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REGIONAL SEAS

Overview on Land-based Pollutant Sources and Activities Affecting the Marine, Coastal, and Freshwater Environment in the Pacific Islands Region

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SPREP

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Contents

Acronyms

EEZ	Exclusive Economic Zones
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organisation of the United Nations
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
HTW	Hazardous Toxic Wastes
IAEA	International Atomic Energy Agency
IFCS	Intergovernmental Forum on Chemical Safety
IPCC	Intergovernmental Panel on Climate Change
PAHs	Polycyclic aromatic hydrocarbons
POPs	Persistent organic pollutants
SAP	Strategic Action Programme
SPREP	South Pacific Regional Environment Programme
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	United Nations Commission on Sustainable Development
UNEP	United Nations Environment Programme
WB	World Bank
WHO	World Health Organisation

Preface

The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities (UNEP (OCA)/LBA G.2/) was adopted by an intergovernmental conference held in Washington D.C., USA from 23 October to 3 November 1995. The goal of the GPA is to prevent the degradation of the marine environment from land-based activities, by facilitating the realisation by States of their duty to preserve and protect the marine environment.

The Washington conference designated the United Nations Environment Programme (UNEP) as the Secretariat of the GPA and requested that, as co-ordinator and catalyst of environment activities within the United Nations system and beyond, it should:

- Promote and facilitate the implementation of the Programme of Action at the national level;
- Promote and facilitate the implementation at the regional, including, sub regional, level through, in particular, a revitalisation of the UNEP Regional Seas Programme; and
- Play a catalytic role in the implementation at the international level with other organisations and institutions.

The projects and activities for the South Pacific Region that launched the region's participation in the GPA include:

- Preparation of A Strategic Action Programme for the International Waters of the Pacific Region in 1998;
- Pacific Pollution Prevention Programme (PACPOL);
- UNITAR/IOMC National Profiles to Assess the National Infrastructure for the Management of Chemicals Project;
- Management of Persistent Organic Pollutants in the Pacific;
- Development of the Hazardous Waste Management Strategies in Pacific Island Countries Project; and
- Pacific Regional Waste Awareness and Education Programme.

A workshop was convened with the following aims:

- To review the objectives of the GPA and its implications for the region;
- To identify possible elements of regional framework strategies with special reference to recommended approaches by sources category;
- To consider the development and implementation of national programmes, including the assistance required and available for this purpose through the organisation supporting the GPA; and,
- To review and amend a draft regional programme of action to addresses land-based activities.

The present overview of land-based sources and activities affecting the marine, coastal and other associated water resources was prepared as the main background document for the workshop. The workshop, which was held in Apia, Samoa on 14 October to 16 October 1999, was organised by South Pacific Regional Environment Programme with assistance provided by the UNEP/GPA Coordination Office. The objective of the overview is to present information that will assist the governments of the region, both individually and collectively, in their efforts to protect the marine environment and achieve sustainable development of their coastal areas. The aim is to achieve sustainable development through integrated coastal management activities. The overview identi-

fies and assesses the problems related to each country and the region as a whole. This information is intended to serve as the basis for remedial action as well as effective environmental management to prevent future degradation from the identified land-based sources.

Background and Executive Summary

This report provides a regional overview of the land-based pollutant sources and activities and their impacts on the marine, coastal, and freshwater resources of the South Pacific Region. The overview includes the 14 Pacific Island States participating in the GPA Activities.

There is a high level of uncertainty with the specific estimation of pollutant loads. A large body of work has been completed that provided qualitative and quantitative data; however, the noting of data gaps and inherent uncertainties of the methods used have qualified much of the quantitative data. Much of the data are based on rapid assessment methods that utilise generic loading rates, assumed waste flow composition, typical production methods, local production rates. Unfortunately, production rate data are inconsistently available and are difficult to verify.

Regardless of the quality and volume of quantitative data, there is ample visual and anecdotal evidence of the effects of land-based activities on the Pacific Island Countries (PICs).

