Workshop and symposium on
Collaboration for sustainable development of the Pacific Islands: Towards effective e-learning systems on environment
27-28 February 2006
Okinawa, Japan

Review of Environmental Issues in the Pacific Region and the Role of the Pacific Regional Environment Programme

Stuart Chape
Programme Manager – Island Ecosystems
Secretariat of the Pacific Regional Environment Programme

The Region

The island countries and territories served by the Pacific Regional Environment Programme (see Figure 1) are characterised by extremes in physical characteristics, remoteness, exposure and vulnerability. There are approximately 8 million people speaking more than 2000 different languages, living on – with the exception of Papua-New Guinea - small high islands, raised coralline islands and low-lying atolls dispersed over the expanse of the south western Pacific Ocean. Socio-economic pressures and natural and human induced hazards exacerbate the region's vulnerabilities. The region faces a limited range of resources, dependence on imports, high population growth on many islands and increasing urbanisation, limited supplies of freshwater, high transaction costs, costly administration and infrastructure and limited institutional capacities and domestic markets. There is high species endemism and globally significant biodiversity, but relatively low species diversity. Soils and land resources are limited in capacity and ability to accommodate growing development demands, and coastal and marine resources are under increasing pressure. The degradation of ecosystems, land and marine resources impinge on the quality of life opportunities for many island communities.

Establishment and Role of the Pacific Regional Environment Programme

The South Pacific Regional Environment Programme (SPREP) was originally established as a result of a decision taken at the Conference on the Human Environment in the South Pacific held in Rarotonga in 1982. It was established as a separate entity within the South Pacific Commission (SPC – now the Secretariat of the Pacific Community) based in Noumea, New Caledonia; and formed part of the UNEP Regional Seas Programme. SPREP was also given responsibility for servicing two regional conventions, which came into force in 1990:

- the Convention on Conservation of Nature in the South Pacific adopted at Apia, Samoa in 1976 (known as the 'Apia Convention'); and

- the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and its Related Protocols, adopted at Noumea in 1986 (the 'SPREP Convention').

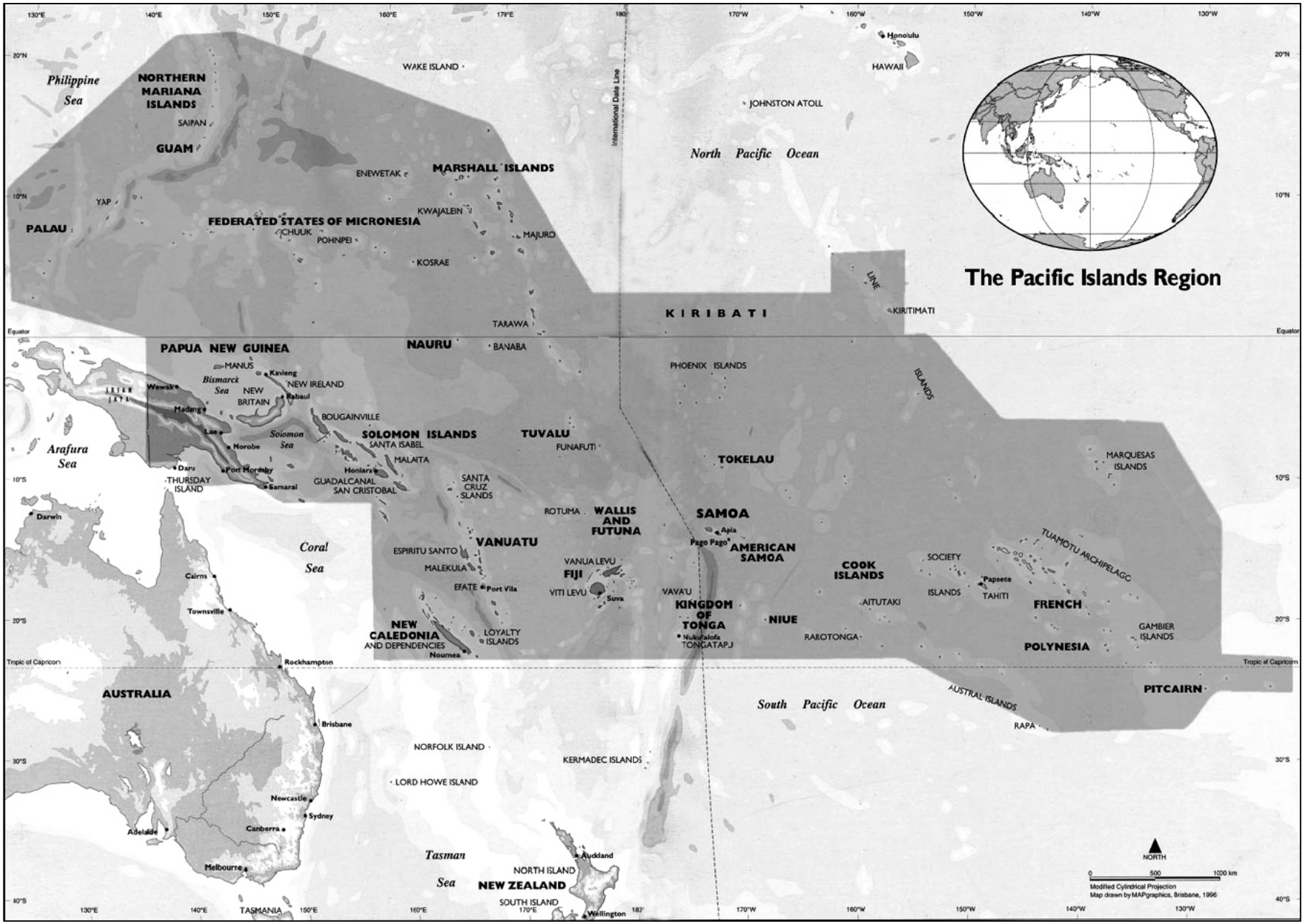


Figure 1: SPREP Member Countries and combined EEZs

Following decisions taken at the 3rd and 4th Intergovernmental Meetings of SPREP in 1990 and 1991, and subsequent endorsement by the 30th South Pacific Conference held in 1990, it was agreed by participating countries that SPREP should be an autonomous body. An agreement to establish SPREP on this basis was adopted in 1993 and to formalise its location at Apia, Samoa. A Secretariat was established to mange the programme, directed by an annual intergovernmental SPREP Meeting comprised of representatives of the participating governments[1]. In 2004 the member countries agreed to change the name of the programme to the Pacific Regional Environment Programme to better reflect its geographic scope that spans from 25° South to 20° North latitude, and 130° East to 125° West longitude. The 'SPREP' acronym, however, is retained through the Secretariat of the Pacific Regional Environment Programme.

SPREP Action Plan and Strategic Approach

The 1993 agreement states that the purpose of SPREP is to:

> "promote cooperation in the South Pacific region and to provide assistance in order to protect and improve its environment and to ensure sustainable development for present and future generations."

This is to be achieved through implementation of an Action Plan adopted by SPREP Meetings, which defines the strategies and objectives of the programme. The agreement specifies that the Action Plan must include:

- coordinating regional activities addressing the environment;
- monitoring and assessing the state of the environment in the region including the impacts of human activities on ecosystems, and encouraging development to maintain or enhance environmental qualities;
- promoting and developing programmes, including research programmes, to protect the atmosphere, and terrestrial, freshwater, coastal and marine ecosystems and species, while ensuring ecologically sustainable utilisation of resources;
- reducing, through prevention and management, atmospheric, land-based, freshwater and marine pollution;
- strengthening national and regional capabilities and institutional arrangements;
- increasing and improving training, educational and public awareness activities; and
- promoting integrated legal, planning and management mechanisms.

Based on these principles, the Action Plan has been reviewed and adjusted a number of times since the establishment of SPREP in 1993. The current version, for the period 2005-2009, was adopted at the 15th SPREP Meeting in 2004 following a review process that included national and community level consultations across the region (SPREP 2005a). The Action Plan provides the basis for the Secretariat to develop strategic programming and prepare annual work programmes and budgets to support national, regional and global priorities. The Action Plan notes that:

[1] American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, France, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, the United States of America, Vanuatu and Wallis and Futuna

> "In the context of the Action Plan, the following main high level instruments are of particular relevance: Agenda 21, the Barbados Programme of Action for Small Island Developing States (1994), National Assessments for the review of the Barbados Programme of Action (2003), the Johannesburg Plan of Implementation, the Pacific islands 14 Type II umbrella partnership initiatives, the WSSD Type II initiatives, Regional Synthesis for the review of the Barbados Programme of Action (2003), the Pacific Island Forum Leaders decisions, the SPREP Meeting Officials' and Ministerial decisions, national sustainable development strategies and plans, Pacific submissions made to the conferences of the Parties of global conventions and the Millennium Development Goals." (p. 8)

Three main focus areas with corresponding outcomes have been agreed by SPREP member countries:

1. *Natural Resources Management*

- The sustainable management and conservation of terrestrial, marine and coastal resources, ecosystems and species improved, through the development of programmes for sustainable development.
- Significant reduction of the current rate of biodiversity loss by 2010.
- Effective implementation of the ecosystem approach to natural resource conservation.

2. *Pollution Prevention*

- Effective management of pollution due to waste and other land based human activities through the implementation of appropriate systems for waste disposal and treatment.
- Pacific island countries and territories capabilities to manage and respond to terrestrial, atmospheric, marine pollution, hazardous waste, solid waste, sewage and other land-based sources of pollution enhanced.
- Maximised reuse, recycling and reduced waste generation.

3. *Climate Change, Climate Variability, Sea Level Rise and Stratospheric Ozone Depletion*

- Pacific islands countries and territories (PICTs) responses to the known and potential impacts of climate change enhanced through the implementation of adaptation measures.
- Alternative energy technologies and systems that are adequate, affordable, efficient and environmentally sound, in particular renewable energy resources developed and used.
- Meteorological and climatological capacities of PICTs developed and enhanced.
- Improved accuracy of information, modelling and clearinghouse mechanisms on the effects of climate change.
- Import of CFCs into PICTs banned by 2005.

In addition to national legislation, plans, policies and assessment reports, these components of the Action Plan also support a range of regional and global Instruments, agreements and strategies (see Annex 1). The Action Plan also identifies implementation mechanisms for priority attention, the issues of integrated policy, planning and partnerships; environmental monitoring and reporting; multilateral environment agreements (MEAs) and processes; human resources development and training; public awareness and education, and knowledge management.

