions within a limited geographical space and the loss of endemic species and rare ecosystems. Also, forests and trees contribute directly to food security through the provision of edible forest products. Forest cover, by preventing erosion, is also important for the health of the marine environment and freshwater. The average deforestation rate remains high in many SIDS and this phenomenon, combined in some cases with an arid climate and steep terrain, has often resulted in widespread desertification and soil erosion.

13. Severe pressure imposed by expanding housing, industry, tourism and other economic activities affecting marine and coastal, inland and forest ecosystems also impact on agricultural ecosystems. In general, primary production in SIDS is an important source of export earnings, although much of agricultural activity is of subsistence type. Agricultural production in many SIDS has been a primary occupation for hundreds of years, although intensification and diversification is now constrained by ecological and economic circumstances, such as poor soils, a limited capacity to support intensive crops and animal production, difficult product storage. Soil fertility has also declined in many islands, and a common trend in SIDS is the decline in land under arable use and a simultaneous increase in the area of land under urban development. In general, SIDS are responding to the degradation of island environments with initiatives trying to diversify agricultural production and move towards more marketable crops, also in order to increase their degree of food security and self-reliance.

14. In the present note the importance of biodiversity conservation and sustainable use for the sustainable livelihoods and food security of islanders is often reiterated. In addition to self-reliance, island biodiversity is of significance at the global scale. In fact, many of the insular systems coincide with the sites of highest priority "hot spots". The importance of protected areas is therefore of paramount importance in island settings. In this regard, it is possible to register some positive trends in the establishment of protected areas in small islands, with an increase of 900 per cent in the number of protected areas created over the last ten years. It is also important to note the different shift of priorities in the establishment of different categories of protected areas, as now more attention is given to the establishment of Managed Resource Protected Areas, which allow for the multiple use of natural resources within those areas.

15. Another important aspect of island biodiversity is the emphasis given to the conservation driven approach of traditional cultures. Although deterioration of such systems and knowledge is occurring as a result of westernisation, industrialization, urbanization and alienation of new generations from their traditions, in many SIDS traditional practices have been rediscovered and adapted to current needs. Indeed, islanders have increasingly realized that conventional approaches to biological resources management have not been effective in promoting sustainable resources utilization. As a result, innovative approaches to management that build on traditional institutions and conservation and management knowledge and practices are considered more appropriate.

16. The paper concludes that the extreme fragility and increasing threat to island biodiversity is due to the interplay of factors described throughout the document and stressed how in SIDS this fragility is further exacerbated by their economic vulnerabilities, with limited financial capacity to protect high value biodiversity. Thus, the situation presents a special challenge for the sustainable financing of biodiversity conservation.

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I. INTRODUCTION

1. The main mandate of the Ad Hoc Technical Expert Group on Island Biodiversity, as described in the annex to decision VII/31 of the Conference of the Parties to the Convention on Biological Diversity, is to develop proposals for a programme of work on island biological diversity incorporating priority actions to enhance conservation of island biodiversity, sustainable use of its components and the fair and equitable sharing of benefits from the utilization of genetic resources from islands.

2. In carrying out its work, the Group was requested, among other tasks, to draw on material provided by the Secretariat which reviews, *inter alia*, the status and trends of, and major threats to, island biological diversity, and identifies the specific characteristics of island biodiversity. The present note is intended to facilitate the task of the Group in this respect.

3. Section II provides a snapshot of island ecosystems, from a historical perspective. Section III describes the main pressures, including current human activities that exert negative effects on island biota. Section IV contains an overview of the status and trends of biodiversity in the thematic areas considered by the Convention. The status and trends of protected areas are also considered. The conclusion section summarizes the main characteristics of island biodiversity highlighting its uniqueness and fragility.

4. The information contained in the present note was derived from the second national reports submitted, in the framework of the Convention, by small island developing States in 2000 and 2001, 1/ the scientific literature, other relevant United Nations publications, and the outcomes of the island biodiversity electronic forum 2/ organized in March and April 2004.

II. A HISTORICAL PERSPECTIVE ON THE STATUS OF ISLAND BIOLOGICAL DIVERSITY

5. Islands may be classified into those located in oceans and non-marine isolated habitats within land masses. Both types are isolated ecosystems and as such can share some features resulting from their remoteness from other ecosystems. The present note will consider only islands surrounded by saltwater.

6. Islands located within seas can be categorized in many ways, for example by their size into small and large islands; by their altitude into high and low-lying islands; by a combination of the size of the land area, and political and demographic criteria to identify small island developing States; or as continental (land areas that used to be connected to the mainland) or oceanic (those that rose from the sea as a result of coral deposits, volcanic activity or tectonic forces) islands.

7. The particular biogeographical circumstances of each island create a specific ecosystem, with its own evolutionary dynamics. In the case of continental islands, evolution works via a long-term process of biota reduction: a progressive loss of species (extinction), which is bound to occur irrespective of the impact of humankind. In the case of oceanic islands, evolution works via a long-term process of biota addition: a progressive accretion of new species coming in from the outside, starting from nothing (Quammen, 1996 cited by Baldacchino, 2004). In general, oceanic islands tend to have smaller founder populations, and thus less evolutionary potential than species on continental islands. Oceanic islands typically have faunas that are ecologically and taxonomically unbalanced. Colonization of these islands is by some form of over-water dispersal. Continental islands generally have a more complete and balanced fauna that fills the available habitats and closely resembles that of the adjacent mainland portion

1/ Reports were received from: Antigua and Barbuda, the Bahamas, Barbados, Cape Verde, Comoros, Cuba, Dominica, Dominican Republic, Fiji, Grenada, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshal Islands, Federated States of Micronesia, Niue, St. Lucia, Samoa, Seychelles, Trinidad and Tobago and Vanuatu. The reports are available at: http://www.biodiv.org/world/reports.aspx

2/ The Forum gathered comments and information from different stakeholders interested in the development of the programme of work on island biodiversity, including information on the status and trends of, and major threats to, island biodiversity; case studies; information on the implementation of CBD provisions in island ecosystems; and proposals for the programme of work on island biodiversity.

of the continent (Gibsons, 1990). In both cases, differentiation then occurs as a consequence of relative isolation and biota specialization. However, also in both cases, reduction and vulnerability of both the number and variety of species is accentuated with the impact of human activities (Baldacchino, 2004).

8. The size, distance and period of isolation of islands from large land-masses has resulted in high levels of specialization with associated high endemism and the occurrence of unusual phenomena, such as gigantism, flightlessness, mutualistic association 3/ and plant dioecy 4/ (Dullo *et al.*, 2002). Indeed, the presence of the marine environment and physical distance between the mainland and islands limit the number and taxa of organisms that can naturally reach and colonize islands. As a result, island territories tend to have a rich variety of invertebrate fauna and large populations of birds as compared to large mammals.

9. Island ecosystems also present restricted genetic diversity, reduced competitive ability due to the repeated "founder effects'"5/ and narrow ranges prior to human colonization compared to continental areas (Dullo *et al.*, 2002). Populations tend to be quite small in proportion to the size of most island territories, and species often become concentrated in specific small areas. The greatest evidence of this phenomenon is the fact that many of the areas with large quantities of endangered endemic species are found in islands (INSULA, 2001). It has been often remarked how, in global terms, for a variety of taxa, islands make a contribution to biodiversity out of proportion to their land area, and in this sense collectively they can be thought of as 'hot spots'. With increasing isolation, island size and topographic variety, the number and proportion of endemics increase. Endemicity within a taxon appears to be at its greatest in regions that are near the edge of the effective dispersal range (Whittaker, 1998).

10. Island species often differ in size from closely related continental species. Small species are often larger, while larger species are often smaller on islands, although these tendencies do not always hold. Traits other than size may also be involved, sufficient to justify classification in separate genera or higher taxa. In some cases, plausible ancestry of endemic insular genera can be postulated from the mainland fauna. In other cases, the origins of an endemic group are unknown. It is generally assumed that the more distinctive a species is, the older it must be. However, the distinctiveness of species on isolated oceanic islands may be a reflection of the degree of isolation rather than the amount of time involved. Without competitors or predators, aberrant individuals might survive and give rise to a new species able to adapt to a different ecological niche. Such species might be expected to be vulnerable to extinction if competitors or predators were to become established in their habitat (Gibson, 1990).

11. Island species evolved in competition with a relatively low number of other species under the influence of natural selective forces peculiar to insular conditions. While this has resulted in the evolution of survival strategies based on interdependency among species and highly specialized mutualistic associations, it has also made island biota more fragile. Compared with organisms found on the mainland, the space-constrained island species are generally less capable of moving elsewhere. Islands tend to have a different balance of species compared to equivalent patches of mainland, and this tendency is more accentuated with increasing isolation (Fisher, 2004).

12. These characteristics, coupled with isolation and endemism, make island ecosystems especially sensitive to disturbances and island species prone to extinction at rates that often exceed those of continental systems. As a matter of fact, islands are places for concentrated extinction. Of the 724 known animal extinctions in the last 400 years, about half were of island species. At least 90 per cent of

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3/ An intimate relationship between two or more organism that is beneficial to all participants.

4/ Plants in which the female and male reproductive organs are separated on different individuals, making cross fertilization obligatory.

5/ Chance easily alters allele frequencies in small populations. If only a few individuals from a population contribute to the next generation, the allele frequency is unlikely to be the same as that in the original population. One important cause of genetic drift is the founder effect. The founder effect occurs when populations are started from a small number of pioneer individuals of an original population. Due to small sample size, the new population could have a much different genetic ratio than the original one. An extreme example would be that which results when a plant population is established by a single seed (http://tidepool.st.usm.edu/crswr/founder.html)

bird species that have become extinct in that period were island-dwellers. Island species are especially prone to extinction as a result of natural evolution and/or human activities because they have a small geographic range. They are limited to the island or a particular part of the island, and they usually have low populations numbers.