This overview builds on the body of work that has been completed previously, which includes several South Pacific Regional Environment Programme Reports (SPREP). These are:

- Strategic Action Programme (SAP) for International Waters of the Pacific Islands Region (June 1998)
- Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (1995), *by UNEP, Washington, D.C.*
- Report to the United Nations Commission on Sustainable Development (UNCSD) (1996*), by SPREP, Apia, Western Samoa.*
- Land-Based Pollutants Inventory for the South Pacific Region (1993*), by Nancy Convard, SPREP Reports and Studies Series No. 68, by SPREP, Apia, Western Samoa.*
- Transporting Sediments via Rivers to the Ocean and the Role of Sediments as Pollutants in the South Pacific (1994), *by M. Asquith et al., SPREP Reports and Studies Series No. 72, SPREP, Apia, Western Samoa.*

The region has identified domestic sewage-discharges, solid waste from domestic, industrial, and construction activities, fertiliser use, sediments, and increasingly toxic wastes from industrial, agricultural, and domestic sources as the significant land-based sources. Domestic wastes dominate the waste stream from land-based sources. Nevertheless, the relatively small quantities of hazardous and toxic materials (e.g. persistent organic pollutants [POPs] and heavy metals) are of critical concern based on known and potential effects on the marine environment.

Strategies and measures are suggested to address the priority issues identified. These include activities in five categories:

- Management;
- Capacity building;
- Awareness / education;
- Research / information for decision-making; and
- Investment.

I. Introduction

A. NATURAL CONDITIONS AND PROCESSES

The 22 countries and territories of the Pacific region consists of only 530,000 km^2 of land with approximately 5.4 million inhabitants spread across 29 million km^2 of ocean. If Papua New Guinea is excluded, the figures drop to 65,000 km^2 of land and 1.8 million people. The Exclusive Economic Zones (EEZ) of the regions' governments encompass 30 million km^2 or about one-sixth of the world's surface. These countries are shown in Figure 1.

1. Climate and Oceanography

As expected from the geographic extent of the region and the various island types, climatic conditions vary greatly. The high island climates vary the greatest while smaller islands generally have mild and humid temperature with typical annual rainfall of approximately 2 metres. All of the islands, however, lie in the tropical latitudes, where sea temperatures generally stay above 20^{0}C. In general, the region is subject to tradewinds and is vulnerable to tropical weather disturbances, particularly devastating cyclones. Parts of some island groups, particularly those islands very close to the equator and thus located in the doldrums are outside the cyclone zone.

2. Geology and Geomorphology

The islands vary greatly in their physical characteristics and include high volcanic islands, and low islands, which include atolls and uplifted limestone islands. The high islands are large, mainly volcanic rock, forested with fertile soil and usually an ample fresh water supply. The low islands are usually small with limited fresh water and poor soil. Table 1 describes the physical characteristics of the fourteen member countries of SPREP and American Samoa. The Melanesian countries of Fiji, Papua New Guinea (PNG), Solomon Islands, and Vanuatu are extensions or parts of undersea mountain ranges. They are comprised of large mainly volcanic islands, which are generally rich in natural resources. Many have mineral wealth, fertile land, and abundant terrestrial resources. The Polynesian and Micronesian countries are made up of small island groups. These islands groups include the Cook Islands, Federated States of Micronesia (FSM), Tonga, and Samoa have some larger volcanic islands as well as small atolls. Kiribati, The Marshall Islands (RMI), and Tuvalu, consist only of atolls or small uplifted limestone islands. With the exception of Nauru and Niue all member nations are archipelagic.

3. Ecosystems

The South Pacific Region has a high degree of ecosystem, species diversity, and endemism. Marine and terrestrial ecosystems both have this diversity. The type of island, "high" or "low", is the major determinant for the types of ecosystems present. The ecosystem diversity is greatest on the larger high islands of the Western Pacific (PNG, Solomon Islands, and Vanuatu). The low islands and atolls have much lower ecosystem and endemism. The high endemism is related to the isolated evolution of islands species. This isolation also renders these ecosystems particularly vulnerable to disturbances.