The Secretariat develops its strategic programmes and annual work plans based on the Action Plan, although the Strategic Programme has a 10-year time frame (subject to review and monitoring) – currently 2004-2013 (SPREP 2005b). This programme has refocused and redesigned the way the Secretariat operates, moving away from previous organisational structures and project orientation. Projects are still important and will continue to play a valuable role in SPREP's work, but they do so within the context of achieving programmatic goals for the benefit of SPREP members. Two operational programmes have been established:

- **Programme 1: Island Ecosystems**

Goal: Pacific island countries and territories able to manage island resources and ocean ecosystems in a sustainable manner and that support life and livelihoods.

The programme focuses on sustainable management and conservation of the terrestrial, coastal and marine ecosystems of Pacific islands. Sub-programmes deal with nature conservation and island biodiversity, coastal and marine issues including marine species, alien invasive species and capacity development.

- **Programme 2: Pacific Futures**

Goal: Pacific island countries and territories able to plan and respond to threats and pressures on island and ocean systems.

This programme focuses on supporting member countries and territories with sustainable development policies for improved environmental governance. Issues of concern include improving monitoring and reporting on environmental performance and socioeconomic pressures on the environment; improving the understanding and strengthening the capacity of Pacific islands to respond to climate change and variability, and sea level rise; marine pollution, hazardous and solid waste, sewage and other land-based sources of pollution.

The principle of sustainable development underpins SPREP's strategic approach, focusing on biodiversity and the natural environment, economic activity, and the cultures, traditions, social situations and welfare of Pacific island peoples. The overarching objectives and principles necessary to achieve sustainable development that guide SPREP's work include:

- promoting an environment that alleviates poverty, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base for economic and social development;
- promoting the long-term sustainable use and development of resources for intergenerational equity;
- promoting a transparent operating environment;
- promoting and using participatory community approaches in development processes;
- promoting equal opportunities for men and women and aim to benefit all, particularly women, youth, children and vulnerable groups;
- promoting the appropriate transfer of technology and strengthening our information clearinghouse role and functions to support SPREP members;
- collaborating with other regional and international organisations, members, civil society, and the private sector, to strengthen efforts and develop effective partnerships;

- assisting to further build national capacity by providing professional, competent and timely policy and technical advice, institutional strengthening and human resource development support.

Pacific Island Environments

The 22 Pacific Island nations and territories in the SPREP region are scattered across a vast area of the Pacific Ocean. They are characterised by a range of oceanic biogeographical and geomorphological features, from large, mountainous islands, predominately in Melanesia, to smaller volcanic high islands and extensive atolls in Polynesia and Micronesia, and raised coralline limestone islands, such as Nauru and Niue. This terrestrial and marine biophysical diversity, and the geographical isolation of many islands, generally increasing in a west to east direction across the Pacific, is reflected in high levels of species endemism. There is also considerable climatic range, from tropical to sub-tropical and temperate climates. Although the ocean area is enormous, with a combined Exclusive Economic Zone (EEZ) of more than 30 million km², the land area is comparatively minute at almost 552,000 km² (see Table 1).

Table 1: Geographic Features of Regional Countries and Territories
(Source: + *Pacific Environment Outlook 2005 * Pacific Islands Population Update 1995*)

	Main Island Type	Land Area+ (km^2)	EEZ* (km^2)
American Samoa	High islands and atolls	200	390,000
Cook Islands	High islands and atolls	237	1,830,000
Federated States of Micronesia	High islands and atolls	701	2,978,000
Fiji	High islands and atolls	18,333	1,290,000
French Polynesia	High islands and atolls	3,521	5,030,000
Guam	High island – part coralline plateau	541	218,000
Kiribati	Predominantly atolls	811	3,550,000
Marshall Islands	Atolls	181	2,131,000
Nauru	Raised coral islands	21	320,000
New Caledonia	High islands	19,103	1,740,000
Niue	Raised coral islands	259	390,000
Northern Mariana Islands	High and raised coral islands	471	1,823,000
Palau	High islands	488	629,000
Papua New Guinea	High islands – few small atolls	462,243	3,121,000
Pitcairn Island	High, raised coral islands and atolls	39	800,000
Samoa	High islands	2,935	120,000
Solomon Islands	High islands – a few atolls	28,370	1,340,000
Tokelau	Atolls	12	290,000
Tonga	High and raised coral islands	688	700,000
Tuvalu	Atolls	26	900,000
Vanuatu	High islands – few small atolls	12,190	680,000
Wallis and Futuna	High islands	255	300,000
		551,625	**30,570,000**

The discovery and settlement of these islands by Melanesian, Polynesian and Micronesian people occurred over thousands of years, from the early settlement of Papua-New Guinea (PNG) 46,000 years ago to the more recent occupation of more distant islands by Polynesians by 1200 AD (Diamond 2005). The discovery and colonisation of the Pacific islands, many of which are thousands of kilometres from other islands, is recognised as one of the greatest feats of human endeavour. However, similar to other regions of the world, human occupation and settlement has had major impacts on native species, existing ecosystems and landscapes. It is now known that many fauna species were extirpated on Pacific islands (Steadman 1995, Mead *et al.* 2002, Steadman and Martin 2003), and ecosystems often radically altered, for example, from their original forests to grasslands, as a result of hunting, burning and cultivation; other impacts resulted from the introduction of

domestic animals and rats. On the Tongan island of ‘Eua, Steadman and Martin (2003) report the extinction or extirpation of 46 vertebrate species (“26 landbirds, 12 seabirds, 5 bats, and 3 lizards”, p. 135) by about 850 BC, following human settlement. Human impact on island ecosystems was, and is, a complex interaction of abiotic, biotic and cultural factors – see Tables 2 and Figure 2.

TABLE 2: A summary of the Abiotic-Biotic-Cultural model - factors that influence extinction of vertebrates on oceanic islands after human arrival
(Source: Steadman and Martin 2003)

	Promotes extinction	**Delays extinction**
Abiotic factors		
A1. Island size	Small	Large
A2. Topography	Flat, low	Steep, rugged
A3. Bedrock	Sandy, or noncalcareous sedimentary	Limestone or knife-edge volcanics
A4. Soils	Nutrient-rich	Nutrient-poor
A5. Isolation	No adjacent islands	Many nearby islands
A6. Climate	Seasonal aridity	Reliably wet
A7. Sea level	High stands (atolls only)	Low stands (atolls only)
Biotic factors		
B1. Plant diversity	Depauperate	Rich (short-term delay only)
B2. Faunal diversity	Depauperate	Rich (short-term delay only)
B3. Terrestrial mammals	Absent	Present
B4. Marine resources	Depauperate; easy access	Rich (temporary delay only); difficult access
B5. Species-specific traits	Ground-dwelling; flightless; large; tame; palatable; colourful feathers; long and straight bones for tools	Canopy-dwelling; volant; small; wary; bad taste; drab plumage; short and curved bones
Cultural factors		
C1. Occupation	Permanent	Temporary
C2. Settlement pattern	Island-wide	Restricted (coastal)
C3. Population growth and density	Rapid; high	Slow; low
C4. Subsistence	Horticulture as well as hunter-fisher-gatherers	hunter-fisher-gatherers only, especially if marine-oriented
C5. Introduced plants	Many species; invasive	Few species; noninvasive
C6. Introduced animals	Many species; feral populations	Few or no species; no feral populations