13. Nevertheless, due to their isolation from more widespread continental species, islands are ideal places for unique species to evolve. Because of the founder effect, and the availability of new niches, evolution in an island population happens at an accelerated rate. The study of islands has provided evidence that could help answer several important questions such as specialization, methods of dispersal, and past events. By comparing the characteristics of fauna from different types of islands, scientists are improving their understanding of the history of our world (Gibson, 1990). Islands provide a suite of natural laboratories enabling theories of general importance to be developed and tested. Consequently, they can be considered suitable laboratories to test sustainable-development policies and projects.

14. The present note addresses island ecosystems collectively, but it places emphasis on oceanic islands and particularly small island developing States (SIDS) because these systems are often perceived to be the most at risk. As articulated in chapter 17 of Agenda 21 and emphasized in the Barbados Programme of Action as well as in the Plan of Implementation of the World Summit on Sustainable Development, small island developing States experience even more specific challenges and vulnerabilities arising from the interplay of such socio-economic and environmental factors as small populations and economies, weak institutional capacity in both the public and the private sector, remoteness from international markets, susceptibility to natural disasters and climate change (including in particular sea-level rise from global warming and extreme weather events) , fragility of land and marine ecosystems (particularly affected by tourism development and unsustainable agriculture), high cost of transportation, limited diversification in production and exports, dependence on international markets, export concentration, and income volatility and vulnerability to exogenous economic shocks, greater volatility than those of other countries. It is however understood that considerations on SIDS, which are considered the most ecologically vulnerable among islands could be applied to other island ecosystems, which might experience a lower degree of vulnerability.

Box 1: Island endemism

At the global level islands contribute to biodiversity disproportionately to their land area. Although islands constitute 3% of the land surface of the world, one in six of the earth's known plant species occur on oceanic islands (Fisher, 2004). Indeed, the percentage of endemic species is often very high in island ecosystems. Examples include Dominican Republic, Fiji, Haiti and Jamaica, in which more than 30% of the higher plant species are endemic.

In Mauritius, around 50 percent of all higher plants, mammals, birds, reptiles and amphibians are endemic to the island, and the Seychelles has the highest level of amphibian endemism of any island in the world. Over 1,200 species of reef fish, 250 species of thematic corals and 285 species of algae have been identified in the Maldives. In addition, five sub-species of seabirds have been identified as endemic to the Maldives.

The Pacific islands contain the world's highest proportion of endemic species per unit of land area or human inhabitants. With regard to birds, Fiji and the Solomon Islands have 24 and 20% endemism respectively. One third of the mammals in the Solomon Islands and a quarter of those in Fiji are found nowhere else.

Source: UNEP, 2004a, b and c

III. THREATS TO ISLAND BIODIVERSITY

15. Island biodiversity is under pressure from various types of human activities, often amplified by natural disasters. The major direct threats include invasive alien species; tourism development; climate change and variability, and sea-level rise; natural disasters; unsustainable uses; pollution and waste disposal. Underlying factors that create an environment favourable to these direct pressures are important

to consider when long-term strategies for controlling the direct pressures and their impacts on island ecosystems are to be developed and implemented. The loss of genetic resources and species, exemplified by the demise of the Dodo attributed to over-hunting and the introduction of invasive alien species, and the degradation and destruction of habitats and ecosystems, resulting from the impact of these factors are known to undermine the resilience of islands and their ability to withstand or recover from severe disturbances (Briceño, 2004).

A. Invasive alien species

16. Invasive alien species are one of the primary threats to biodiversity on most islands and cause serious ecological and economic damage and high social costs. Some scientists believe that islands are more susceptible than mainland areas to invaders, because their species populations tend to be small, localized, highly specialized and not to have developed defence mechanisms against a broad range of potential predators or competitors (UNEP, 2004a). However, a recent assessment indicates that this appears to be a poorly supported generalization with the exception of some taxa because there are an equal number of reports of the invasion of woody plants from continents and oceanic islands (UNEP/CBD/SBSTTA/9/INF/33). However, there is general agreement that islands are more susceptible to the effects of invaders.

17. Ever since humans first colonized islands, some 3,000 years ago, plants and animals have been introduced for food, medicines, building materials and ornamentation. Some of these deliberate introductions and other species that were introduced accidentally became pests. Examples include pigs, dogs and the Pacific rat (*Rattus exulans*). Following European colonization from the mid nineteenth century onwards, hundreds more species of plants and animals were introduced, often accidentally. Now, there are, on many islands, as many or more introduced flora and higher vertebrates than native species. Many of these alien species have become serious pests (Dullo *et al*., 2002).

18. The risk of the introduction, establishment, and spread of invasive alien species in island systems (as well as other ecosystems) depends on a number of ecological and socio-economic factors that are context-specific and often inter-related, listed in annex I to the information document on the ecological and socio-economic impacts of invasive alien species on island ecosystems circulated at the ninth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) (UNEP/CBD/SBSTTA/9/INF/33), including, *inter alia*, the different pathways of introduction, and the strong influence of an island nation's or territory's trade status. The spread of invasive plants has been hastened by habitat degradation on islands from cyclone damage or agricultural and logging activities (UNEP, 2004c).

19. Ports generally offer great opportunities for the introduction of many alien marine species in ballast water. The demand for exotic pets and the smuggling of such pets, pose particular problems. Similarly, the desire for exotic ornamental plants and the ease with which seeds or cuttings can be smuggled, increase the chances that invasive alien plants will be introduced. In the Bahamas for example, alien plants have been introduced with little control or by accident mainly by gardeners and horticulturists. Several exotic species are now recognized as serious threats to natural ecosystems and to biodiversity. Indeed, many invasive alien species have been intentionally introduced either as ornamental gardens plants or economic agricultural plants. The strawberry guava *Psidium cattleianum* and *Syzygium jamobs* are examples of fruit trees introduced in islands such as Mauritius, Hawaii, Galapagos and Pitcairn where they quickly spread and soon became a severe problem. Other species were introduced with ship cargoes, either intentionally for hunting (e.g. deer) or as food (e.g. goats).

20. The speed of introduction and spread is increasing. On the Galapagos Islands, the number of introduced plants has doubled in 10 years from 240 species to 483, now representing 45 per cent of the total flora. In Hawaii, naturalized species account for about 47 per cent of the flowering plant flora. In Bermuda, naturalized introductions and garden ornamentals comprise more than 90 per cent of the plant biomass. Recent research indicates that on Rodriguez Island (Indian Ocean) alien plants may account for as much as 95 per cent of the total composition of the remnant patches of semi-natural vegetation (Dullo *et al*., 2002).

21. The exact number of invasive alien species found on islands is not known. Estimates indicate that the number can run into the hundreds. The Global Invasive Species Database for instance currently lists 34 invasive species for the Pacific region, but it is believed that over 80 more will be added shortly (UNEP, 2004c). The importance of individual invasive alien species varies from country to country but a few species including in particular rats, such as the Pacific rat, and ants cause problems on almost every island. Rats have been reported to have colonized at least 82 per cent of the world's islands, and implicated in the extinction of birds on at least 31 islands (Dullo *et al.*, 2002).

22. The level of damage of an invasion depends on how and to what degree the indigenous biotic community is disrupted and on island ecosystem's resilience. In theory, the ecological impacts of invasive alien species on islands can occur in the same manner as on mainland ecosystems. However, these impacts are usually more rapid and more pronounced on island ecosystems due to their vulnerabilities. The information document on the ecological and socio-economic impact of invasive alien species on island ecosystems prepared for the ninth meeting of SBSTTA (UNEP/CBD/SBSTTA/9/INF/33) contains case-studies describing the ecological and socio-economic impacts of invasive alien species on biodiversity at the genetic, species and ecosystem levels. The impacts of invasive plants on native flora and vegetation include decreased dominance of native species, decreased overall species richness, fewer vertical tiers of plants, and a lower range of biodiversity overall.

23. The exclusion, eradication or reduction in numbers of large introduced mammals has historically been the main focus of restoration efforts on many islands, and this activity alone has resulted in substantial levels of vegetation regeneration. Extensive work on the biology and control of invasive alien species has been undertaken on many islands notably Hawaii, New Zealand, islands of the south-west Indian Ocean (Mauritius and Seychelles), and Atlantic islands such as Pitcairn and Ascension. On many small islands complete eradication of introduced mammals has been possible, with a very significant positive impact on the native biota, and offering unique opportunities for further restoration interventions (e.g. Dullo *et al.*, 2002). Additional examples of successful control or eradication of invasive alien species have been described by Loope and Helweg (2004) and the Invasive Species Specialist Group (ISSG).

24. In 2002, a cooperative Initiative on Invasive Alien Species on Islands was launched by New Zealand, the IUCN-ISSG and Global Invasive Species Programme (GISP). This initiative is aimed at building management capability (understanding, skills and technology) and overall capacity (capability and political and institutional support) within island states and countries with islands to more effectively manage the threat posed by invasive alien species. Considering the level of threat posed by invasive alien species on island biodiversity, it is imperative that the international community and island States and territories take urgent action to address them.

B. Tourism development

25. Tourism is a principal economic activity in a large majority of SIDS. Its importance and degree of development vary among islands. Tourism in SIDS increased by about 60 per cent in the 1990s, providing expanded economic opportunities, but also posing economic, social and environmental challenges (ECOSOC, 2004). Many SIDS, particularly in the Caribbean region, have well-established tourism industries built on diversified activities, strong reputations, high levels of business, and a solid infrastructure. In general, in the Caribbean there has been a fast transition from an agricultural economy based on cheap peasant labour to a tourism-based economy with a relatively advanced standard of living. In the AIMS region, islands support well-developed tourism industries that are important sources of income and foreign exchange. Coastal tourism is, for example, the mainstay of the economy in Seychelles, contributing 46 to 55 per cent of GDP, 70 per cent of foreign exchange earnings, and employing 20 per cent of the population (UNEP, 2004a).