The marine ecosystems, particularly in the Western Pacific, include the greatest biological diversity and greatest and extent of coral reef systems in the world. Marine and coastal ecosystems include the coral reefs, mangroves, lagoons, beaches, sea grass beds, bays and estuaries, and large open ocean ecosystems. The marine and terrestrial ecosystems are closely linked. The region recognises the importance of the inland ecosystems to the health of the coastal ecosystems. Environmental degradation of inland areas is also potentially devastating to the coastal area.[1]

The coastal environments are closely related economically-and they in turn are the keystones of all Pacific Island countries (PIC) particular coral reef-is frequently noted times. It is also true that for many Pacific Island Countries (PICs) given the size of the

[1] "The Perspective" as cited in International Waters SAP

Figure 1. **AREA SERVED BY THE SOUTH PACIFIC REGIONAL ENVIRONMENT PROGRAMME**

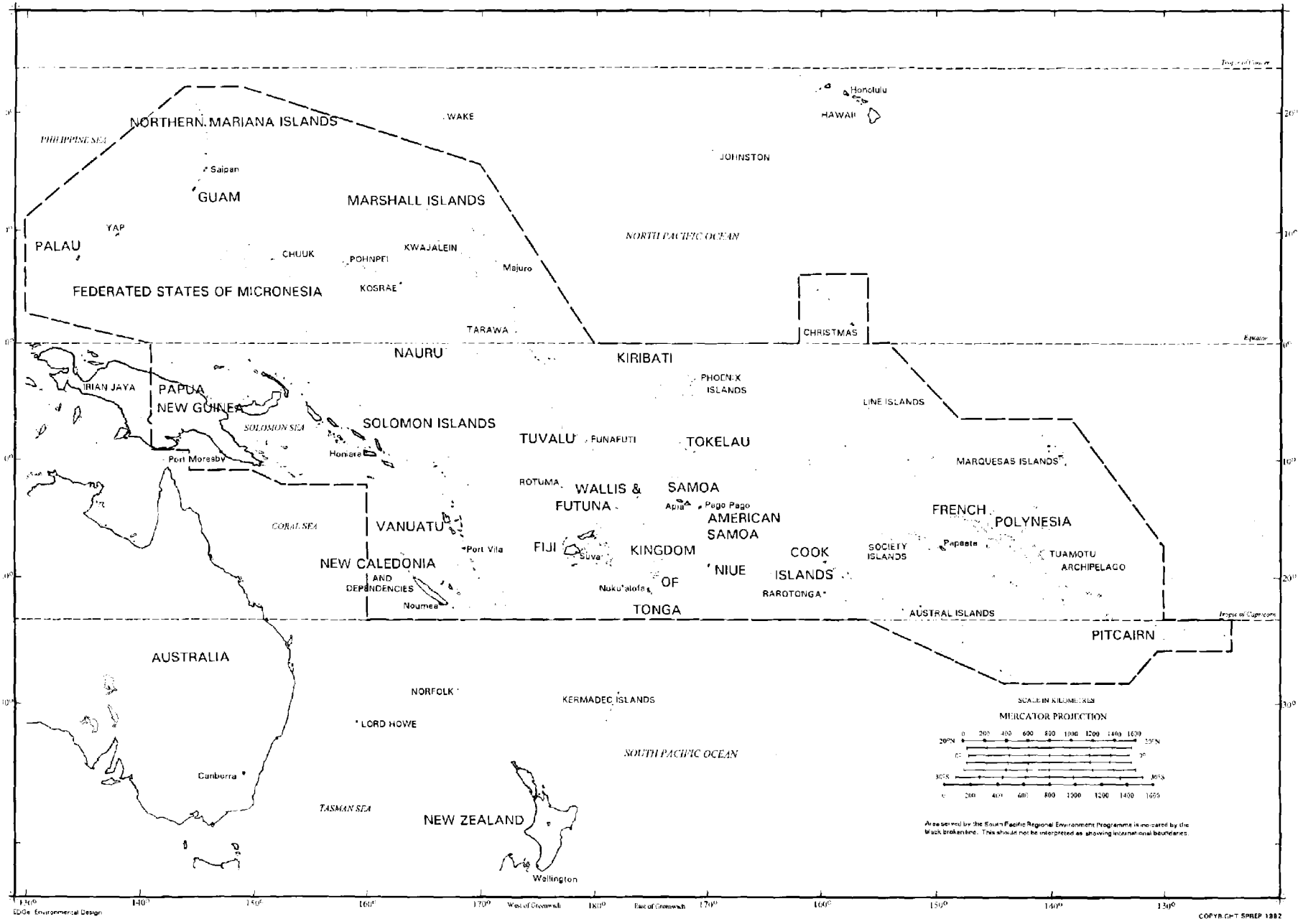

Table 1: Physical Characteristics of the Countries Considered in the Overview.[2]

Country	Approximate Land Area (sq. km)	Island Types[1]	Population Density[2] (persons/km^2)	Approximate Population[2]
American Samoa	200	High volcanic	233	46,773
Cook Islands	197	High, atolls	237	18,600
Federated States of Micronesia	710	High, atolls	149	105,506
Fiji	18,333	High	39	772,655
Kiribati	811	Atoll	96	77,658
Marshall Islands	181	Atoll	240	43,380
Nauru	21	Raised Coral	472	9191
Niue	259	Raised Coral	8	2,082
Palau	488	High	35	17,225
Papua New Guinea	462,243	High	8	3,607,954
Samoa	2,935	High	55	161,298
Solomon Islands	28,370	High	131	285,176
Tonga	747	High	131	97,784
Tuvalu	26	Atoll	348	9,043
Vanuatu	11880	High	12	142,419
	527,401			**5,396,744**

1. Island type refers to principally populated islands; other island types may be part of country
2. Population estimates from UNEP (1999).[3]

islands, the entire country comprises coral reef and related coastal environments.