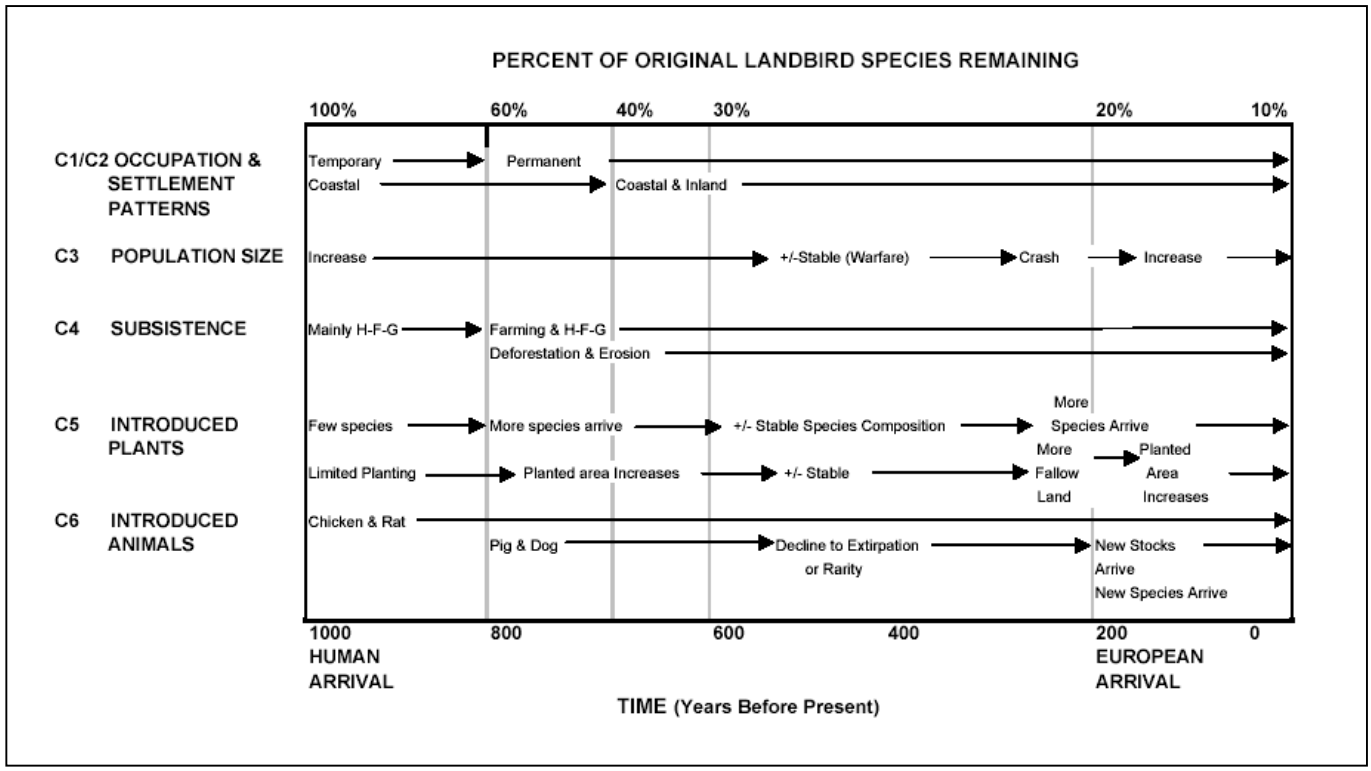
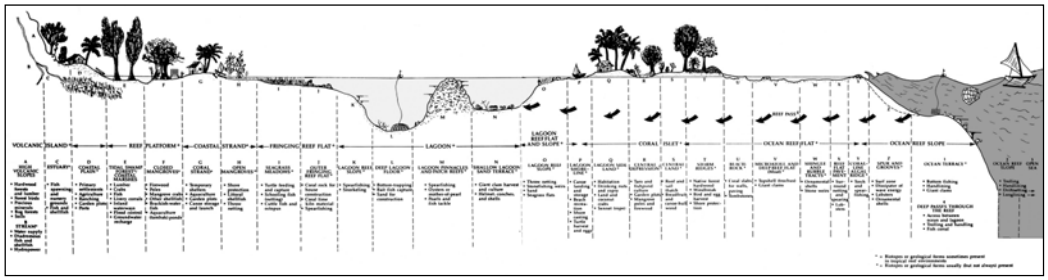
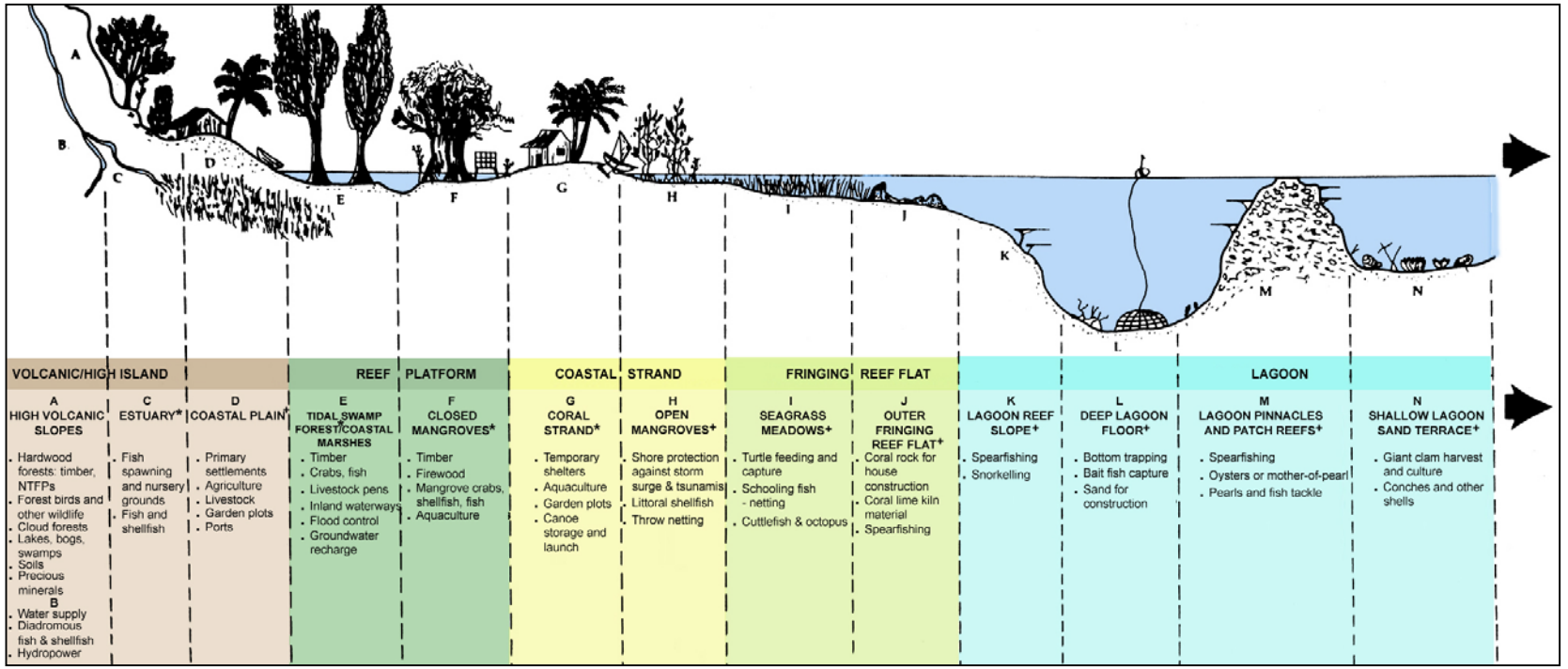


Figure 2: Hypothetical example of cultural (C) factors, taken from the ABC model (Table 1), that drive anthropogenic extinction on Pacific oceanic islands
(Source: Steadman and Martin 2003)

While many societies lived sustainably in island ecosystems, others failed in their endeavour to survive as coherent societies either permanently, temporarily or were set on the course to long term decline, such as Rapanui, Mangareva, Pitcairn and Henderson islands ((Diamond 2005). The constraints faced by Pacific island societies throughout thousands or hundreds of years were not much different to the constraints and issues faced by island people today. These included: limited arable land, often limited freshwater, population growth and depletion of natural resources, dependence on marine resources, vulnerability to extreme events (cyclones, earthquakes, tsunamis), climate change and variability (sea level change, droughts, floods) and, in some cases, dependence on external trade relationships to supply certain commodities (such as stone for tool making, shells, bird feathers). Island society responses to these constraints included various social controls on resource use, population control and voluntary or forced migration to other islands.

With the possible exception of PNG with its vast inland area, and even then only a matter of degree, all Pacific islands have ecological, subsistence and now commercial relationships with their coasts and seas. In fact, for most islands it is irrelevant to artificially define 'coastal zones' in the context of ecologically sustainable development, since ecological connectivity – and therefore development impacts – occurs from mountaintop, to watershed to lagoon and reef. In addition, although the classic typology of high island, low island and atoll is reflected across the Pacific, there are also many islands that combine many of these features. Figure 3 is a representation of biophysical features, human traditional subsistence and some modern commercial uses of resources along a theoretical high to low island cross-section.





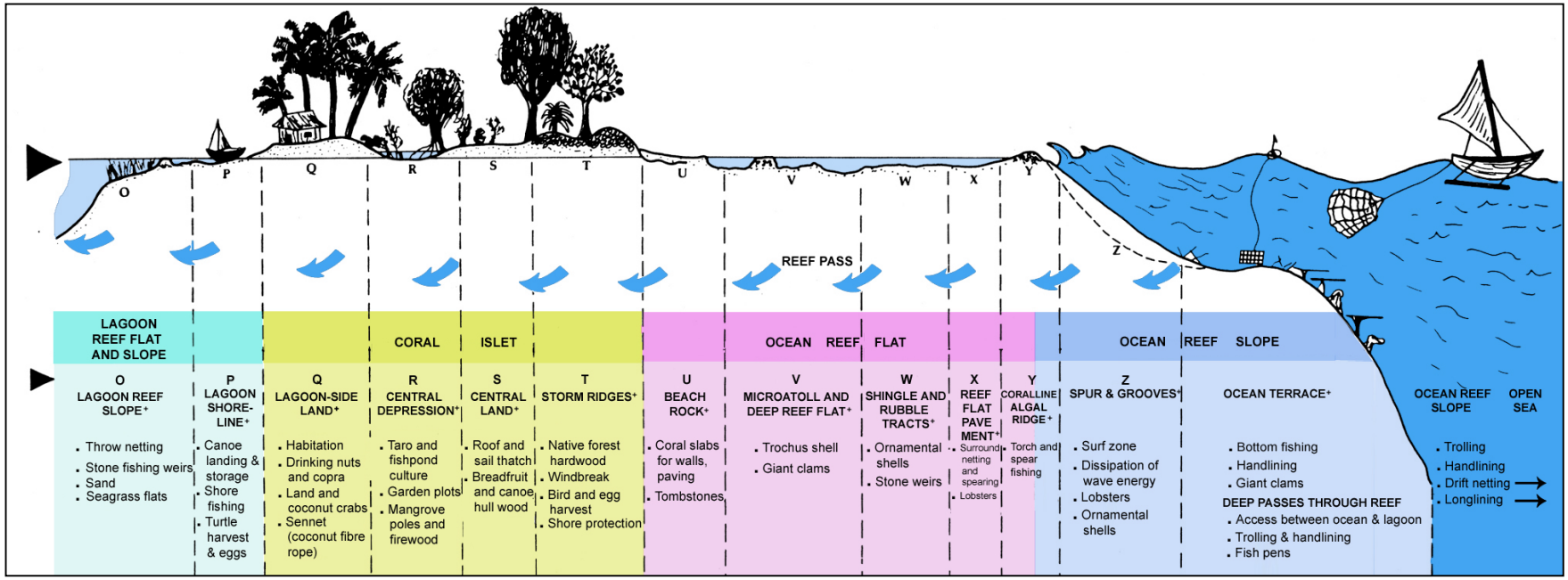


Figure 3: High to low island ecological cross-section showing indicative biophysical features, human traditional subsistence and some commercial uses of resources

(Adapted from Carpenter and Maragos 1989)

* Ecological or geomorphological features sometimes present in Oceanic island environments **+** Ecological or geomorphological features usually (but not always) present

Pacific Islands Environmental Issues

Overview

The major environmental issues facing Pacific island countries and territories (PICTs) have been identified, analysed and articulated for more than a decade. The 1990s were characterised by an intense level of support for many Pacific countries; for example, through the preparation of National Environment Strategies for seven countries through SPREP, funded by Asian Development Bank regional technical assistance, and a National Environment Strategy for Fiji funded bilaterally by the ADB. This strategic environmental work provided a basis for national reporting to the 1992 UN Conference on Environment and Development (UNCED).

The major outcomes of UNCED were the Convention on Biological Diversity (CBD) and Agenda 21 – both of which have driven the environmental and sustainable development agenda forward since 1992, reinforced by the World Summit on Sustainable Development (WSSD) in 2002 and the adoption of the Johannesburg Plan of Implementation. The establishment of the Global Environment Facility (GEF) following UNCED has provided millions of dollars for investment in environmental projects, including US$60 million for Pacific countries. The Millennium Summit in 2000 adopted the Millennium Development Goals, a set of targets and indicators to reduce poverty and achieve sustainable development. In addition, the concept of Small Island Developing States (SIDS) was formalised at a meeting held in Barbados in 1994, which adopted the Barbados Programme of Action for the Sustainable Development of Small Island Developing States (BPOA). A follow-up meeting, BPOA+10, was held in Mauritius in 2005. Pacific island countries are also engaged in a suite of environmental conventions in addition to the CBD, including the UN Framework Convention on Climate Change (UNFCC), the Vienna Convention and Montreal Protocol and, more recently, the UN Convention to Combat Desertification (UNCCD - 14 countries have joined this convention since 1999). All of these agreements require national action and reporting from participating countries, a major burden on the capacity of PICTs with their limited staff resources in national agencies to undertake this work while progressing much-needed ‘on-ground’ environmental programmes. Perhaps somewhat ironically, the GEF has initiated a National Capacity Self Assessment (NCSA) process to enable countries to assess the progress and barriers to national implementation of the UNFCC, CBD and UNCCD. As part of this process a further round of strategies, National Sustainable Development Strategies (NSDSs), has been advocated to progress the environmental policy agenda. Table 3 lists the reporting undertaken by Pacific countries since 1992.