26. Fast and uncontrolled economic growth from tourism can be a major cause of ecosystem degradation and destruction, as well as the loss of cultural diversity. Participants in the IBEF (Hammerton; Moultrie) described ways in which tourism threatens island biodiversity as follows: (i) destruction of habitats for the development of tourism infrastructures such as hotels and amenities like

golf courses as well as infrastructure to support development; (ii) transportation facilitating the deliberate or unintentional introduction of invasive alien species, e.g. through the important of often sizeable trees and palms which may harbour new pests and diseases (Hammerton, IBEF, 2004); (iii) degradation of habitats from waste associated with large-scale developments and cruise ships (solid and liquid waste, sewages); and (iv) damage of habitats with tourism activities (e.g. diving, fishing using illegal or unregulated activities (such as off-road driving, plant-picking, methods or outside designated season, anchoring reefs). Literature confirms that tourism impact is nowhere more sudden, pervasive, transparent—and perhaps even irrevocable—than on islands, especially small islands, and their communities (Baldacchino, 2004).

27. In most countries, it is the coastal and lowland ecosystems that have been the most severely degraded because they are the closest to fast growing population centres that tend to be in the coastal zone (UNEP, 2004 (c)). In the Barbados, the construction of hotels and marinas, particularly along the west and south coasts, has reportedly caused the destruction of native plant communities and introduction of exotic species. Several proposals for the creation of golf courses were also submitted by investors to the government for approval. The loss of nesting habitat is considered to be the greatest threat to the three species of endangered sea turtles that are known to nest in Antigua and Barbuda. Significant areas of wildlife habitat in both terrestrial and marine ecosystems have been eliminated to accommodate development.

28. There is also a basic inverse correlation between the health of coastal ecosystems and the levels of coastal and watershed development. The apparent relationship between levels of coastal development and coral-reef deterioration is influenced by factors such as terrestrial hydrology, the nature of activities in the adjacent watershed, coastal currents, climatic and biotic phenomena, which will modify the level of impact to coastal reefs (UNEP, 2004b). In particular, direct destruction of reefs occurs due to the improper placement of fish traps, boat and anchor damage and offshore dredging. Recreational diving and marine resource extraction is also having adverse impact on reefs.

29. Nevertheless, tourism has a high potential for biodiversity conservation and sustainable use. In Seychelles, for instance, tourism has been a major force and source of funding for biodiversity management and conservation, as well as ecosystem rehabilitation. Tourism in many cases is the only means by which a management infrastructure can be put in place on isolated islands in order to enable conservation activities; also an increasingly well-informed tourist is the driving force behind making the industry act to enhance biodiversity management (Nevill, IBEF, 2004).

C. Climate change and variability and sea level rise

30. By the end of the twenty-first century, the Earth's mean surface temperature is projected to warm 1.4 to 5.8^{o}C. The associated sea-level rise is projected to be 0.14 to 0.88 metres, with a central value of 0.47 metres, which is about 2 to 4 times the rate over the 20th century. Climate change is projected to affect individual organisms, populations, species distributions and ecosystem composition and function.

31. In response to a request from SBSTTA at its fifth meeting, the Intergovernmental Panel on Climate Change identified the following projected impacts of climate change on biodiversity in small island:

(a) Coral reefs will be negatively affected by bleaching and by reduced calcification rates, which can lead to the loss of many reef-associated communities and species. Consequently, loss of revenues from key sectors such as tourism and fisheries could be expected;

(b) Mangrove, seagrass beds, other coastal ecosystems, and the associated biodiversity would be adversely affected by rising temperatures and accelerated sea-level rise;

(c) Saltwater intrusion into freshwater habitats will affect their biodiversity;

(d) Increases in typhoon/hurricane frequency or wind speed could negatively impact some habitats;

(e) Inundation and flooding of low-lying forested areas in islands will lead to the loss of some endemic bird species, likely due to physiological stress and change; and loss in habitat caused by changes in disturbance regimes, such as fires; and

(f) A rise in sea level will have a serious impact on atoll agroforestry and the pit cultivation of taro.

32. Erosional changes in the shoreline will disrupt populations, and the combined effects of freshwater loss and increased storm surges will stress freshwater plants and increase vulnerability to drought. The projected temperature rise is not expected to have widespread adverse consequences on the terrestrial ecosystems in the tropical SIDS. However, some changes are likely to occur especially with regard to the alteration in the range of species (flora and fauna); the increase in forest pest and diseases; reduced food and water available for wildlife; and increase in forest fire frequency, especially where precipitation remains the same or is reduced. However, temperature rise will continue to have a devastating impact on marine ecosystems. The highest risk of coral bleaching due to elevated sea-surface temperature has been reported in Indian Ocean islands (Payet, 2004) as compared to Caribbean (1 per cent) and Pacific (5 per cent) islands.

33. SIDS are particularly vulnerable to the effects of climate change and variability due to the fact that: (i) SIDS have no control over the underlying causes of these phenomena; (ii) most SIDS (e.g. Maldives and Tuvalu) are low-lying and their existence is threatened by sea-level rise resulting from global warming; (iii) SIDS have larger exposure of coasts in relation to land mass than continental land and a high concentration of population and infrastructure in coastal zone. Areas under most threat have been identified as marine ecosystems, coastal systems, tourism assets, human settlement and infrastructures. Sea level rise will cause loss of coastal ecosystems due to inundation; increased salinity due to encroachment of the sea and salt water intrusion into freshwater lenses; increasing pressure on forest reserves due to loss of coastal agricultural land by salination; and migration or loss of wildlife species.

34. In the Pacific, there is growing evidence of impacts indicative of a changing climate. Atolls have been lost due to rising seas or experienced more extreme events and weather. Coupled with the El Niño phenomenon, the results have included water shortages and drought in Papua New Guinea, the Marshall Islands, Federated States of Micronesia, American Samoa, Samoa and Fiji, and floods in New Zealand (UNEP, 2004c). As a consequence, any sea-level rise would have momentous and profound effects on settlements, living conditions and island economies. This is particularly evident for low-lying states such as Maldives, where 80 per cent of land is less than 1 metre above sea level. Many Maldivian islands are already suffering from inundation and shoreline erosion, which also leads to freshwater shortages and disease outbreaks (UNEP, 2004 a).

35. SIDS have already started some remedial and mitigation actions. For instance, set back zones for coastal building and infrastructure have been imposed in several SIDS to mitigate impacts in the coastal zone, and roads have already been moved further inland in some countries.

D. Natural and environmental disasters

36. With few exceptions, SIDS are prone to extremely damaging cyclones, storm surges, volcanic eruptions, earthquakes, forest fires, landslides, extended droughts and extensive floods. More than half of the 25 disaster-prone countries in the world are classified as small island developing States (SIDS). In many of the States, populations depend for their livelihood on local biological and other natural resources (Briceño, 2004). SIDS have only limited capacity to respond and recover from disasters. Many of them have become more vulnerable to disasters because of environmental degradation caused by various human activities, including, *inter alia*, poor land use, deforestation and pollution from mining (Briceño, 2004). Expensive or no insurance coverage, adverse consequences for investment, and rehabilitation costs are major constraints for SIDS (FAO, 1999). Since damage often occurs on a national scale, a single disaster can cripple an island's infrastructure and economy. In the past decade, SIDS have collectively suffered annually from the effects of numerous extreme weather. Because of the consequent

diversion of resources from long-term development, plans to deal with reconstruction and rehabilitation after natural disasters continue to pose a grave challenge to sustainable development of many SIDS.

37. It should also be noted that the traditional resilience of island communities to natural disasters is under threat from unsustainable practices and various economic and social pressures. The quick recovery of ecosystems can no longer be assured. Poor farming and logging practices are creating massive erosion during storms; over-harvesting of coastal fish and invertebrates remove important sources of nutrients from coral reefs and sewage from urban areas have destabilized near-shore coral communities making these vital ecosystems less able to withstand and recover from the waves and rain of hurricanes (Briceño, 2004).

38. In general, much effort has been put into the establishment of disaster-management agencies, and some SIDS have established national early-warning systems and disaster-mitigation plans. Still, contingency planning and response preparedness in SIDS remain fairly weak, and disaster-management and response offices are inadequately staffed with trained personnel (ECOSOC, 2004).

1. Cyclones and hurricanes

39. Cyclones are a common feature for islands with some countries experiencing them almost each year. In the AIMS region, the western Indian Ocean islands lie between the tropics, and are subject to about ten tropical storms or cyclones each year in the period between November and May (UNEP, 2004a). With global warming the likelihood of weather extremes is expected to increase. For instance, as reported in UNEP (2004c), Tokelau had only three major storms since 1846; it was struck by two cyclones (Tusi and Ofa) in the early 1990s. Tuvalu was hit by an average of three cyclones per decade between the 1940s and 1970s; eight cyclones occurred in the 1980s. The impacts of cyclones on native wildlife include, *inter alia*, mortality due to the cyclone itself; starvation as a result of the disappearance of fruits for long periods after the cyclone; predation of grounded wildlife by domesticated animals; hunting by humans and failure to breed because of the destruction of broods and stress; and degraded health of habitats and ecosystems (UNEP, 2004c). In Samoa, cyclones Ofa (1990) and Val (1991) defoliated up to 90 per cent of all trees and may have caused a drastic population decline of some species (UNEP, 2004c). In the Caribbean, hurricane Hugo (September 1989) significantly impacted the coral reefs of Antigua and Barbuda. Hurricanes have also inflicted serious damage to the southern and south-eastern reefs, although signs of recovery are evident. Hurricane Luis (September 1995), followed by Marilyn two weeks later, caused additional stress to the country's reefs.

2. Droughts, floods and landslides

40. In small islands, droughts and floods are localised and ephemeral problems often related to the El Niño Southern Oscillation phenomenon. Droughts *per se* are not generally of long enough duration to be a serious problem to biodiversity. However, they can impact on biodiversity by creating the conditions necessary for fires. In the islands of eastern Caribbean, which serves as an important link in the seasonal migration of numerous birds, several two-three year periods of severe drought over the past two decades have reduced bird populations (UNEP, 2004c).