The Pacific Region Strategy for the International Coral Reef Initiative (ICRI) is an attempt to place emphasis on the fact that coral reef systems are under threat. These threats are many and of varied origins ranging from global climate change and any associated change of sea level, to the actions of individual using explosives for fishing or removing (mining) sand.

The statement in the Pacific Region Strategy for ICRI (SPREP 1996) is a very comprehensive and useful summary of issues and threats, many if not all of which, are critical to this review. As such it is reproduced in full.

"...Coral reefs are one of the most important and extensive ecosystems within the Pacific region. When considered in conjunction with mangrove, seagrass and beach systems, their importance to the

[2] General data from a variety of sources and meant to provide a general indication of the physical characteristics of each country rather than definitive data.
[3] Due to obvious typographical error in cited source population for Cook Islands was estimated based on Convard (1993)

well being of the Pacific people and their island environments cannot be overstated. They are a critical element of the complex and vulnerable tropical small island environment. Without reefs, many atoll countries and most tourist beaches in the Pacific region would not exist. Coral reefs constitute the primary coastal protection structures on most tropical islands and provide the sand for construction of atoll islets and beaches. This is in addition to their important functions as sources of subsistence food resources, reservoirs of high biodiversity and environmental health indicators. The social, cultural and economic prosperity of the Pacific islands region has been, and will continue to be, directly dependent upon the health of coral reefs and related ecosystems.

Natural disturbances have been affecting coastal environments for millions of years and have a role in maintaining the diversity of coral reefs and related ecosystems. Biological communities can be considered robust systems that can and indeed have, recovered from acute disturbances over geological time scales. However, the synergistic effects of human-induced chronic disturbances acting in concert with natural disturbances alter the capacity for recovery.