Has this analytical, strategic and policy work made a difference to the state of Pacific environments? Unfortunately, current evaluations of environmental conditions throughout the region suggest not. It is true that general awareness of environmental concerns has undoubtedly been raised as a result of national, regional and global agendas, and much good work has been done at sector and project level. However, the fact is that major environmental issues and problems have not been effectively dealt with – in fact in most cases their severity has increased, such as waste and pollution, loss of biodiversity, depletion of marine resources and population increase. Of course, the Pacific is not alone. At the global level, a principal finding of the Millennium Ecosystem Assessment (MA 2005) was that:

> "Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber, and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth."

Within this larger context some aspects of the PICTs' environmental and sustainable development situation compare favourably with other regions of the world. For example, this region has the healthiest reefs, and absolute poverty is not widespread. However, present trends cannot be ignored, nor can the fact that current environmental issues were identified a decade ago and remain unresolved.

Table 3: Reports containing national priorities for sustainable development
(McIntyre 2005)

	UNCED Country Report	NEMS	UNFCCC National Report	CBD NBSAP	WSSD/BOPA+10 National Assessment	UNCCD Country Report	Civil Society Report
Cook Islands	✓	✓	✓	✓	✓	✓	✓
Federated States of Micronesia	✓	✓	✓	✓	✓	✓	✓
Fiji	✓	✓	✓	✓	✓	✓	✓
Kiribati	✓	✓	✓	✓	✓	✓	✓
Marshall Islands	✓	✓	✓	✓	✓	✓	
Nauru	✓						✓
Niue	✓	✓	✓	✓	✓	✓	
Palau	✓	✓	✓			✓	✓
Papua New Guinea	✓		✓		✓	✓	
Samoa	✓	✓	✓	✓	✓	✓	
Solomon Islands	✓	✓	✓		✓	✓	✓
Tonga	✓	✓			✓	✓	✓
Tuvalu	✓	✓	✓			✓	
Vanuatu		✓	✓			✓	✓

Source: Conservation International and SPREP 2004
NEMS = National Environment Management Strategy; civil society reports were conducted by the Pacific Concerns Resource Centre using support from the Earth Council and SPREP in the lead-up to WSSD.

Two recent major reports, the ADB *Pacific Region Environmental Strategy (PRES) 2005-2009* (ADB 2004) and the UNEP-SPREP *Pacific Environment Outlook* (McIntyre 2005) synthesize and discuss a range of environmental and development information on the Pacific. The analyses in these reports are used as a basis for the discussion in this paper. The reports concur on the key characteristics of Pacific islands as:

- *Geographical Isolation*

While contributing to the unique cultural development, ecological diversity and species endemism of the Pacific, the vast distances between many islands, both nationally and intra-nationally (for example, in the case of Kiribati) and between islands and major trade centres, imposes major constraints on development. Although electronic communications has improved significantly in the last decade, countries and territories are dependent on long distance shipping or more expensive airfreight for their imports and exports. With declining (and eventually depletion of) fossil fuel reserves costs will continue to escalate, straining even more the tenuous economies of many PICTs – unless viable fuel alternatives are found to support regional (and global) transportation networks.

- *Limited Land Resources*

Except for PNG, all Pacific islands have limited land resources. This is especially so for the atoll countries and territories, but also for the smaller high islands where the area of available flat land for development, especially urban areas, is often as limited as it is for atolls. A number of countries have attempted to deal with this problem by reclaiming shorelines, usually at the cost of reefs, mangroves and seagrass beds. Availability of land resources are expected to become even more problematic with predicted sea level rises resulting from climate change but, again, sea level rise will also affect the low-lying coastlines (including reclaimed shoreline) around high islands. Apart from the extent of available land for development, terrestrial resources in general are limited on most islands, in particular arable soil and forests. In many cases these have been depleted historically, and in others more recently.

- *High Population Growth Rates*

Pacific island populations have expanded rapidly over the past 100 years with improved health care and development, even taking into account significant migration to other countries. Although the ADB PRES considers that "pressures are now easing as population growth rates are beginning to slow", growth rates are still very high in a number of countries and territories (see Table 4) and there is concern that on some islands this is clearly unsustainable if development goals are to be achieved. Seven PICTs have population growth rates between 3-6 per cent per annum, and another six have a 2 per cent growth rate - with some of the highest rates in atoll countries and small high islands. As well as high growth rates many islands have high population densities. For example, South Tarawa in Kiribati has a population density in excess of 2,000 people per km².

Table 4: PICT Demographic, Social and Economic Data
(McIntyre 2005)

	Population	Annual Growth Rate (%)	Density (people/km^2)	Urban Population (%)	GDP Per Capita (US$)
American Samoa	52,291	4	261	48	3,950
Cook Islands	18,027	0	76	59	7,785
Federated States of Micronesia	107,008	2	152	27	2,058
Fiji	775,077	1	42	46	2,353
French Polynesia	245,405	2	70	54	19,802
Guam	154,805	2	286	38	16,077
Kiribati	84,494	1	104	37	785
Marshall Islands	50,840	4	281	65	1,817
Nauru	9,919	3	472	100	2,500
New Caledonia	196,836	3	10	71	-
Niue	1,788	-1.3	7	32	4,845
Northern Mariana Islands	69,221	6	147	90	7,939
Palau	19,129	2	39	71	6,157
Papua New Guinea	5,190,786	2	11	15	838
Pitcairn Island	48	na	1	88	na
Samoa	176,710	1	60	21	1,766
Solomon Islands	409,042	3	14	13	460
Tokelau	1,537	-0.9	128	0	na
Tonga	97,784	0	151	36	1,798
Tuvalu	9,561	2	368	42	1,640
Vanuatu	186,678	3	15	18	1,441
Wallis and Futuna	14,944	1	59	0	na
	7,871,930				

- *Dependence of Marine Resources and Environments*

Use of marine resources continue to be an important factor in PICT subsistence and formal economies, supporting local inshore fisheries as well as commercial fishing activities in

EEZs. Reefs and mangroves provide buffers against storm surge and embayments and harbours are an important part of regional shipping networks.

- *Important Ecosystems and Unique Species Conservation Values*

Geographical isolation has resulted in the evolution of unique species and communities of flora and fauna, many of which are endemic to one island or island group within the region. These species often have small populations, making them vulnerable to loss or overexploitation and habitat degradation. The Pacific region has the greatest extent, and generally least degraded coral reefs in the world and the region has the highest marine diversity in the world.

- *Vulnerability*

Pacific island countries and territories have high environmental and economic vulnerability, which is a key factor in their prospects for achieving sustainable development. They are not only vulnerable to environmental impacts resulting from poor development decisions as well as natural events (see Table 5), but also to the vagaries of global and regional trade and to the tyranny of distance to international markets for their limited range of export products.

Table 5: Estimated level of vulnerability of selected PICTs to specific natural hazards
(Source: UNDP South Pacific Office 2002)

	Tropical Cyclone	Storm Surge	Coastal Flood	River Flood	Drought	Earthquake	Land-slide	Tsunami	Volcanic Eruption
Cook Islands	H	H	M	L	H	L	L	M	-
Fiji	H	H	H	H	H	H	H	H	L
FSM	M	M	H	-	H	L	L	M	-
Kiribati	L	M	H	-	H	L	L	L	-
Marshall Is.	H	H	H	-	H	L	L	L	-
Nauru	L	L	L	-	H	L	L	L	-
Niue	H	H	L	-	H	M	L	M	-
Palau	H	H	M	-	H	L	L	M	-
PNG	H	H	H	H	H	H	H	H	H
Samoa	H	H	H	M	L	M	H	H	M
Solomon Is.	H	H	H	H	H	H	H	H	H
Tokelau	H	H	H	-	M	L	L	M	-
Tonga	H	H	H	L	H	H	L	H	H
Tuvalu	H	M	H	-	H	L	L	M	-
Vanuatu	H	H	H	H	H	H	H	H	H

Key: H high; M medium; L low level of vulnerability

Priority Environmental Challenges Facing Pacific Island Countries and Territories
Taking into account the fundamental characteristics of Pacific islands, the ADB PRES (ADB 2004) identifies eight challenges of the highest priority:

1. Freshwater resources
While larger islands, especially Papua-New Guinea (PNG), have watersheds with rivers and streams, availability of freshwater is a major issue on small islands and atolls, which tend to be dependent on rainfall collection and extraction of limited groundwater lens reserves. Severe water shortages are experienced on many of these small; islands. Nevertheless, even availability of water does not necessarily guarantee access to *safe* water. For example, in 2001, 85 percent of Tuvalu's population had access to safe water, 99 percent in the Cook Islands, but only 41 percent in PNG (ADB 2001). Freshwater resources are threatened by:

- damage to and/or poor management of watersheds (logging and erosion, agriculture including use of pesticides, pollution, diversion);
- over-abstraction of groundwater lenses, and development that damages or drains the lens (for example, excavations that allow saltwater penetration;
- climate change (predicted to alter the rainfall patterns and quantity) and sea level rise (increased saltwater intrusion into groundwater lenses);
- unplanned urban development and increasing population pressures that place too high demands on supplies;
- poor waste disposal systems that pollute groundwater and streams; and
- poor maintenance of water supply infrastructure and excessive wastage.

Integrated water resource management is urgently needed in all countries, including improved watershed management and reduced deforestation, linked to broader national sustainable development planning. Evaluations of watershed risk, such as one recently carried out in Fiji (Figure 4) are an essential step in an integrated approach to planning and management.