41. Floods and landslides caused by storms, tidal waves or heavy rainfall are common in small islands. Flash floods can devastate agricultural areas. Landslides exacerbate local devastation when floods obstruct rivers. In most SIDS, people have no choice but living in flood prone areas because of limited land size (FAO, 1999). The islands of the Caribbean, Indian and Pacific Oceans face the largest relative increase in flood risk. While native forests are somewhat immune to flood damage, rainfall runs off much more rapidly from degraded forests, often resulting in soil erosion and flooding downstream with impacts on coastal zones and lagoon ecosystems.

3. Volcanic activities and fires

42. Volcanic eruption can affect agriculture over a wide area through the deposition of ash and other volcanic material that destroys crops and grazing areas and damages irrigation systems.

43. Forest, land and bush fires cause problems to human health, disrupt major social and economic activities, are detrimental to biodiversity, pollute the atmosphere and aggravate greenhouse effects. Forest fires can be caused by natural events (such as lightening or volcanic eruptions) and mainly by human carelessness or design (such as land clearing for agriculture through burning). However, fire has shaped ecosystems in many countries, especially where it has been traditionally used to clear land such as in parts of Fiji and Micronesia. When forests are burned, especially in dry zones, a savannah dominated by grasslands emerges. This ecosystem is ecologically impoverished compared with what preceded it. During the dry season, and especially during droughts, these areas are often set on fire again, an action that perpetuates the savannah and demonstrates how the effect of natural phenomena can be amplified by human actions (UNEP, 2004c).

E. Unsustainable uses

44. Overexploitation of resources is a major cause of loss of biodiversity in island ecosystems. Over-fishing is a major factor for coral reef degradation in many areas of the Caribbean and other SIDS (Payet, 2004). It has caused a significant decline in the fish population. The continued removal of excessive numbers of fish from the reef may have long lasting deleterious effects on all aspects of reef ecology.

45. Hunting is a threat to some species. For instance, in the Pacific, this activity has had a negative impact on coconut crabs (*Birgus latro*), fruit bats (mostly *Pteropus* spp), pigeons (mostly *Ducula* and *Ptilinopus* spp) and other large birds that are traditional food sources in many parts of the Pacific. Fruit bats in Samoa and Palau have been particularly susceptible to over-hunting because of the export trade to Guam, where they are a culinary delicacy. Legal trade in fruit bats was terminated following a 1989 ban under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), except in Palau, which has now become the major supplier of fruit bats (UNEP, 2004c). Catches of non-target, endangered species, especially turtles, dolphins, and dugongs resulting from dynamite fishing, purse-seining and drag-netting (UNEP, 2004a), are also cause for concern in the AIMS region. In Mauritius, the usual burning of sugar cane fields to facilitate the harvesting of sugar cane usually destroys the natural habitats of insects, birds and reptiles, and pollutes air (UNEP, 2004a)

46. Some plant species are also in serious decline due to harvesting at an unsustainable level. An example is *Afzelia bijuga*, also known as "*ifilele*", a highly valued timber tree in many islands. This formerly widespread tree is threatened because the wood is highly valued for carving, such as kava bowls in Samoa and Fiji, and it has been extirpated from many places, even in forest conservation areas (UNEP, 2004c).

47. Overgrazing by livestock (mainly goats, sheep, cattle and donkeys) also poses a serious threat to the biodiversity of many SIDS, particularly in the upper watershed areas.

48. The use of destructive fishing practices (e.g. dynamite, cyanide, poison weed and bleaching), although outlawed in most SIDS, continues to be common in some islands (UNEP, 2004c).

49. The extraction and refinement of mineral resources such as gold (e.g. in Fiji), manganese (e.g. in Vanuatu), bauxite (e.g. in Haiti), phosphate (e.g. in Nauru) and oil (e.g. in Trinidad and Tobago) have been reported to contribute to pollution and negatively impact on local biodiversity (FAO, 1999). These activities are generally regarded as national economic necessities, and as such, need to be carefully planned and strictly controlled to ensure minimization of the potential negative impacts, such as loss of species diversity, and degradation of habitats.

50. Sometimes the incorrect uses are linked to unsustainable customary practices or laws of local and indigenous communities. The customary communities have unique inheritance and limited re-distribution mechanisms with land and resources managed through village and family units. Individualism results in rising land and resource conflict, as it is inconsistent with community mechanisms where communal sharing, reciprocation and community status is linked to agriculture and food production and consensus decisions are the norm. The scenario has serious implications for land and biodiversity degradation. To avoid conflict, families either reduce the shifting nature of land use, shortening fallow periods and placing

a heavier reliance on the use of fertilizers, thus leading to forms of land degradation. Alternatively, the families shift their efforts to family land which is not subject to individual allocation. This is invariably made up of primary forested areas. The result is increased clearance of forests rich in biodiversity or ecological value. Primary forested areas are usually the poorer soils and with deforestation comes the potential for accelerated soil erosion. Agricultural use of marginal lands for farming can also result in soil-structure decline. Forest conversion caused by rural communities can adversely affect biodiversity, the residual vegetation, the local micro-climate, local water quality, crop yield and the soil fertility of these areas (SCBD, Composite report, 2003).

F. Pollution and waste disposal

1. Liquid and solid waste

51. In small islands, incidents of dangerous and illegal pollutants being discharged into streams and oceans have increased, with growing urbanisation and establishment of manufacturing industries, as a result of, *inter alia*, inappropriately sited and poorly managed garbage dumps, and poorly planned development, inadequate disposal methods, and destruction of and encroachment onto coastal habitats. (UNEP, 2004a and c).

52. In particular, the last decade has seen an increase in the importation of goods and has resulted in dramatic shifts in the waste stream in some countries with plastics, cardboard, paper and metals now being of greater significance than organic waste. An expansion of the tourism industry and an increase in the number of stop-over and cruise ship tourist arrivals has resulted in an increase in the quantity of waste generated by the tourism industry (UNEP 2004b).

53. In the Caribbean, the effluents generated by the sugar, citrus and banana agro-industry produces large volumes of wastes which pose significant threats to the environment. Untreated wastes from factories released into rivers usually lead to severe changes in the temperature, chemical and/or physical state of the aquatic systems, most often threatening habitat stability and biodiversity. Inadequate sewerage has severe health and environmental implications causing degradation of river, sub-surface and coastal water quality with adverse effects on recreational and fishing activities (UNEP, 2004c).

2. Agrochemicals

54. The use of agrochemicals has become a standard practice in the agricultural production systems in SIDS to respond to export requirements. However, efficient pest and pesticide control and monitoring programmes are usually absent. Only few SIDS are participating in the Rotterdam Convention on the Prior Informed Consent (PIC), which contains provisions for the exchange of information between exporting and importing countries about potentially hazardous chemicals (FAO, 1999).

55. The fertilizers, pesticides and herbicides required to maintain high crop yields are transported in water ways, contaminating aquifers, and affecting the biology of sensitive riverine and coastal ecosystems (UNEP, 2004b). A number of cases have been reported in recent literature. For instance, agrochemical contamination of underground water supplies, near-shore waters and biota in Barbados, presents a serious risk to human and animal health.

56. Pollution of land is a major concern, for example, in Mauritius where inorganic fertilizers, herbicides and pesticides are used in agriculture especially in the sugar plantations. It has been estimated that the country uses five times more fertilizer than the world average of 113 kilogramme per hectare. This level of use of chemicals poses a serious threat to freshwater supplies since the chemicals are washed into freshwater reservoirs which are a source for domestic and industrial water supply (UNEP, 2004a). Similarly, both Pacific and the AIMS countries have little capacity for monitoring and controlling the pollution from toxic or hazardous substances but there is increasing awareness of the impacts and magnitude of the problem (UNEP, 2004c).

G. Major underlying causes of island biodiversity loss

57. The Conference of the Parties listed in its Strategic Plan, contained in decision VI/26, possible obstacles to the implementation of the Convention on Biological Diversity. The list is relevant to island

States, in particular the SIDS, more specifically with respect to lack of mainstreaming and integration of biodiversity issues into other sectors, including use of tools such as environmental impact assessments; inadequate capacity to act, caused by institutional weaknesses, lack of financial and human resources, transfer of technology and expertise, appropriate policies and laws; poverty; and population pressure. Some of these constraints were described in a note by the Executive Secretary (UNEP/CBD/AHTEG-IB/1/4), which reviews ongoing work on the different thematic areas and cross-cutting issues under the Convention and related work being carried out in the framework of other processes.

1. Institutional, technical and capacity-related obstacles

58. Pressures and threats to the conservation and sustainable use of biodiversity are often exacerbated by the lack of public awareness and appreciation by decision makers of environmental issues, a lack of knowledge of the current status of biodiversity, a lack of capacity especially in terms of the paucity of trained staff and resources to deal with environmental problems and the poor integration of environment and development in decision-making. Most SIDS lack sufficient resources, institutional capacity, and scientific and technical expertise for effective national surveillance, monitoring and management of biodiversity (ECOSOC, 2004). The lack of human, technical and financial resources assigned to environmental management is a fundamental constraint to effectively dealing with environmental problems. Despite the recent strengthening of environment units in many SIDS, a major constraint remains the shortage of staff to perform the wide and expanding range of environmental management functions.

59. Another major constraint to good management is the lack of critical mass of qualified scientists and associated institutions. In addition, when population is small as that of SIDS, government functions tend to be very expensive *per capita* due to the fact that certain expenses are not divisible in proportion to the number of users. The difficulty of a sophisticated division of labour (again due to the small population base) is further compounded by brain-drain when specialists are developed.

60. Moreover, often in SIDS, it is very difficult to have a coherent approach to ecosystem management. Land and water areas are usually under separate jurisdictions and management authorities. Many SIDS are exploring a range of mechanisms and procedures to articulate the work of agencies having different management responsibilities (Troost and Hadley, 2004).

2. Inadequate knowledge and policy frameworks

61. A serious constraint to the development of effective environmental management strategies is the poor knowledge of much of the islands' biodiversity and the lack of consolidation of existing biodiversity information. A good knowledge of the current population and threat status of endangered species is particularly lacking, even for fairly well known species. Furthermore, there are many threatened species candidate for the Red List that urgently require an assessment of their population and conservation status. In the Pacific, the taxonomic data deficiency is particularly pronounced for fish, plants and invertebrates, while the geographic data deficiency is most serious in the more isolated islands especially in the less developed countries (UNEP, 2004c). In the Caribbean, knowledge of species diversity is fragmentary.