Human activities are the primary cause of coral reef degradation and most of these are chronic threats. Environmental conditions resulting primarily from human population growth, water pollution, resource over-exploitation and direct physical damage are causing reefs to deteriorate at an alarming rate. Increasing social and economic demands are placing new levels of stress on Pacific coral reefs.

Threats to coral reefs and related ecosystems

- Pollution from sewage, fertilisers, biocides, toxic wastes, oil spills, solid wastes, freshwater runoff and other land-based sources of pollution;
- Siltation due to soil erosion from inappropriately conducted land use practices (agriculture; forestry; mining; road building; site clearance);
- Over-exploitation of coral reef resources (for example commercially valuable species such as beche-de-mer, giant clams, trochus, certain fish and shell fish; live coral harvesting for aquariums and the tourist trade; mining coral heads for construction; subsistence fishing pressure);
- Destructive fishing and collecting methods (for example poisons, explosives);
- Land reclamation (including mangrove and reef-flat destruction), inappropriate coastal protection works, and unsound mariculture practices;
- Coastal and marine development projects progressing without environmental impact assessment (EIA), or with inadequate EIAs;
- Channel blasting and dredging activities;
- Mining of beach and reef materials;
- Coastal erosion and accretion;
- Tourism activities and related developments;
- Military testing, training and dumping (for example nuclear testing, munitions disposal); and
- Catastrophic events (for example tropical cyclones volcanic eruptions, earthquakes, tsunamis, coral bleaching, crown-of-thorns starfish infestations, severe El Niño-Southern Oscillation (ENSO) events, and possible climate change and sea-level rise).

To address these stresses, new approaches to management must be developed which draw upon the foundations of traditional use and practices and incorporate the understanding and procedures developed through relevant science and technology..."

Mangroves have gained less attention than reefs, although of course they are a critical "related environment" and specifically mentioned in the Regional ICRI. A recently completed draft Regional Wetlands Action Plan (Idechong *et al*, 1995) prepared for SPREP highlights the major issues including threats in relation to mangroves. A summary based largely on this draft action plan follows.

Mangroves have traditionally provided, and still continue to provide, a direct resource as a source of fuel

wood, but their destruction has many negative economic impacts. A total of 34 mangrove species occurs in the region and covers nearly 350,000 hectares (Table 2). Abundance is very much restricted to the western Pacific with fewer species and substantially reduced areas eastwards of a line from Fiji to Marshall Islands.

Mangrove ecosystems are a useful buffer between the land and the sea. They act as a sink for sediments, nutrients and other contaminants to maintain coastal water quality, and so promote coral reef and seagrass growth offshore. They also protect the land from marine inundation, during storms and sea-level rise.

Mangroves occur in close association with offshore benthic communities of seagrasses and coral reefs. The habitats are influenced by common physical conditions at each location, and they are closely linked through common food chains, sediment fluxes and chemical cycles.

Table 2. Mangrove Areas and Species Diversity in the Pacific Islands from Idechong *et al.* (1995). Source: Idechong *et al.*, 1995 from Howarth (1997)

Country (listed from west to east)	Mangrove Species	Mangrove Area (ha)
Palau	13	4,708
Federated States of Micronesia	14	8,564
Papua New Guinea	33 (2)	200,000
Solomon Islands	20 (2)	64,200
Vanuatu	14	?2,750
Marshall Islands	5	?
Nauru	2	1
Kiribati	4	?
Tuvalu	2	40
Fiji	8 (1)	41,000
Tonga	8	1,000
Samoa	3	?700
American Samoa	3	52
Niue	1	0
Tokelau	0	0
Cook Islands	0	0
TOTAL	34 (3)	343,735

Mangroves are important fish habitats, particularly their functions as a fish nursery. Mangroves sustain a food chain within the mangrove habitat, and associated research has demonstrated the levels of tidal export of mangrove material, and the significance of this in offshore food chains.