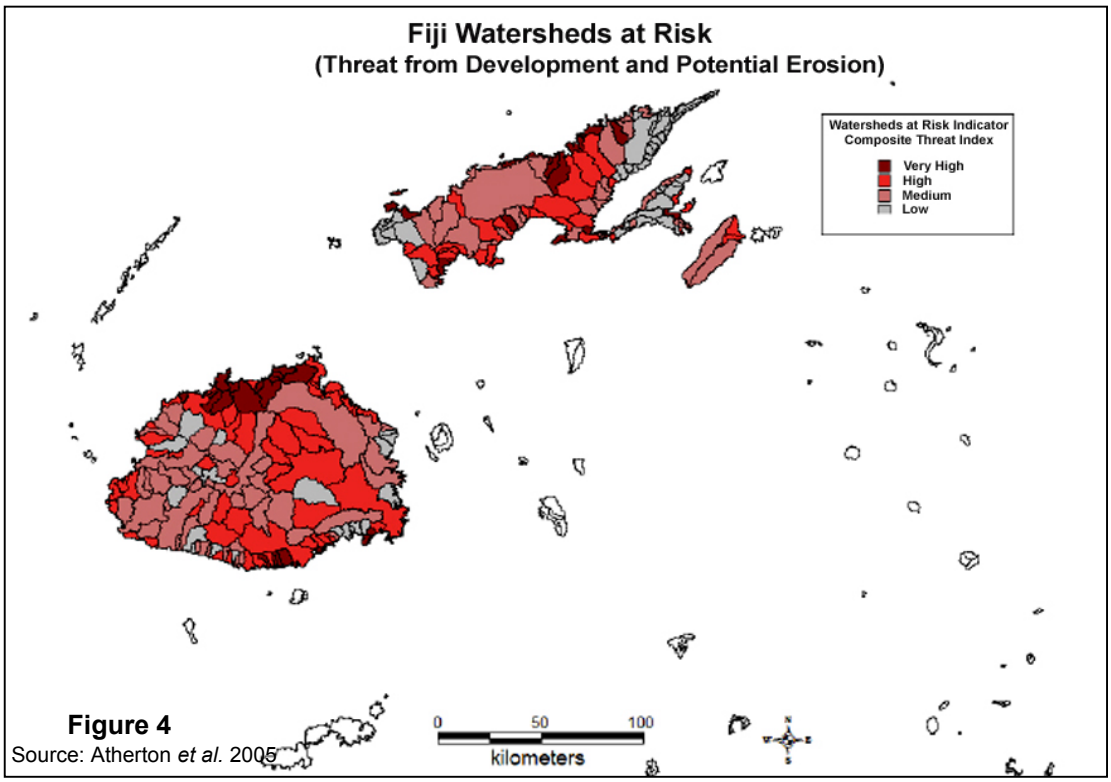


Figure 4
Source: Atherton *et al.* 2005

2. Degradation of land and forests

The *Pacific Environment Outlook 2005* (McIntyre 2005) notes that: "for most Pacific societies, land resources are the basis for the majority of subsistence and commercial production". It notes that these resources are being affected by:

- socioeconomic pressures created principally by high population growth rates and/or density;
- displacement of traditional land and resource management systems;
- introduced agricultural systems;
- land shortage;
- land tenure conflict;
- mining;
- deforestation; and
- poor development practices.

The impacts of these factors include:

- loss of vegetation and other habitats, with associated impacts on island biodiversity;
- extension of agriculture into marginal land (as seen in the cultivation of sugarcane and ginger in Fiji);
- excessive use of chemicals;
- overgrazing
- erosion of watersheds and downstream sedimentation impacts, including damage to lagoons and coral reefs; and
- introduction of invasive species.

Many of these land degradation issues are closely related to forest exploitation on Pacific islands. Forest cover is highly variable across the Pacific, from virtually non-existent on some low islands to as high as 86 percent in PNG ((McIntyre 2005). Logging has been an important part of the economy of a number of countries, principally in Melanesia. For example, in 1995 the forestry sector earned PNG over US$300 million¸ and in the Solomon Islands 30 percent of the workforce was employed in forestry (ADB 2004). However, in Melanesia "only limited attention is being given to improving management systems so that the resource can become sustainable" (ADB 2004) despite the implementation of sustainable and ecoforestry projects, and the adoption of codes of logging practice. If proper resource accounting was undertaken, taking into account economic losses resulting from increased erosion impacts on marine environments, the loss of traditional forest and non-timber products that may support local communities, as well as impacts traditional agroforestry farming systems, then the profits of logging are likely to be considerably less than they first appear.

3. Urbanization, waste management and pollution

Generation and disposal of solid and liquid waste is a growing problem in Pacific islands as populations increase and become more urbanized, and demand for disposable commodities increases as economic development progresses. In 14 PICTS the urban population is already close to or exceeding 40 percent (McIntyre 2005). Inadequate disposal systems have resulted in contamination of groundwater, rivers and coastal lagoons. Fiji provides a number of examples. The Suva City dump at Lami, operated for decades on the shore of the Suva lagoon, was only closed down in 2005 following the construction of a proper sanitary landfill at Naboro. Even by 1990 the dump had exceeded its surface capacity and was growing vertically to cope with the amount of garbage. The immediate lagoon area is heavily used for recreational and fishing purposes and contaminated leachates are expected to pollute the immediate area for decades to come. Similarly, the Nausori town dump was on the banks of the Nausori River until 2005, polluting the river through leachates and runoff and susceptible to being washed away in floods (Watling and Chape 1992). The Lautoka and Savusavu dumps are still located in mangrove areas on the shoreline in western Viti Levu and Vanua Levu respectively. In some countries the change to more effective waste disposal systems is resulting in improved disposal systems, thanks to financial and technical support from bilateral and multilateral funding agencies. In Suva the new landfill site was finance by the European Union, and a new landfill was recently opened in Apia as a result of technical assistance and funding provided by the Japanese International Cooperation Agency (JICA).

Movement from rural areas and outlying islands is straining the capacity of many of the Pacific's urban centres. In some countries unplanned squatter settlements is increasing existing problems of urbanization. Urban expansion requires more investment in basic infrastructure to service new areas and places higher demands on water supplies, energy, communications and transport networks. The air quality in many towns is also declining due to poorly controlled industrial development and vehicle emissions. A number of countries are also affected by persistent organic pollutants (POPs), some by the residual effects of nuclear testing and others with the presence of contaminated World War 2 shipwrecks in lagoons, such as Chuuk in Micronesia.

4. Depletion of biological diversity

As noted elsewhere in this discussion, the Pacific region has biological diversity of outstanding global as well as regional and national value. In addition, the region is critically important for the survival of migratory species, including several bird species, cetaceans and turtles. However, terrestrial biodiversity in particular is highly vulnerable to habitat change and over-exploitation and, as noted previously, the Pacific island region has been characterized by human-induced extirpation and extinction. Ninety percent of bird species that have become extinct since 1800 were island species (McIntyre 2005). On a global basis the largest number of documented extinctions (28 between 1600 and 1899) has occurred on islands of Oceania, which now have more threatened species (110) than any other region (Given 1992). A recent analysis of global biodiversity hotspots indicates that the Conservation International designated Polynesia–Micronesia hotspot (see Table 5) is among those that can least afford additional habitat loss because of previous destruction and fragility of ecosystems and species (Brooks *et al.* 2002). Virtually all the other issues raised in this section threaten the viability of the region's biodiversity, but especially forest and watershed degradation, logging, climate change and over-exploitation of marine resources. However, there is a growing interest by Pacific island governments to establish protected area systems and also, importantly, by communities who have customary ownership of resources to establish community conserved areas and locally managed marine areas (LMMAs). Fiji is leading the way in the establishment of LMMAs and local leaders recently announced plans for the protection of Fiji's Great Sea Reef, the third longest barrier reef in the world. Similarly, the announcement by President Remengesau, Jr. of Palau in November 2005 called for Micronesian countries to join the 'Micronesia Challenge' is to be applauded.

Specifically, the challenge calls for these countries to effectively conserve 30 percent of near shore marine resources and 20 percent of forest resources by 2020.

Table 6 lists protection needs for ecosystems and organisms in the Pacific.

Table 5: Summary of Numbers of Native and Endemic Species in Major Taxonomic Groups by Country for the Polynesia-Micronesia Hotspot
(Source: Conservation International and SPREP 2004)

	Native Vascular Plants		Breeding Birds		Native Mammals		Native Reptiles		Native Amphibians		Native Land Snails	
	Species Known	% Endemic	Species Known	% Endemic	Species Known	% Endemic	Species Known	% Endemic	Species Known	% Endemic	Species Known	% Endemic
American Samoa	373	3	34	0	3	0	11	0	0	0	47	na
CNMI	221	37	28	7	2	0	11	0	0	0	na	na
Cook Islands	284	12	27	26	1	0	na	na	0	0	na	na
Easter Is.	na	na	na	na	0	0	na	na	0	0	0	0
Fiji	1,628	50	74	35	6	17	25	36	2	100	na	na
French Polynesia	959	58	60	43	0	0	10	0	0	0	>160*	na
FSM	782	24	40	45	6	83	na	na	0	0	na	na
Guam	330	21	18	11	2	na	11	9	0	0	27	na
Hawaii	1,200	83	112	55	1	0	na	1	0	0	763	98
Kiribati	22	9	26	4	0	0	na	0	0	0	na	na
Marshall Islands	100	5	17	0	0	0	7	0	0	0	na	na
Nauru	54	2	9	11	na	na	na	0	0	0	na	na
Niue	178	1	15	0	1	0	4	0	0	0	na	na
Palau	175	na	45	22	2	50	22	5	1	100	68	na
Pitcairn Island	76	18	na	na	0	0	na	na	0	0	~30	~15
Samoa	770	15	40	20	3	0	8	0	0	0	64	na
Tokelau	32	0	5	0	0	0	7	0	0	0	na	na
Tonga	463	5	37	5	2	0	6	17	0	0	na	na
Tuvalu	44	0	9	0	0	0	na	0	0	0	na	na
US Minor Islands	na	na	na	na	0	0	na	na	0	0	na	na
Wallis and Futuna	475	15	25	0	1	0	na	0	0	0	na	na
HOTSPOT TOTAL	**~6,500**	**50**	**254**	**60**	**16**	**56**	**69**	**54**	**3**	**100**	**na**	**na**

na = data not available CNMI = Commonwealth of the Northern Mariana Islands FSM = Federated States of Micronesia
* Society islands only; note that species totals do not always add up because some species are distributed in more than one country.