62. There is a lack of information on the complex nature of disasters and their consequences on island biodiversity. There is also a lack of models of good practice for disaster preparedness and response. There is a need to improve disaster communication, early-warning systems, coordination systems and practices including in outer island communities.

63. Improving capacity is a prerequisite for enhancing the overall management of biodiversity and thereby realizing its full contribution to national food security and social and economic development. It is being increasingly recognized, for instance, that as a result of high staff turnovers in small national fisheries administrations of SIDS, institutional strengthening and capacity-building, particularly in terms of human-resource development, requires an ongoing and long-term commitment on the part of island governments and technical assistance agencies (FAO, 1999).

64. Capacity is also lacking for the development and implementation of policies for the sustainable use of agriculture and natural resources, which is in part exacerbated by outward migration of skilled islanders. Grenada, for instance, identifies national policy failures in the form of lack of implementation of good policies, implementation of policies with negative environmental impacts, ineffective or non-enforcement of laws and regulations (UNEP, 2004b).

65. The lack of a clear policy on biodiversity, together with the absence of clear legislation or an adequate institutional framework and inadequate enforcement of existing regulations that provide for the protection of biological resources are indeed all obstacles to the sustainable management and conservation of biodiversity.

3. Emerging issues

66. The incidence of emerging health issues such as HIV/AIDS, drug-resistant malarial strains, dengue, and nutritional disorders and their impacts on human potential and productivity are increasing and taking a severe toll on SIDS economies. Recent terrorist events and related activities have highlighted the vulnerability of the most productive sectors of SIDS economies including in particular tourism. This has been exacerbated by the obligations under Security Council resolution 1373 (2001), on threats to international peace and security caused by terrorist acts that have created particular difficulties for all small island developing States, especially those with large coastal areas and the archipelagic SIDS.

IV. STATUS AND TRENDS OF BIODIVERSITY IN ISLAND BIOMES/ECOSYSTEMS

67. The present section covers the status of island biodiversity in different biomes, focusing in particular on thematic areas of the Convention on Biological Diversity, including marine and coastal biodiversity, inland waters biodiversity, forest biodiversity, mountain biodiversity, agricultural biodiversity, and dry and sub-humid land biodiversity. The section also includes information on biodiversity in protected areas and the knowledge, innovations and practices of indigenous and local communities relevant to the conservation and sustainable use of biodiversity. Specific information on the actions taken in the framework of the Convention and the status of implementation of relevant provisions and programmes of work of the Convention in island ecosystems are contained in the review of ongoing work on different thematic areas and cross-cutting issues under the convention on biological diversity and related work being carried out in the framework of other processes in island ecosystems (UNEP/CBD/AHTEG-IB/1/4).

A. Marine and coastal biodiversity

1. Coral reefs

68. At least 60,000 km^2, or 21 per cent of global coral-reef areas lie within SIDS, with another 18 per cent found within Indonesia's islands, which implies that at least 40 per cent of the world's coral reefs are found around islands (Payet, 2004). The coral reef communities are of great ecological and socio-economic importance to small islands. Ecologically, they contribute significantly to biodiversity by providing shelter, feeding and breeding grounds, recruitment sites and nursery grounds for a diverse collection of adult and juvenile marine organisms. Socio-economically, they contribute to food supplies by supporting several commercial fisheries. With their diverse marine life, they have a high aesthetic, recreational and educational value to both visitors and locals. In Antigua and Barbuda, for instance, coral reefs are used by island communities on a subsistence and commercial level. The shift and focus to a tourist-based economy has also increased the significance of these marine resources in the country. Coral reefs support an estimated 25 to 34 million islanders, and services such as tourism contribute about US$8.9 billion in foreign exchange earnings in the Caribbean only (Payet, 2004).

69. In all the SIDS, coral reefs show signs of severe stress, resulting from both natural events and anthropogenic activities including high sedimentation, increase nutrient loading, direct destruction and over- exploitation of the reef. High nutrients/sediments levels can smother corals or encourage the growth of green algae, which prevents light reaching the reef and can kill both coral and algae. Many

coral reefs also experience mass coral-bleaching events, the most severe on record being those of 1998. Increasing pressures threaten not only the reefs but also the livelihood and sustainability of island people (Payet, 2004).

70. In the Caribbean, reef development within the region is affected by surface runoff, wave exposure, periodical hurricane disturbances, and sea temperatures that are influenced by cool upwelling from nearby deep trenches and the Gulf Stream. Hard coral diversity is high in most areas, although coral diseases have affected much of the hard coral cover. Associated species and ecosystems includes over 500 species of fish, large areas of mangroves (especially on the larger islands, such as Cuba), and algal beds. Sedimentation arising from deforestation (such as in Cuba, Haiti, Jamaica and the Dominican Republic) also have an important effect at local levels in the larger islands (Payet, 2004).

71. Dramatic changes in the community structure of coral reefs have also taken place over the past two decades. Prior to the 1980s scleractinian (stony or hard) corals dominated coral reefs and the presence of algae on coral reefs was low. Over the past two decades a combination of anthropogenic and natural factors have reduced the abundance of hard corals and increase macro-algae cover to the point where some reefs are over-grown by algae (UNEP, 2004b). Inshore reef fish appeared as among the most depleted resources along with some stocks of conch, lobster, shrimps prawns, sharks and rays. This is particularly the case for inshore shallow shelf stocks (UNEP, 2004b). In the Pacific, where coral reef systems are considered as the healthiest on the planet, increasing human pressure as well as mass coral bleaching episodes are threatening reefs in isolated areas.

2. Fisheries

72. Many SIDS have large coastal zones and very large exclusive economic zones (EEZ) relative to their size, populations and economies. Fisheries are economically critical in many SIDS, providing a large share of the food supply, employment, economic activity and income (ECOSOC, 2004). Fish are a critical source of animal protein for populations in island States. In 22 SIDS fish accounts for more than 20 percent of animal protein; in 15 countries fish accounts for more than 30 per cent of animal protein, while in six States, fish accounts for more than 50 per cent of the animal protein intake (FAO, 1999). Per capita fish consumption rates in SIDS are higher than international standards. The fisheries sector contributes 6 per cent of the GDP and employs about 20 percent of the workforce in the AIMS small islands (UNEP, 2004a). In the Caribbean, fisheries contribute up to 8 per cent of GDP in some countries (e.g. Guyana) and make significant contributions to foreign exchange earnings (UNEP, 2004b).

73. Notwithstanding the high production and consumption of this resource, fish is not a cheap commodity in SIDS. This is due to a number of reasons, including, *inter alia*, the over-exploited state of most of the accessible inshore fish stocks and competition by exporters and the local tourist industry. For these reasons, other types of imported animal products (e.g. lamb/mutton in the South Pacific and chicken in the Caribbean) compete with local fish supplies. Indeed, it is not uncommon for fish to be imported into SIDS, sometimes in large volumes, to meet the national demand from the population and the tourist industry (FAO, 1999).

74. The largest tuna fishery is found in the Pacific. With the exception of one species, *Thunnus obesus* (bigeye), the resource is assumed to be in good health (UNEP, 2004c). In the Indian Ocean, the combination of freshwater and saltwater in coastal estuaries creates some of the most productive and richest habitats on earth and forms a favourable habitat for diverse fisheries, seafood species and other marine lives. There are also extensive seagrass beds, mangroves and lagoons. These resources mainly support artisanal fishers. About 90 per cent of all fish landings are from small-scale operators and are important economically and in local diets. Mauritius and Seychelles are also exploiting open sea tuna fisheries on a more commercial scale and shrimp fisheries, which have a high potential for foreign exchange earnings from export, are growing in importance (UNEP, 2004a).

75. The unsustainability of fisheries in SIDS is the result of a series of interlinked factors that constrain the development and management of the fisheries sector in island States, including lack of institutional strength and capacity of the public sector; high post-harvest losses due to poor fish handling, marketing and processing; inadequate safety regulations and systems for fishers (FAO, 1999). The

situation is further exacerbated by overexploitation of living marine resources, toxic waste dumping and pollution, other degradation of coastal habitats, as well as lack of effective surveillance mechanisms at both national and regional level (UNEP, 2004c).

B. Inland waters biodiversity

76. Inland waters in islands, just like on the continents, include rivers, temporary and permanent streams, marshes, swamps, underground springs, flood plains, mangroves and constructed systems such as dams and irrigation and aquaculture ponds. On islands, in particular the small islands, the extent of many ecosystems is often restricted; wetlands in the form of swamps and mires tend to be small in extent and often ephemeral. Rivers rarely have the opportunity to develop to maturity, and lakes are rare. The fact that the extent of many island ecosystems is often restricted does not reduce their importance for ecosystem functioning and services. Freshwaters and associated habitats are important not only because they provide for freshwater fish production, based on available living aquatic resources, but also because they can be very significant due to characteristic or distinct patterns of aquatic biodiversity and aquatic genetic resources found in such water bodies.

77. The extensive and intimate linkages between terrestrial and coastal marine systems make inland water ecosystems prone to salt water intrusion to the freshwater groundwater "lens", thus putting island wetland ecosystems and the biodiversity they support, in considerable jeopardy.

78. Inland water ecosystems are home to birds, fish, shrimp, insects and molluscs. Many of the birds that nest and forage in the wetlands are migratory but most of them are resident on the island. Little is known about the freshwater fish. There are few recorded species but those that are known have been observed to live in even the most degraded habitats. Bridgewater (2004) presents examples of plants and animals in inlands wetlands at the Equator Galapagos Islands; in the Southern hemisphere, in the Siberut island in Indonesia; in Indian Ocean in Mauritius where considerable settlement and anthropic changes took place; in the Caribbean region in Trinidad; across the Pacific in the islands of Micronesia and Polynesia; in the sub-tropical zones, the Canary Islands where climate landform and vegetation interact to promote a water cycle, which in turn, drives other systems, including small marshes and wetlands; in higher latitudes of the northern hemisphere, the West Estonian Archipelagos; and the typically treeless Aleutian Islands, with sub-arctic alpine vegetation; and in the sub-Antarctic region, the Macquarie Island south of Tasmania.