Threats to Mangroves

- Losses/clearance of mangrove areas due to a variety of developmental projects for example: urban expansion of capital cities in Fiji, Vanuatu and Tonga, aquaculture projects in Fiji, Samoa and Palau, and poldering for agriculture in Fiji. All significant mangrove areas of Tonga are now allocated for clearance;
- Ongoing degradation of mangrove ecosystems from spills of petroleum products and other chemicals;
- Excessive sedimentation from upstream disturbances ;
- Solid waste disposal; and
- Mangrove swamps are likely to be a sensitive ecosystem to the effects of climate change and sea-level rise. Mangroves of low islands have been shown to be particularly vulnerable to sea level rise, owing to low accretion rates.

B. ANTHROPOGENIC IMPACTS ON NATURAL CONDITIONS AND PROCESSES

Anthropogenic sources of land-based pollutants have been identified as significant threats to the marine environment by several previous studies in the region including the regional studies cited above.[4] While each of these studies considered the issues from different perspectives including, by source, by threatened resource, and environmental impact, each linked the land-based sources to major human activities. These major activities can be summarised into five categories:

- Domestic sources (Including urbanisation);
- Agricultural activities;
- Industrial activities;
- Mining and quarrying activities; and
- Physical alteration of habitats.

This section provides an overview of these activities and their impact on the environment in the Pacific region. The following section provides available quantitative information to assess the problems associated with these activities.

1. Domestic Sources and Urbanisation

Like other coastal regions of the world, much of the region is experiencing increasing urbanisation both in terms of density and extent. Population distribution varies widely. Migration to urban areas, usually to the national or provincial capital, is steadily increasing. These urban areas are invariably located on the coast. The urban growth rate is at least 50-100% higher than the already large overall population growth rates.[5] National averages do not adequately reflect the actual densities found in some parts of the countries, many of which have extraordinarily high concentrations of people in the urban area and very low densities in rural parts of the "capital" island and on outer islands. Already in the early nineties, seven of the region's countries were more than 50% urban, and the others had at least a quarter of their population living in urban areas. The International Waters SAP identified the mutually exacerbating combination of high natural population growth

[4] *Strategic Action Programme (SAP) for International Waters of the Pacific Islands Region* (June 1998); Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (1995), UNEP, Washington, D.C; *Report to the United Nations Commission on Sustainable Development* (UNCSD) (1996), SPREP, Apia, Samoa; *Land-Based Pollutants Inventory for the South Pacific Region* (1993), by N. Convard, SPREP Reports and Studies Series No. 68, SPREP, Apia, Western Samoa. *Transporting Sediments via Rivers to the Ocean and the Role of Sediments as Pollutants in the South Pacific* (1994), by M. Asquith et al., SPREP Reports and Studies Series No. 72, SPREP, Apia, Western Samoa.

[5] Bleakley, as cited in International Waters SAP

and low economic growth as probably the most important long-term sustainable development issue facing the Pacific islands.[6]

This urbanisation modifies and destroys critical ecosystems and habitats. It also stresses limited water resources and waste management capabilities, which in turn threatens the quality of both fresh and marine waters. Increased population increases the pressure on marine fisheries for increased catches, resulting in diminishing fish stocks. Diminishing fish stocks pressure for increased catches can also lead to the use of destructive fishing methods such as the use of explosives and chemical, further degrading and damaging the marine environment. All of these impacts have been identified in many parts of the Pacific region.

The urbanisation results in increased solid and liquid waste generation. Domestic sources of pollution remain the major contributors to marine pollutant loads.[7] Contaminants of concern associated with domestic sources include nutrients, biochemical oxygen demand (BOD), solids, and microbial pollution. Much of the region's domestic wastewater is managed and disposed of through individual systems such cesspools, septic tanks, and simple latrines. Only the largest urban centres have reticulated sewage collection and treatment schemes. The increased concentration of the individual systems increases the overloading of the land's ability to absorb the wastes and both surface waters and groundwater is increasingly degraded. The nutrient overload to marine waters particularly threatens coral reef ecosystems, weakening the reef carbonate skeleton and smothering the reef with algae. Increased solid waste generation with inadequate disposal system results in smothering of wetlands and reef flats with the solid waste and release of nutrients and toxic chemicals to the environment.