Table 17: Protection Needs for Ecosystems and Organisms in the Pacific Region
(Source: Thaman 2002)

Category	Melanesia	Polynesia	Micronesia
Ecosystems			
Uninhabited islands	2	3	3
Coastal littoral and mangrove forests	2	3	3
Lowland forests	2	3	3
Montane/cloud forests	2	2	2
Rivers and lakes	3	3	3
Wetlands/swamps	2	3	3
Shifting agroforestry lands and agroforests	2	3	3
Semi-permanent/intensive agricultural areas	2	2	3
Houseyard and village gardens	2	2	3
Selected productive reefs	3	3	3
Intertidal zone and sea grass beds	2	3	3
Reef passages	2	3	3
Coral reefs	3	3	3
Terrestrial Organisms			
Native coastal and mangrove plants	2	3	3
Native inland trees and plants	2	3	3
Cultivated trees and plants	2	3	3
Plant cultivars/varieties	2	3	3
Native insects/arthropods	2	3	3
Land crabs	2	3	3
Native molluscs	2	3	3
Other native invertebrates	2	3	3
Native amphibians	3	NP	1
Native reptiles	3	2	2
Native birds	3	3	3
Native mammals	3	3	3
Humans (ethnobiological knowledge)	3	3	3
Freshwater Organisms			
Freshwater plants	2	3	3
Crustaceans	2	3	3
Shellfish	2	2	2
Insects	3	3	3
Finfish/eels	2	3	3
Amphibians	2	NP	NP
Reptiles	3	1	1
Marine Organisms			
Seaweeds (marine macro-algae)	2	2	2
Sea grass	3	3	3
Stony reef-forming corals	3	3	3
Shellfish (giant clams, trochus, turban snail, pearl oyster, triton)	3	3	3
Bêche-de-mer/holothurians	3	3	3
Crabs, lobsters, mantis shrimp	2	3	3
Reef and lagoon fish	2	2	2
Eels (conger, moray)	2	2	2
Large demersal finfish (rockcods, wrasses, parrotfish)	3	3	3
Sharks and rays	2	3	3
Billfish	3	3	3
Turtles	3	3	3
Crocodiles	3	NP	1
Sea birds	3	3	3
Mammals (whales, dolphins, dugongs)	3	3	3

Legend: 3 serious widespread concern and in need of immediate protection; **2** some widespread concern or of serious concern in specific areas; **1** limited or localized concern; **NP** not present

5. Energy use

Sustained availability of energy is essential for development and human well-being. However, supply of energy is a problematic issue in PICTs. The *Pacific Environment Outlook 2005* (McIntyre 2005) reports:

> "Despite some positive developments in the region, PICTs still face unique challenges with regard to energy, including: the increased pressure of tourism developments and urbanization on current energy infrastructure and energy supply; high cost of and

dependence on imported fossil fuels for electricity transport; widely distributed and isolated small population centres; limited awareness and acceptance of suitable alternative sources of energy; lack of financially sustainable renewable energy installations on the ground; and the high initial capital costs for most renewable energy technology. There is limited awareness of the benefits of energy efficiency and conservation measures, and misconceptions over capability of renewable energy because of the failures of earlier pilot projects. The constraints to sustainable energy development are characterized by the following issues:

- only 30 percent of the people of the region have access to electricity;
- there is heavy reliance on imported fossil fuel;
- there is a lack of comprehensive adopted energypolicies and plans; and
- there is a lack of qualified, experienced and committed island nationals."

6. Adaptation to the consequences of climate change

The Intergovernmental Panel on Climate Change (IPCC) has found that global mean surface temperatures have increased between 0.3°C and 0.6°C since the late 19th century, and predicts that the average temperature may rise by 1.4°C-5.8°C by 2100. Although there is still considerable uncertainty in the scale of predicted changes on the basis of measured change, modelling and forecasting, it is clear that we need to adopt the precautionary principle in dealing with climate change issues. It is likely that climate change will bring further changes to global temperatures, precipitation patterns, sea level and the distribution and intensity of extreme events to all corners of the globe. In its third report in 2001, the IPPC confirmed the threat to islands from increasing sea levels and other aspects of climatic change. The Millennium Ecosystem Assessment (2005) reports that observed impacts of climate change have already included:

- changes in species distributions and population sizes;
- changes in the timing of reproduction or migration events;
- increase in the frequency of pest and disease outbreaks; and
- that many coral reefs have undergone major, although partially reversible, bleaching episodes when local sea surface temperatures have increased.

The MEA has concluded that by the end of the century, climate change and its impacts may be the dominant direct driver of biodiversity loss and changes in ecosystem services globally. Maintaining ecosystem services, in turn, is essential for achievement of the Millennium Development Goals by 2015 and beyond. Critically, the impacts of climate change magnify the impacts of other human-induced changes, such as deforestation, over-fishing and pollution, increasing the species extinction crisis that we already face. In a recent analysis, WWF (2003) has categorised the types of climate change impacts on natural systems:

- Disappearance of habitats and ecosystems

Anticipated to affect low-lying, coastal and marine areas, principally coral reefs, mangroves and salt marshes. Globally, these kinds of impacts are already being recorded at a number of sites as a result of sea level rise, unseasonable flooding and increased sea temperature. A recent study has confirmed that that loss of ice from the Greenland ice sheet doubled between 1996 and 2005, raising the prospect that predictions for global sea level rise will have to be revised upwards (Rignot and Kanagaratnam 2006).

- Catastrophic long term changes to ecosystems

Even where ecosystems are not completely eliminated there are a range of impacts that may cause major and irreversible damage. Coral bleaching events are now recorded with increased frequency, but notably in 1998 when tropical sea surface temperatures were the highest on record. Climate change is postulated to be the primary cause of steadily rising marine temperatures, in concert with more frequent El Niño and La Niña events. The death of coral reefs would severely impact the innumerable reefs that provide subsistence and livelihoods for island and coastal communities in the Pacific region. A rise in water levels in estuaries and shallow coastal areas will reduce the size and connectivity of small islands and protected areas (Lal *et al.* 2001)

- Catastrophic Temporary Changes to Ecosystems

Includes the impacts of more frequent long-term drought events on ecosystems and species, especially wetlands but also a wide range of other ecosystems that already have a fine balance of ecosystem dynamics and seasonal aridity. The consequences of sustained droughts can result not only in impacts associated with water deficits but also the frequency of catastrophic fires that can potentially change even fire-adapted ecosystems. The impacts on ecosystems that are less fire-adapted are likely to be long lasting.

- Dramatic Changes to Habitats and Ecosystems

These changes cover issues such species shifts to cooler latitudes and altitudes – more likely to be an issue on larger Pacific islands.

In the Pacific some impacts have already been recorded, with the disappearance of atoll islets and more extreme climatic variation. Data gathered by the New Zealand Institute of Water and Atmospheric Research (NIWA) indicates the following changes in climate throughout the Pacific from the mid-1970s (McIntyre 2005):

- Kiribati, the northern Cook Islands, Tokelau and northern parts of French Polynesia have become wetter;

- New Caledonia, Fiji and Tonga have become warmer, sunnier and drier;

- Samoa, eastern Kiribati, Tokelau and northeast French Polynesia have become warmer and cloudier and differences between daytime and night-time temperatures have decreased;

- the southern Cook Islands and southwest French Polynesia have become warmer and sunnier; and

- Western Kiribati and Tuvalu have become sunnier.

There is an urgent need for practical adaptation strategies to be implemented, and to be included within all national development planning and activities. Many of the impacts of climate change will be exacerbated by current issues associated with coastal development, watershed degradation and deforestation – highlighting the need for an integrated approach to managing all developmental sectors.

7. Weaknesses in environmental management capacities and governance

With regard to institutional capacity in its Pacific Developing Member Countries (PDMCs) to deal with environmental issues, the ADB (2004) notes in its Pacific strategy that:

> "Despite considerable external support - notably to environment ministries or other national focal agencies for environment - the past decade has not seen much measurable progress either in terms of national institutional capacity (other than the designation/creation focal

> points) or impact on environmental quality. On the contrary, most anecdotal measures of environmental quality and natural resource management indicate deteriorating conditions in most PDMCs. Environment units and departments and their legal counterparts in government have been grappling with the introduction of regulatory environment that takes account of, or weaves in, customary practice and tenure and at the same time leads to improved environmental governance."

Across the region environment agencies or units tend to be under-staffed and under-resourced, and have less influence in government processes and decision-making than economic development sectors. At the same time, governments have adopted sound policies and joined many regional and global environmental agreements. However, more effective institutional support needs to be provided and better integration occur across different sectors as a basis for sustainable development planning and implementation.

8. Coastal and marine environments

Healthy marine and coastal environments are fundamental to the long-term sustainability of island societies, as well as providing a basis for subsistence livelihoods they underpin commercial fisheries and tourism development – already mainstays of many island economies. The ADB (2004) notes that the main threats to coastal resources come from:

- discharges of nutrients derived from sewage, soil erosion, and agricultural fertilizers;
- improper solid waste disposal;
- accelerated sediment discharge, for example from building construction sites or road building;
- physical alterations through destruction of fringing reefs, beaches, wetlands, and mangroves for coastal development and from sand extraction;
- logging; and
- over-exploitation of fisheries.

Table 18 presents a comprehensive list of the major impacts of development on coastal ecosystems and mitigation measures that can be taken to reduce or prevent such impacts. While some types of development are clearly focused on coastal and marine features, on most islands of the Pacific all developments are likely to cause impacts due to the small size of the islands, and so comprehensive, integrated island development planning is essential. Even so, erosion from poorly managed logging, for example far inland on large islands, can silt rivers that deposit sediment on coral reefs many kilometres distant.

Technology, in particular remote sensing and sophisticated computer modelling, is much more available and accessible today than it has been in the past for island countries and territories to undertake effective environmental planning and assessment. For example, the recent work by Atherton *et al.* (2005) analysing the relationship between critical watersheds and marine ecosystems in Fiji (Figure 5). The constraints lie in the capability and/or capacity of national agencies to use this technology effectively, and also for planners and resource managers to convince decision-makers to make the necessary investments. Having undertaken basic analyses, the critical next step is to use the information to make wise resource use decisions based on the principles of sustainable development, and to make information available in a form that can inform and engage communities directly affected by development. Table 19 lists various methods for gathering key ecological information to assess proposed developments.