1. *Freshwater*

79. Many small islands are extremely freshwater-scarce. They rely mainly, for the majority of their resources, on rainfall harvesting, surface reservoirs and flows or groundwater lens floating on top of the salt water. Severe water shortages have been experienced on the atolls and raised limestone islands where there are no rivers. The quantities of groundwater are declining due to rising population and demand. For instance, the groundwater in the Maldives is only a fraction of what it used to be. In some islands, desalination of groundwater has become necessary (UNEP, 2004a) to avoid contaminating ecosystems fed by groundwater flow. The situation is critical in the low limestone islands of the Eastern Caribbean, where seasonality of rainfall (a marked dry and wet season regime) is pronounced (UNEP, 2004b). The ability of the smaller atolls to sustain an exploitable freshwater lens has determined whether these islands have been able to sustain permanent habitation (UNEP, 2004c). Changes in freshwater habitats may affect freshwater fish production and aquatic biodiversity (FAO, 1999). In the case of Seychelles, freshwater is obtained almost entirely from rivers and, to date, about 20 per cent of the population of the country still uses untreated water often from local streams (UNEP, 2004a).

80. In several SIDS (e.g. Bahrain, Barbados, Cape Verde and Malta), freshwater shortage is amplified by the lack of effective delivery systems and waste treatment, coupled with increasing human populations and expanding tourism, which contributes to water over-abstraction and contamination by poor sanitation, use of pesticides and fertilizers, as well as leachate from solid waste (Bridgewater, 2004). Shortage of freshwater has significant economic implication including increased costs for alternative water supplies and reduced agriculture productivity (UNEP, 2004c).

2. Wetlands

81. Wetlands play significant roles in general flows of water through the groundwater aquifers (e.g. in the Galapagos), in water purification, sediment removal and flood control. The sponge-like action of swamps often facilitates the slowing down of surface run-off, the extraction of organic and inorganic compounds and the deposition of suspended solids (Bridgewater, 2004). In the AIMS region, wetlands are also important habitats on all of the islands, providing breeding grounds for large numbers of waterfowl. However, these are coming under pressure for land development, especially in the smaller islands, where tourism and population growth are driving the demand for housing and industry (UNEP, 2004 a). Wetlands are also vulnerable to pollution events, drainage, and invasion from alien species, and, especially in small and low islands, salt-water intrusion to the fresh groundwater "lens " (Bridgwater, 2004).

3. Fisheries and aquaculture

82. In many SIDS, the perceived "dominance" of marine fisheries has diverted attention from little known inland fisheries. However, in SIDS, only those people who actually live along the coast have marine resources. The rest rely upon inland resources. The freshwater fish fauna of many islands have not been well studied, and consequently little is known about it. Several of the species that exist are known to have been deliberately introduced for aquaculture, while several others appear to be aquaria fish that have been naturalized in ponds and waterways after being discarded.

83. In some of the larger island countries (e.g. Fiji, Jamaica and Papua New Guinea) catches of finfish, freshwater prawns and shellfish contribute in a significant way to food security and provide economic opportunities for self-employment, often for women. However, the prospects for increasing production from inland fisheries in SIDS is not great, and like their marine counterparts, inland capture fisheries are in need of management (FAO, 1999).

84. Aquaculture is being promoted in SIDS to augment fish production (e.g. tilapia culture in Jamaica and Fiji for food and for export) together with other marine products such as pearls (e.g. Cook Islands), seaweed (e.g. Kiribati and Tonga) and aquarium fish. Reef enhancement is being tested with a variety of organisms in various states, but its viability is still to be demonstrated. Natural-resource endowments for inshore, offshore and inland capture fisheries as well as the capacity of island States to promote the development of aquaculture vary among and within SIDS regions. It is therefore difficult to make generalizations about fisheries and aquaculture in SIDS (FAO, 1999).

C. Forest biodiversity

85. Forest resources are crucial to sustaining the livelihoods of many in islands by providing timber, other building materials, fuelwood, food, medicines, traditional and cultural materials, soil and water protection, and shelter (Miles G., IBEF, 2004). Bridgewater (2004) described the main floral and faunal species in an indicative number of islands. Non-timber forest resources contribute directly to food security through the provision of edible forest products such as fruits, nuts, berries, leaves, shoots, roots, mushrooms, animals, (mammals, rodent, fish, birds and insects) and animal products (e.g. honey, eggs and bird's nest) (Dulloo, 2002). Beekeeping is an important activity in many countries including the Dominican Republic and Cuba and dependence on wildlife species for protein is high in SIDS with dense forest cover. Edible forest plants also provide essential vitamins and trace elements to local populations, which may be of particular importance to children and women. In the Pacific, the total value of forest and the rich biological diversity they support is remarkable ((Miles G., IBEF, 2004).

86. Forest cover, by preventing erosion, is also important for the health of the marine environment. A problem of considerable concern in many islands is the high sediment load in rivers which, when deposited in the sea, smothers coral reefs and other coastal environments such as seagrass beds. Another important role of forests in small islands, in particular in the tropics, is the protection of coastal areas. Forests act as buffers against the impacts of tropical storms, hurricanes and cyclones combined with high rainfall levels and storm surges which are common occurrences in many islands. They also protect agricultural land from the effects of salt spray (Wilkie *et al,* 2002).

87. In addition to the above direct benefits, forests and trees have other important environmental and socio-economic functions. Coral-based soils, which are common in many SIDS, are among the least fertile in the world. Increased organic matter provided by trees improves soil fertility by increasing the water retention capacity, reducing soil pH, providing nutrients, reducing the leaching effects of wind and rain, and reducing run-off and evaporation. The soil improvement roles of trees are of great importance to the success of agriculture and plant growth in atolls and other coral-based islands.

88. The combined forest cover of small islands may be insignificant in global terms. SIDS forest cover for example represents less than per cent of the forest area of the world; however, their forest resources are of global importance in the conservation of biological diversity (Wilkie *et al.*, 2002).

89. Loss of forests in SIDS may have far more serious impacts than in other larger countries due to intensified interactions within a limited geographical space and to the loss of endemic species and rare ecosystems (FAO, 1999). Because of their small land area, most SIDS are characterized by comparatively short distances between uplands and coastal areas. Under such conditions, forest ecosystems are critical regulators of freshwater supply for consumption, irrigation and industrial uses and for the generation of energy (Dulloo, 2002). Although the overall rate of deforestation appears to have slowed down in the last decade, annual deforestation is almost three times higher than the world average (0.8 per cent compared to 0.3 per cent) (FAO, 1999). The main causes of deforestation include conversion of forested land for agricultural use and for infrastructure development such as roads, ports, housing and tourism development.

Box 2: Forest cover in SIDS

According to a recently completed global forest resources assessment coordinated by FAO, forest were estimated to cover a total of 75 million ha or about 63 per cent of the combined land of SIDS (41 SIDS considered). However, due to the considerable variation in land area (ranging from 20 km^2 (Nauru) to more than 450,000 km^2 in Papua New Guinea) population density and climatic, geological and topographic conditions, the extent of forest cover varies greatly among islands.

(a) Bahamas, Cook Islands, Palau, the Solomon islands and the two of the low-lying coastal states (Guyana and Suriname) are highly forested with a forest cover ranging from 76 to 96 per cent of the total land area.

(b) Conversely, 11 of the SIDS have a forest cover of 10 per cent of the total land area (Bahrain, Barbados, Comoros, Haiti, Maldives, Malta, Marshall Islands, Mauritius, Nauru, Singapore and Tonga).

(c) Four of these (Bahrain, Malta, Marshall Islands and Nauru) reportedly have less that 1 per cent forest cover.

(d) Looking only at island states with a land area of less than 50,000 km^2 (excluding the low-lying coastal states Papua New Guinea and Cuba) the combined forest cover was estimated at 38 per cent of total land area in 2000, as compared to the world average of 29.6 per cent. In the Pacific, forest cover varies greatly across the region, ranging from 40–90 per cent of total land area in the high islands to 5-40 per cent for lower islands and atolls.

Sources: Wilkie et al, *2002, Dulloo* et al*., 2002 , FAO, 1999, Miles G, IBEF, 2004*

90. In addition to deforestation, forest degradation also takes place in some SIDS. Samoa, the Solomon Islands and Tonga are among countries with high rates of forest degradation due to over-exploitation of merchantable timber resources (Wilkie *et al.*, 2002). The destruction and degradation of protective forests in critical watershed areas have resulted in environmental degradation, critical impairment of water supply and damage to coastal/marine habitats and natural resources (FAO, 1999).

91. In some cases, market forces outside the forestry sector have led to the import of various forms of agricultural products resulting in an expansion in some of the islands of lands available for plantation or forest regeneration. Such natural expansion of forests can already be witnessed in Barbados, Dominica, Grenada, St. Vincent and the Grenadines, St. Kitts and the Nevis (Dulloo *et al.*, 2002). For instance in St. Kitts and the Nevis, decline in sugar-cane production has also led to natural expansion of forests which results in a decrease in net deforestation rate. Bahrain, Cape Verde, Cuba, Cyprus, Grenada and Vanuatu

all registered an increase in forest cover from 1990 to 2000, mainly as a result of concerted afforestation efforts.

92. In the Caribbean, most plantations reported are established for the purpose of wood production for industry. However, notable exceptions are found in Cape Verde and Cuba, where a large portion of the plantations are established for other purposes e.g. fuel wood production and/or protective purposes (FAO, 1999). The Melanesian SIDS (Papua New Guinea, Solomon Islands, Fiji and Vanuatu) are all relatively well endowed with significant land area, fertile soils and natural resources. Their exports bases are, however, narrow. The SIDS of Polynesia and Micronesia are generally less well endowed with resources. Those which are of volcanic origin (e.g. Samoa and Tonga) have rich soils and agriculture and/or forestry that provide development options. Samoa is presently the only Polynesian country with a timber export industry (UNEP, 2004 (a)).