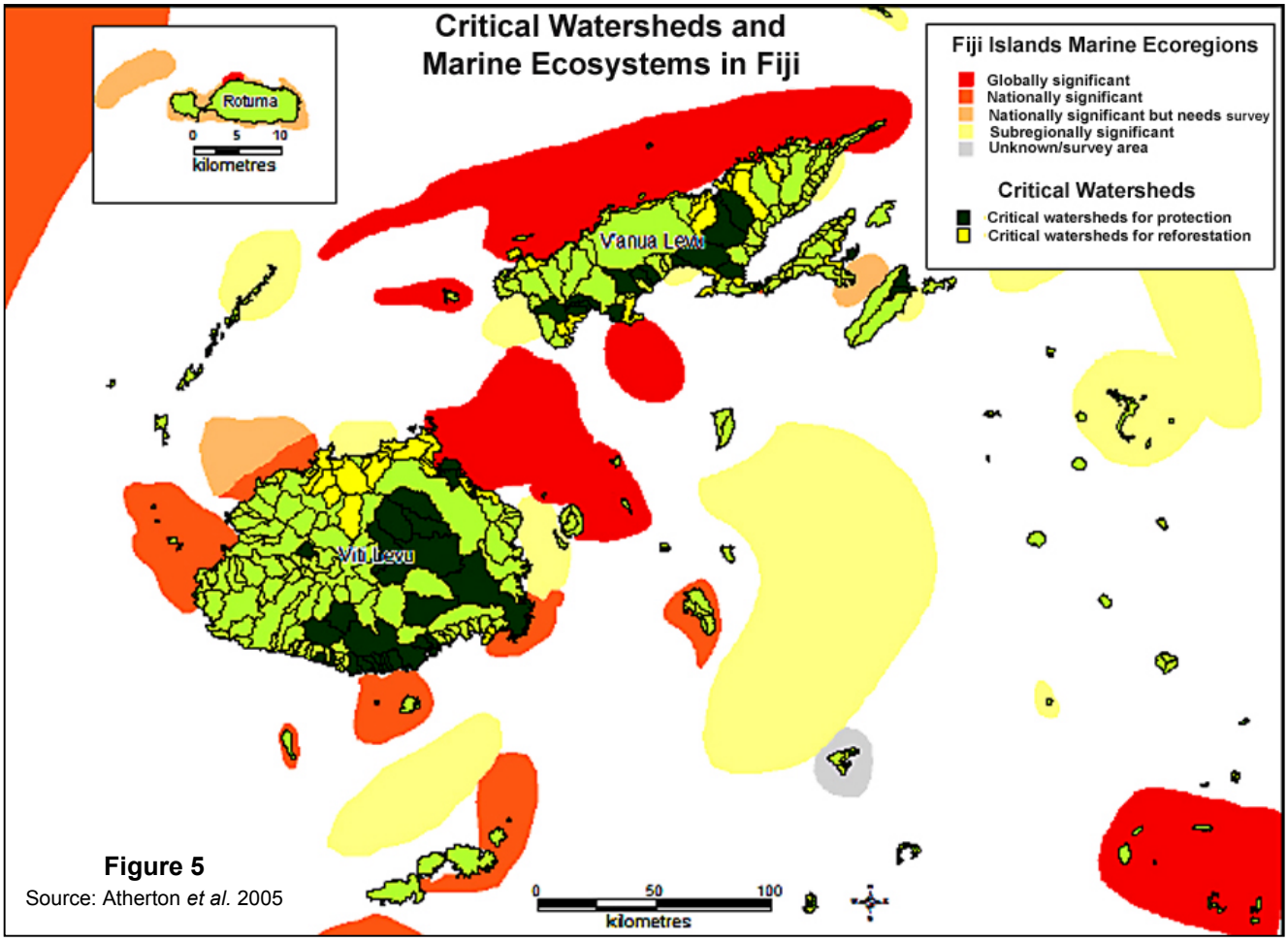


Figure 5
Source: Atherton *et al.* 2005

Table 18: Major impacts of development on coastal ecosystems
(Source: Carpenter and Maragos 1989)

Ecosystem	Uses and Value	Sensitivity to changes in the environment	Hazards from development activities	Mitigating measures
Coral reef	*Sustainable* 1. Marine fisheries are dependent on a reef system for support 2. Local fisheries catch is directly from the reef 3. Tourism related to snorkeling and scuba diving to view corals and fish 4. Protection of beaches and islands from storm surge and wave erosion 5. High aquaculture potential (giant clams, pearl oysters, etc.) Not sustainable 6. Harvesting of coral for jewelry 7. Harvesting of exotic marine organisms for aquarium market *8.* Mining for lime production	1. Prolonged fresh water flows that reduce salinity. 2. Sediments that reduce light, interfere with filter feeding, and accumulate on bottom 3. Water temperature changes beyond tolerance of coral 4. Toxic chemicals from land or ships 5. Breakage by storms, boat anchors, blasting 6. Excessive nutrients that cause "blooms" of phytoplankton or competition from benthic algae 7. Oil spills due to toxic, light, temperature and oxygen effects 8. Reduced water flow that reduces removal of sediment and waste products *9.* Changes in sea level causing desiccation or increased exposure to wave action	1. Dredging, filling and coastal construction practices. 2. Discharge of mine tailings, storm runoff 3. Upland soil erosion from agriculture, roads, construction 4. Freshwater diversions 5. Sewage outfalls, discharges from fish and agricultural processing 6. Industrial discharges of oil and pollutants 7. Heated water discharges 8. Destructive and over-exploitive fishing practices 9. Offshore petroleum and recovery	1. Site non-water dependent development away from reef areas to the extent possible 2. Create and protect permanent reef parks and preserves as compensation for areas damaged 3. Contain sediment on land in settling ponds and in water with silt curtains 4. Use deep ocean outfalls for sewage and industrial wastes 5. Set and enforce regulations against destructive and over-exploitive fishing and coral harvesting and pollution from land or ships 6. Control construction that modifies circulation, water currents and water levels in lagoons and coastal areas
Mangroves and other wetlands	1. Production and maintenance of nearshore fisheries (fin and shellfish) 2. Storm protection for low lying land 3. Trapping of nutrients and sediments from drainage 4. Wood and other forest products	1. Cessation of tidal flushing 2. Oil spills 3. Excess siltation 4. Salinity change 5. Excessive harvesting	1. Damming, dredging, bulk-heading, impoundment, etc. that change the topography and water flow 2. Sediment production 3. Freshwater diversions, discharges, groundwater pumping 4. Clear-cutting or deforestation 5. Land reclamation	1. Maintain natural patterns of water movement 2. Set and enforce harvesting limits 3. Establish buffer zones
Estuaries	1. High biological productivity – fish	1. Pollution from chemicals, oil and	1. Dredging, filling, construction	1. Sewage and waste treatment

Ecosystem	Uses and Value	Sensitivity to changes in the environment	Hazards from development activities	Mitigating measures
and lagoons	and shellfish 2. Harbour and navigation 3. Fish and wildlife habitat, breeding grounds for migratory species 4. Commercial and residential land	sewage leading to contamination of fish and shellfish 2. Siltation of floor, smothering of benthic organism 3. Change in circulation pattern	2. Spills of chemicals and oil from land or ships 3. Upland erosion and freshwater impoundment 4. Excess nutrients from agriculture and aquaculture	2. Deep ocean outfalls 3. Lagoons and settling basins for storm runoff 4. Use of piles instead of solid fill 5. Seasonal operation of dredge and fill to avoid biologically sensitive periods
Beaches	1. Construction material 2. Tourism destination sites 3. Nesting areas for rare sea turtles and marine mammals 4. Boat launching and retrieval 5. Shoreline stabilization	1. Change in current patterns affecting accretion/erosion 2. Overexploitation if sand removal in excess of natural replenishment 3. Increased wave action from loss of protection from dredged reefs	1. Coastal engineering works (e.g. groins and seawalls) that alter longshore currents or wave forces 2. Coastal dredging or dune mining 3. Coastal transportation (docks, airfields, roads) 4. Placement of damaging property too close to shoreline	*1. Understand the natural beach system* 2. Use a setback line and foredune ridge for construction 3. Minimize structural intrusions into the water 4. Shoreline management
Seagrass	1. High biological productivity – fish and shellfish 2. Nursery grounds for reef and mangrove species 3. Beach sand replenishment and stabilization source 4. Synergistic interactions with onshore mangroves and offshore coral reefs 5. Feeding grounds for rare turtles and mammals	1. Pollution from chemicals 2. Change in current patterns causing either scouring or stagnation 3. Changes in sedimentation causing accumulation and burial 4. Changes in longshore movement of sand 5. Dredging of offshore reefs 6. Denudation of onshore mangroves	1. Dredging, filling and construction of coastal structures 2. Oil and chemical spills 3. Damming or blockage of water flow and sediment movement	1. Understand effects of proposed project on sediment or water movement 2. Avoid damage to adjacent reef and mangroves 3. Use culverts and bridge openings in causeways 4. Locate non-water dependent facilities onshore

Table 19: Relationship between methods to gather essential ecological information and phase of coastal and marine development planning (Source: Carpenter and Maragos 1989)

Type and Description of Technique	Study Objective and Purpose	Applicable Types of Development	Phase of Development	Applicable Ecosystem
Remote sensing surveys (satellite or aerial photo imagery)*	Map and describe major types of ecosystems and resources in order to base decision on future data collection and development alternatives	Comprehensive regionally planned development or all specific types of development	Earliest	All
Coastal resources inventories (field checks, interviews, literature reviews)*	Qualitative description of resources characteristics and uses in order to identify appropriate location for development	Same as above	Earliest	All
Quantitative ecological surveys (to compare and describe ecosystems to be affected by development)	Provide valid basis for comparing ecosystems and the impact of development at all alternative sites	Same as above	After identification of the feasible alternative development sites.	All significant ecosystems within or adjacent to alternative sites.
Exposure-level survey (one-time ecological studies of comparable ecosystems elsewhere previously affected by comparable development)	Assess significance and zones of ecosystem impacts and rates of recovery in order to specify minimum buffer zones and other precautions	All types of development causing impact in study area that are comparable to proposed development.	Early, during identification of alternative project sites.	All, provided that ecosystems subjected to impact in study area are comparable to those to be affected by proposed development.
Annual/seasonal habitat surveys near proposed project development*	Identify seasonal periods of sensitive breeding, feeding and migratory activity of important species in order to specify time, distance, and other controls to limit development impacts	All development that will be sufficiently close to important coastal ecosystem	Middle planning phase: after most feasible project alternative identified	All that will likely be affected by projects
Ambient water current, circulation, and water quality studies	Assess circulation patterns and water quality of adjacent ecosystems to predict future water quality zones of influence and treatment or dilution required to control impacts	All development categories that directly affect or are located adjacent to aquatic ecosystems	Middle planning phase: after most feasible alternative sites and designs have been identified	All aquatic ecosystems adjacent to proposed development
Environmental quality monitoring studies (water quality and ecosystem monitoring of important pollutants and indicator species or habitats)	Document compliance with standards or criteria and establish a rapid feedback mechanism to contractors/ operators to take corrective action and eliminate impacts, when warranted	All development that will generate pollutants that can impact ecosystems if not carefully monitored	Construction and/or operational phases	Sensitive or vulnerable ecosystems adjacent to development
Emergency action plans (for control or containment of accidental fires and spills during emergencies)	To prevent the spread of fire or pollutant spills that can cause catastrophic ecological damage	Development that runs the serious risk of fire, fuel spills, or other accidental hazards	During construction and/or operational phases	Ecosystems vulnerable to spills or fires
Post construction/ operational environmental surveys (specific study methods are variable)	Refine the accuracy of future impact assessments conducted before development, identify unforeseen impacts, and assess magnitude of ecological damages for compensation/restoration	All major development likely to cause significant and uncertain ecological impacts	After construction and/or operational phase	Significant ecosystems affected by the development

* These studies are also valuable for comprehensive regional initiatives (coastal resource planning and management).

Type and Description of Technique	Study Objective and Purpose	Applicable Types of Development	Phase of Development	Applicable Ecosystem
Habitat restoration and enhancement analyses (a combination of scientific and engineering measures to facilitate reestablishment of valuable habitats	Develop feasible and implementable programmes to enhance ecosystem values or to compensate for the loss of ecological resources from development	Development projects that result in significant ecological losses	After construction and/or operational phase	Ecosystems affected by development and/or that can be enhanced or restored with human assistance
Time series surveys (quantitative ecological surveys before, during and after proposed development at fixed stations both close to and removed from project site)	Quantitatively document the significant and geographic extent of development impacts in order to apply to future development of same type or to establish criteria for compensation for ecological losses	All types of major development that is likely to cause major ecological impacts or where there is uncertainty regarding the nature and significance of impacts	Beginning after project plan is selected and continuing beyond construction and operational phases	All ecosystems likely to suffer major impacts
Toxicity studies (bioassays, bioaccumulation or tissue analyses, microcosm, con-trolled field impact/spill studies)	To assign effluent standards or criteria to control pollution or to prescribe treatment or dilution of pollutants to bring them into compliance with standards or criteria	All development that generates pollutants or effluents that can adversely affect ecosystems	After selection of project sites and during advanced engineering and design phase	Ecosystems vulnerable to pollutants and effluents
Pollution abatement plans (a combination of engineering and scientific measures to control soil erosion, sedimentation, accidental spills, urban runoff, waste-water effluents, contamination and other pollutants)	Avoid, reduce treat, dilute, or confine the generation of significant pollutants	All development that can lead to the gene-ration of significant pollutants	Advanced engineering and initial construction state	Ecosystems vulnerable to the pollutants

Addressing Environmental and Sustainable Development Issues in the Region

For the past 24 years, initially as part of the SPC and as a separate entity since 1993, SPREP has been assisting member countries to implement sound environmental policies, deal with growing issues such as waste management, pollution and climate change, and to build their national capacity to deal with environmental concerns. At the same time, other regional organisations that now form part of the Council of Regional Organisations of the Pacific (CROP) also deal with elements critical to the sustainable development and environmental management of Pacific island countries and territories (PICTs). For example, the SPC for fisheries, forestry and agriculture, the South Pacific Applied Geoscience Commission (SOPAC) for water, energy and disaster issues, and the Pacific Islands Forum with sustainable development. There is, inevitably, some overlap in the roles and responsibilities of these different organisations – all charged with moving the economic and sustainable development agenda in the region forward. All receive major funding assistance from developed metropolitan countries with an historic interest and/or presence in the region, principally Australia, New Zealand, France, Japan, and US but also in recent years from China and Taiwan, and also from multilateral funding and United Nations agencies.

SPREP programmes and projects are focused on assisting island countries and territories to resolve, or at least reduce, the issues discussed in this paper. These programmes and projects are supported by donor agencies and partners, such as the French Government and UN Fund supported Coral Reef Initiative for the South Pacific (CRISP), to be implemented by a range of partners including SPREP. However, it is essential that for this assistance to succeed, national agencies also need to be proactive in implementing effective environmental and sustainable development policies – as Diamond (2005) has noted: “environmental problems do constrain societies, but the societies’ responses also make a difference”.

References

Asian Development Bank (ADB) (2004). *Pacific Region Environmental Strategy 2005-2009, Volume 1: Strategy Document*. Manila.

Atherton, J., D. Olson, L. Farley and I. Qauqau (2005). *Fiji Watersheds at Risk Watershed Assessment for Healthy Reefs and Fisheries*. Wildlife Conservation Society, Suva, Fiji.

Asian Development Bank (ADB) (2001). *Asian Environment Outlook (2001)*. Manila.

Brooks, T., R. Mittermeier, C. Mittermeier, G. da Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield, C. Magin and C. Hilton-Taylor (2002). Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* 16, 909–23.

Carpenter, R.A. and J.E. Maragos (1989). *How to Assess Environmental Impacts on Tropical Islands and Coastal Areas: a Training Manual prepared for the South Pacific Regional Environment Programme*. Environment and Policy Institute, East-West Center, Hawaii.

Conservation International and SPREP (2004). (Draft) *Ecosystem Profile: The Polynesia–Micronesia Hotspot.* Conservation International and SPREP, Apia, Samoa

Diamond J. (2005). *Collapse: How Societies Choose to Fail or Survive*. Allen Lane/Penguin Group.

Given, D. R. (1992). *An Overview of the Terrestrial Biodiversity of Pacific Islands.* South Pacific Biodiversity Conservation Programme Report. SPREP, Apia, Samoa.

Lal, M., Harasawa, H. and Murdiyarso, D. (editors) (2001). Asia. In *Climate change 2001: Impacts, adaptation and vulnerability.* McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (editors), pp. 532–590. Intergovernmental Panel on Climate Change and Cambridge University Press

McIntyre, M. (2005). *Pacific Environment Outlook*. United Nations Environment Programme and the Secretariat of the Pacific Regional Environment Programme.

Mead, J.I, D.W. Steadman, S.H. Bedford, C.J. Bell, and M. Spriggs (2002). New Extinct Mekosuchine Crocodile from Vanuatu, South Pacific. *Copeia:* Vol. 2002 **3** 632–641.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington DC.

Rignot, E. and P. Kanagaratnam (2006). Changes in the Velocity Structure of the Greenland Ice Sheet. *Science* 17 Vol. 311 No. 5763, 986–990.

Secretariat of the Pacific Regional Environment Programme (2005a). *Action Plan for Managing the Environment of the Pacific Islands Region: 2005 – 2009*. SPREP, Apia, Samoa.

Secretariat of the Pacific Regional Environment Programme (2005b). *Secretariat of the Pacific Regional Environment Programme (SPREP) Strategic Programmes: 2004 – 2013*. SPREP, Apia, Samoa.

Steadman, D.W. (1995). Prehistoric extinctions of Pacific island birds: biodiversity meets zooarchaeology. *Science* **267**, 1123–1131.

Steadman, D.W. and P.S. Martin (2003). The late Quaternary extinction and future resurrection of birds on Pacific islands. *Earth-Science Reviews* **61** (2003) 133–147.

Thaman, R. (2002). *Island Life in the 21st Century: Current Status and Challenges for Mainstreaming the Conservation and Sustainable Use of Biodiversity in the Pacific islands.* Paper presented to 7th Pacific Islands Conference on Nature Conservation and Protected Areas, 8–12 July 2002, Rarotonga, Cook Islands.

UNDP, South Pacific Office (2002). *Natural Disaster Reduction in Pacific Island Countries,* Final Report for International Decade for Natural Disaster Reduction 1990–2000 (prepared by J. Chung, A. Kaloumaira, A. Plantz and J. Rynn). United Nations Development Programme, Fiji.

Watling, D. and S. Chape (compilers) (1992). *Environment Fiji: the National State of the Environment Report*. Government of Fiji and IUCN – The World Conservation Union.

WWF (2003). *No Place to Hide: Effects of Climate Change on Protected Areas*. World Wide Fund For Nature, Gland, Switzerland.

Annex: Regional and Global Instruments, Agreements and Strategies Supported by Components of the SPREP Action Plan 2004-2013

Natural Resources:

- 1997 Strategic Action Programme for the International Waters of the Pacific Small Island Developing States
- Action Strategy for Nature Conservation 2003-2007
- Avifauna Conservation Strategy for the Pacific Region 2000
- Cartagena Protocol on Biosafety
- Convention on Biological Diversity (CBD)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention on Nature Conservation in the South Pacific Region (Apia)
- Convention on the Conservation of Migratory Species (CMS)
- Convention on Wetlands of International Importance (Ramsar)
- Global Programme of Action for protection of the marine environment from land-based activities
- International Coral Reef Action Network Pacific Programme (ICRAN)
- Invasive Species Strategy for the Pacific islands region 2000
- National Biodiversity Strategic Action Plans
- Pacific Islands Framework for Action on Conservation 2000
- Pacific Islands Regional Ocean Policy and Framework 2004
- Pacific Umbrella Partnership on mainstreaming conservation and traditional knowledge
- Regional Action Plan 2003–2007 for Dugongs
- Regional Action Plan 2003–2007 for Marine Turtles
- Regional Action Plan 2003–2007 for Whales and Dolphins
- Regional Action Plan on Sustainable Water Management
- SPREP/Ramsar MOU and Joint Work Plan
- Wetlands Action Plan 1999
- World Heritage Convention

Pollution Prevention:

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, (1989)
- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region and Related Protocols, (1986) and its Dumping and Pollution Emergency Protocols
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, (1972)
- Convention to Ban the Importation into Forum Island Countries of Hazardous and Radio Active Wastes and to Control the Transboundary Movement of Hazardous Waste within the South Pacific Region (1995)
- International Convention for the Prevention of Pollution from Ships, 1973 as amended by the Protocol of 1978 relating thereto (MARPOL)
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, (1998)
- SPREP Pollution prevention: a 5-year strategy, 2004-2008
- Strategic Action Programme for International Waters Stockholm Convention on Persistent Organic Pollutants, (2001)
- Strategy and Work Plan of the Pacific Ocean Pollution Prevention Programme

Climate Change, Climate Variability, Sea Level Rise and Stratospheric Ozone Depletion:

- London (1990), Copenhagen (1992), Montreal (1997) and Beijing (1999), Amendments to the Montreal Protocol, 1990
- Kyoto Protocol to the United Nations Convention on Climate Change
- Montreal Protocol on Substances that Deplete the Ozone Layer, (1987)
- Pacific islands Energy Policy and Plan
- Pacific Island Framework on Climate Change, Climate Variability and Sea Level Rise
- Pacific Island Global Climate Observing System (PIGCOS) Action Plan (2003-2008)
- Pacific Islands Global Climate Observing System Implementation Plan (2002-2008)
- Pacific Umbrella Partnership Initiative on Adaptation
- Strategic Action Plan for the Development of Meteorology in the Pacific Islands Region
- Third Assessment of the Intergovernmental Panel on Climate Change
- United Nations Framework Convention on Climate Change
- Vienna Convention for the Protection of the Ozone Layer, (1985)