D. Mountain biodiversity

93. Some islands were formed million years ago by volcanic process and represent the summit of volcanoes, some of which rise over 3,000 m from the ocean floor. This is the case for many of the small island developing States of volcanic origin. Small islands have different mountain formations, often presenting rugged, mountainous landscapes (such as the United States Virgin Islands), or broad valleys (Saint Lucia), volcanic interiors (the Netherlands Antilles), central mountains (like Grenada), and small hills and mountains (Cuba).

94. Mountains have an important role for island ecosystem functioning, as they are important sources of freshwater and shelter essential ecosystems and biodiversity. In particular, in small islands and coastal areas, the proximity of mountain to coastal areas makes marine ecosystems inextricably linked to influences upstream. For instance, when trees are cut down and other mountain vegetation cleared, the soil is easily eroded. Large amounts eventually settle on the ocean floor, often covering coral reefs. As the reefs die, food chains are disrupted and species perish.

E. Agricultural biodiversity

95. Primary production (agriculture, forestry and capture fisheries) in SIDS is an important source of export earnings although much of agricultural activity is of subsistence type (FAO, 1999). In many SIDS, large commercial plantations were established under the colonial system, and continue today in the more fertile plains, forcing many small farmers to cultivate the poorer soils in hilly regions. This, combined with poor land use practices, has resulted in deforestation and erosion. The land area available for productive purposes is limited, which intensifies competition among alternative land use options. In low-lying coastal areas, land well suited for agriculture is under severe pressure from expanding housing, industry, tourism and other economic activities (FAO, 1999).

96. In AIMS, subsistence agriculture is practised in all islands in the subregion, especially in Comoros, where slash-and-burn agriculture is a common means of supplementing household food requirements and income. However, due to economic pressures for agricultural exports and foreign exchange earnings, the best land is often reserved for commercial crop production especially sugar, copra, vanilla, coffee and *ylang ylang* (*Cananga odorata*) (UNEP, 2004a).

97. In the Caribbean, agricultural production has been a primary occupation for hundred of years. In Antigua, for instance, agriculture formerly dominated the country's economy through the sugar industry, and now provides a relatively minor direct contribution mainly through the fisheries sub-sector, including the export of lobsters for Barbuda. In Barbados, the 1898 agricultural census recorded 17,178 agricultural holdings with a total area of 21,560 ha, distributed among the 11 parishes in the country. These holdings were categorized as producing either sugar, vegetables, root crops, fruits, livestock, poultry, mixed or other agricultural uses. These lands contain a wide variety of crops, fruit trees and other foliage which adds to the diversity of the agricultural resources.

98. In general terms, the intensification and diversification of agriculture, forestry and fisheries production is constrained in island States by both natural and economic circumstances. These circumstances include, *inter alia*, a shortage of land, poor soils, a limited capacity of land to support

intensive crop and animal production, difficulties with storage of products after harvest in tropical environments, infrequent and restricted capacity for moving products by sea and air to markets, and distance from, and access to, markets outside the region (FAO, 1999). These factors reduce productivity and are concurring causes in the degradation of agricultural environments.

99. For instance, in Comoros, soil fertility has declined and soil structure has deteriorated, such that enormous soil losses are experienced with each monsoon (UNEP, 2004 a). The Barbados state-of-the-environment report noted an ongoing trend of decline in land under arable use and a simultaneous increase in the area of land under urban development. Indicators of agricultural land use suggest that the decline has spanned the period between the early 1960s to the early 1990s (UNEP, 2004b). In Dominica, the trend towards clearing more land for agriculture has lead to only a slight increase in the percentage of land area in farms. This has been attributed to the removal of land from agricultural to other sectors such as housing, tourism, infrastructure and commercial development. In the Pacific island countries (PICs), the heavy pressure on land in the subregion has resulted in the conversion of natural vegetation, clearing of forests, loss of productivity, and soil erosion. Deforestation rates are high, because land is cleared for commercial cultivation, as well as for urban and industrial development (UNEP, 2004a).

100. Planting-material availability is also generally inadequate to meet demand particularly if rapid expansion of production is to be undertaken. There is a strong dependence of SIDS on imported seeds for many crops. There is also a fundamental problem related to quality control due to the continuing and extensive use of planting material from preceding crops rather than certified and clean source of material (FAO, 1999).

Box 3: Food crops in SIDS

The most important food crops grown in SIDS are starchy staples such as cassava, sweet potato, yam, potato, cocoyam and taro, and plantains and bananas which are mostly produced by small-holders. Grain crops (e.g. maize, wheat, rice etc.), though consumed widely, are only grown on a limited scale. Due to the rapid rate of urbanization and the relatively low level of consumption of root crops and Musa species in towns, these staple crops were increasingly substituted by imported cereals especially wheat and rice in the last decades.

However, root and tuber crops remain the main sources of nutrition in the rural areas of many SIDS. The major export crops of SIDS include banana, sugar cane, cocoa, coffee and coconuts. In many SIDS these crops are the most important net foreign exchange earners. Agricultural exports represent between 20 to 90 per cent of the total trade exports. Livestock in SIDS is mainly based on poultry and pigs raised under traditional small-holder conditions, whereas commercial cattle production is a more recent development.

Source: FAO, 1999

101. SIDS have been taking initiatives to diversify agricultural production in response to declining revenues from traditional export crops (DESA, 2004). In general, SIDS are looking for opportunities to diversify their economies and especially the agricultural sector in order to move toward more marketable crops, to increase foreign exchange earnings, to maintain their agricultural basis, to increase their degree of food security and self-reliance by exploiting their resources more rationally and sustainably and to prevent unemployment from worsening (FAO, 1999). Food security is particularly important for a small, isolated island economy where a stable supply of food is often interrupted by natural disasters. Quite often, for these small islands, domestic food supply is the last resort for survival when natural disasters occur. This is particularly true for fragmented islands located far from their major markets, like in the South Pacific subsistence agriculture, which has provided basic necessity of foods to indigenous islanders, has been rapidly disappearing in all Pacific islands (Kakazu, 1994). Agriculture, which was the dominant industry in all Pacific islands during the 1950s, now accounts for 28 per cent (Samoa) to 1.4 per cent (Okinawa) of islands' gross domestic products (Kakazu, 2004). In many SIDS, government policy aims to modernize farming techniques; encourage export promotion and import substitution; and, through effective linkages with the tourism industry, reduce the leakage of foreign-exchange earnings.

F. Dry and sub-humid lands

102. Large areas in the Caribbean and Mediterranean consist of semi-arid and dry sub-humid lands, and most countries have areas falling within the dryland categories. Some small islands present extremely dry ecoregions, often exposed to the forces of winds along the coasts. In these areas, only hard plants such as cactuses and spiny shrubs survive. Some endemic animals have also adapted to the harsh conditions, including several reptiles. For instance the virgin gorda gecko inhabits the rocky hillsides of the British Virgin Islands. The Anegada ground iguana, a critically endangered species usually living in dry, limestone areas is always found on these islands. Dryland ecosystems in small islands are usually not suitable for agriculture because of low rainfall and soil infertility. However, these areas are also threatened by urbanization and increasing resort development. Feral and introduced animals, overgrazing and wood-cutting are important concerns.

103. Due to their fragile ecosystems, deforestation and overgrazing the small island developing States face severe soil erosion and areas of desertification are evident. For example, Cape Verde originally had extensive dry savannah woodland cover, most of which has now been cleared for agriculture. Deforestation, combined with an arid climate and steep terrain, has resulted in widespread soil erosion and desertification. (UNEP, 2004 (a)).

104. Droughts and desertification, which may be the cause and result of land degradation, respectively, are drivers of the loss of productive land resources in a number of SIDS.

G. Protected areas

105. As noted by Rosabal (2004), the role of protected areas is particularly important when considered in the context of islands as they have to respond to key challenges associated with their vulnerabilities. Island ecosystems deserve particular attention in relation to conservation priorities for a number of reasons, some of which are listed by Rosabal (2004) and Moreda *et al.* (2004):

(a) Biological resources are concentrated at the global level in some critical points or "hot spots" representing only 1 per cent of the planet's surface. Many of the insular systems coincide with "hot spots";

(b) From the 234 centres of plant diversity and endemism, 19 (8 per cent of the total) are located in small island States (WWF and IUCN, 1997);

(c) Some islands have remarkable high percentage of endemism of vascular plants, such as the island of Saint Helena and the Hawaiian islands, each with 83.3 per cent of endemism (WWF and IUCN,1997);

(d) Of the 50 countries with highest number of global threatened species of birds, 7 (14 per cent) are small island States, and some islands have high percentage of threatened species in relation to their total bird population, such as the Pitcairn Islands (42 per cent), French Polynesia (38 per cent) and the Cook Islands (26 per cent) (Birdlife International, 2000);

(e) Of the total number (76) of endemic-bird areas of the world of critical priority for conservation, 22 (29 per cent) are in islands (Stattersfield and Crosby, 1998);

(f) Of the global 200 ecoregions more important for biodiversity conservation, 22 (11 per cent) are associated to islands (Olson and Dinerstein, 1998) ,and;

(g) Coral-reef ecosystems, one of the most productive ecosystems on Earth, are associated to islands; for example the islands of the Caribbean region alone contain over 11 per cent of the world's reefs.

106. Despite the uniqueness of island biodiversity, only 4 per cent of the Ramsar sites and approximately 15 per cent of established biosphere reserves are located in islands, of which 6 per cent are in small islands (Moreda *et al*, 2004). The Galápagos Marine Reserve (2001) is an example of World Heritage site and biosphere reserve in small islands. Currently the World Heritage Centre, together with partners, is working towards establishment of a sustainable development and conservation corridor

between Galápagos and Cocos Island World Heritage sites and with small island sites in Panama and Colombia.

107. Over the last decade, the total number of protected areas in small islands has increased from 137 to 1037 and their coverage has tripled from the 2.3 million ha recorded in 1993 (Rosabal, 2004). They encompass different IUCN protected area management categories.

(a) There are examples 6/ of reserves established mainly for conservation and research purposes in islands. The Ngerukewid Islands Wildlife Preserve of Palau combining the pristine conditions of the islands and the relative lack of introduced species was established as a unique natural laboratory to study the terrestrial and marine biodiversity and ecological processes occurring in the Pacific, thus constituting an important baseline area for biodiversity research and for assessing the impacts of climate change to Pacific islands ecosystems. Similarly, close to 100 micro-reserves were established in Cuba to protect its rich flora and some restricted-range species of fauna. These small areas have contributed to the *in situ* conservation of these species which is often combined, particularly for plant species, with *ex situ* conservation programmes. Most of these reserves are managed by local governments, universities, and provincial botanical gardens and they have been used for environmental education and awareness programmes;

(b) In Dominica, about 21 per cent of the territory is now legally protected as wildland within its National Park and Forest Reserve System. Protecting rainforest habitats and enacting and enforcing legislation have contributed to noticeable recent increases in the populations of Dominica's two endemic and endangered parrot species –the imperial parrot (*Amazona imperialis*) and the red-necked parrot (*Amazona aurasiaca*).

108. Recent reports indicate that, while in 1993 emphasis was given to the establishment of nature reserves, wildlife sanctuaries and national parks (essentially IUCN Categories I to III for protected areas), more attention is now given to the establishment of managed resource protected areas (IUCN Category VI), which allows for the multiple use of natural resources within those areas by national governments (Rosabal, 2004). For example:

(a) In the Bahamas, the Exuma Cays Land and Sea Park established in 1958 became a no-take fisheries reserve in 1986, the first of its kind in the Wider Caribbean region and one of the first no-take marine reserves worldwide. Concentration of conch in the park is now 31 times greater than outside, providing several million conchs per year to areas outside the park available to be harvested by fishermen;

(b) In Saint Lucia, the Soufriere Marine Management Area includes four marine reserves covering 35 per cent of available fishing grounds. Conservation of species in these areas has increased by 46 per cent for large fish traps and 90 per cent for small fish traps in 5 years;

(c) In Samoa, in order to promote sustainable fisheries, the Fisheries Division initiated in 1995 a community-based extension project in 65 villages which recognized the village *fono* (council) as the prime responsible for action. After several years of existence of this network of small Fish Reserves the fisheries stocks have increased of 30 to 40 per cent and there are signs of recovery in reefs previously affected by destructive fishing methods;

(d) Other reserves have been established for recreation and tourism purposes. The financial revenue associated to the recreational use of the Virgin Islands National Park, for instance, is one of the most important sources of income for the population of the islands and also contributes financially to the conservation and management of the park. Similarly, the Bonaire Marine Park was created in 1979 covering all reef areas around the island. While the resident population of the island is less than 15,000 inhabitants, almost 17,000 to 20,000 scuba divers visit the park every year, thus representing the main economic activity of the island. The cost associated with the establishment of the park and the recurrent cost associated to its management was more than covered by visitor fees. The park also generates

6/ Examples were extracted mainly from: Rosabal, 2004.

employment to over 1,000 people. By 1994, the number of divers increased to 24,081 and annual visits totalled about 70,000.

109. Examples of community-conserved areas exist in islands. For example, in traditional fisheries, the re-introduction of *ra'ui* or marine protected areas on the Rarotongan Coast is an initiative of the *Koutu Nui*, the Cook Islands' formal body of traditional chiefs. Ra'ui is a form of *tapu* or ban imposed by the chiefs on fishing grounds and species they deem to be threatened. Ra'ui is considered the most appropriate form of reserve which retains historical links to the way Polynesian people had conserved their resources in the past (SCDB, 2004).

110. Traditional knowledge is being used for the conservation of components of biodiversity. The Ministry of Agriculture of Cuba has rescued traditional practices and species netting of communal gardens. These productions are being commercialized in parallel with the documentation of the local communities' knowledge. Saint Lucia has incorporated traditional and indigenous knowledge to protect cultural, historic and natural heritage at a subregional level.

H. Traditional knowledge, innovations and practices

111. Traditional knowledge is at the basis of most skills of island populations. Traditional biodiversity-related knowledge is a recognized aspect of customary life in small islands, with emphasis given to the conservation driven approach of the traditional cultures. Much of this knowledge is still relevant today and its retention is assisted by publications on histories and traditions. There is a high reliance placed by families upon native plants for food as opposed to purchased foodstuffs (SCDB, 2004).

112. In customary land and sea tenure arrangements, a large degree of control is traditionally maintained over use and exploitation of natural resources. Deterioration of such systems and knowledge about them is occurring as a result of westernization, industrialization, urbanization and accompanying alienation of the youth from their traditions. Although traditional systems were not always applied with a conservation ethic in mind, these controls were nevertheless practical management tools that developed over many generations to ensure the continued supply of particular food stocks or medicines. The decline in the use and knowledge of these systems goes hand in hand with a general erosion of the traditional authority of chiefs over people and resources and a move towards more individualistic and capitalistic socio-economic activity.

113. In the Pacific islands, like in most other SIDS, as aspirations for Western-style livelihoods and demands for material products increase, the traditional subsistence economies of countries are being supplemented or even replaced by cash economies and cash earning opportunities. This change in socio-economic systems has contributed to a number of the proximate threats to biodiversity, including the over-harvest of resources, habitat degradation and development pressures, along with increased waste production and environmental pollution (UNEP, 2004c).

114. Many farmers have now abandoned traditional crop varieties in favour of a few new "high-yielding" strains. In addition, wild relatives of these species are being lost as natural habitat is converted to other land uses. (FAO, 1999).

115. However, in many SIDS other traditional practices have been restored and adapted to the current needs. For instance, it has been observed that conventional approaches to fisheries management have not been effective in promoting sustainable resource utilization. As a result, innovative approaches to management that build on traditional institutions and conservation and management knowledge and practice are now considered to be more appropriate. This recognition has given rise to the promotion of community-based fishery management, which has been successfully demonstrated to be implementable in those island States populated by indigenous communities where marine-use tenure systems remain largely intact.

116. Moreover, there has been a growing awareness throughout SIDS in recent years of the need for regional cooperation for the protection of traditional knowledge and customary practices in relation to biodiversity. One of the key projects undertaken by South Pacific Regional Environment Programme, for instance, is the Capacity-Building for Environmental Management in the Pacific which is designed to

encourage Pacific Island countries to utilise their natural resources in a sustainable manner. A subsequent project proposed to follow will focus on using traditional knowledge systems to develop policies and legislation for conservation and sustainable use of biodiversity in the Pacific (SCBD, 2003).

V. CONCLUSIONS

117. The common denominator of island ecosystems is their uniqueness, their high level of endemism, and their susceptibility "to the effects of almost all types of natural, technological and human-related hazards" (Briceño, 2004). Generally, islands present high levels of endemism and a high number of species with small populations, limited large and few refugia, which makes them highly vulnerable to extinction. Indeed, islands present a high proportion of recorded extinctions and of current critically endangered species.

118. In addition to the fragile nature of island ecosystems, the small size of islands reduces their assimilative and carrying capacity. To the extent that land as a resource is limited, urban settlement and commercial development, agriculture and forestry practices, and conservation are in competition. Islands with limited land areas have limited capacity to either buffer or trade off natural and human environmental impacts (UNEP, 2004b). Moreover, "smallness" limits the capacity to cope with a series of interplaying factors. Small islands are subject to cumulative vulnerability to changes in frequency or intensity of extreme natural events (e.g. floods, droughts, hurricanes, storm surges), other natural hazards (e.g. volcanoes), and anthropogenic stress. In general, SIDS are disproportionately affected by climate change through sea-level rise, changes in sea temperature and their vulnerability to extreme weather events.

119. Size, whether measured by population, surface area or land to water ratio, has implications for sustainable development. In fact, each species and life-form in an ecosystem play a unique but significant role, which contributes to the resilience and robustness of the ecosystem. In small island States, maintaining these ecosystem characteristics is a priority as most of SIDS economies are based on their natural resources, which are essential in providing services to the society. For instance, most of the economies of the Pacific island countries (PIC) are still subsistence-based, and most Pacific islanders are dependant on local biological and other natural resources for survival (UNEP, 2004c). Degradation in the quality of environment lessens the level of service it can provide to meet domestic needs and contribute to export earnings (UNEP, 2002).

120. Relatively large coastal zones, in relation to the land mass, also make small islands prone to erosion. On islands ecosystems services and functions are closely interconnected. Indeed, it can be effectively argued that no part of any small island is sufficiently distant from the sea as to be totally free from its influence. Moreover, low resistance to outside influences facilitates the rapid and devastating spread of invasive alien species. Climate change and variability is also affecting vast proportions of island territories. Deforestation; unsustainable forestry, fisheries and agricultural practices; unmanaged tourism, mining and pollution are other threats to island biodiversity (FAO, 1999).

121. Given the small size and density of human settlements, as well as the generally fragile environment of small island States, the ecological functions and physical processes related to biodiversity are extremely important. In particular, economic development, based chiefly upon tourism, is highly dependent on the quality of its environment, which in turn is influenced significantly by those same ecological functions and physical processes related to its biodiversity.

122. The effect of the interplay of different factors on island biodiversity is shown by the combination of extreme fragility and increasing threat to which is added the fragility of economies, further reducing countries capacity to respond to the impacts of natural and human hazards. For SIDS, their economic vulnerabilities, largely due to the very high exposures of small states to the global economic conditions and the absence of economies of scale, can lead to serious instabilities. Moreover, SIDS have relatively small economies with limited financial capacity to protect high value biodiversity (endemic and endangered). This situation presents a special challenge for sustainable financing of conservation. Many

SIDS also have relatively small human populations and hence the skills sets and capacity to conserve island biodiversity can be disproportionately constrained.

123. These constraints prevent SIDS from investing in effective responses to the negative impacts of developments and natural hazards on their environments. Indeed, economic and social well being of many small islands is intimately linked to the preservation of the natural environment, including their biological resources.

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