The increased urbanisation also affects the fundamental supply of freshwater. The freshwater resources are threatened by overexploitation of the freshwater supply, particularly groundwater. Overexploitation of groundwater in the coastal area also can lead to saline intrusion. This has been a particular concern for the region's low islands.

Non-point sources of pollution from urban areas are also of concern. Pollution from urban non-point sources in the region has yet to be quantified. Typical contaminants anticipated in such runoff include suspended solids, oil and grease, organic chemicals, pathogens, litter and heavy metals. Though yet to be quantified in the region non-point sources of pollution are likely a significant portion of the contamination entering fresh and marine water. Also, this source's contribution is likely increasing at a rapid rate.

Increased urbanisation also brings with it increased construction and development activity that results in habitat modification and destruction through the quarrying of building materials and direct grading and filling of habitats. Sediment loads to the marine environment increase with the increased erosion from construction areas, dredging activities, and coastal and inland land disturbances.

2. Agricultural Activities

The agricultural economy plays a significant role in almost all countries and territories of the region, with the possible exception of Nauru. Much of the agricultural activity in the region is associated with the subsistence economy, but there is a major commercial component as well. The sugar industry in Fiji and the coffee industry in Papua New Guinea are notable examples. The pollutant constituents of concern that result from agricultural areas are nutrients, pesticides, and sediments.

These pollutants are derived from the application of agricultural chemicals, erosion of exposed soils with naturally occurring nutrients, and runoff from piggeries and other areas with concentrated animal wastes. Runoff and wastes from piggeries have been identified by the countries of the region as a major

[6] Preston (1997),as cited in International Waters SAP
[7] Op. Cit.

pollutant source.

The significance of agricultural pollution's effect on the marine environment is based on qualitative understanding and anecdotal evidence. The nutrients and agricultural chemicals loading in runoff from agricultural areas and the resultant concentrations of in marine, or even fresh water, have not been measured. Data regarding the use of agricultural chemicals indicates that the use of these chemicals is small compared to other regions, yet because of current inconsistencies in the quality of current management, use, and disposal practices, localised areas of environmental concerned have been noted.[8] Anecdotal evidence of eutrophication and turbidity in several areas of the region are cited as evidence of the significance of this source.

Table 3 presents the available data for fertiliser and pesticide use in the South Pacific Region. Data from several countries and territories was unavailable. In some cases, the data is out-dated. Some of the data were obtained from Stone (1990) who calculated quantities from monetary totals. The original sources for the Stone data are not known. The use of agricultural chemicals in the region generally does not appear to be changing dramatically; thus the data serve as reasonable estimates of pesticide use.[9]

3. Industrial Activities

The contribution by non-tourism industrial activities to the local economies of the South Pacific Region is currently small but continues to grow. Tourism is a significant sector as a result of the substantial additional waste generation and its related infrastructure, particularly water and sanitation. As such tourism is separately addressed at the end of this section. The growing industrial activity in the region provides the potential for economic expansion and increased environmental impacts. Most of the countries and territories of the countries in the region can be classified as having small or non-existent industrial bases. The most industrialised countries of the region, with the exception of mining operations, still have only small to medium industrial bases in worldwide terms. Still, the limited industry has resulted in environmental contamination in a number of areas.

The industries found in the region are shown in Annex 1. The annex listing is somewhat aggressive as it includes activities in the region that are not truly industries, but services. For example, almost all countries are shown as having health services and pharmaceutical production. However, in reality this may simply be interpreted as health services in the form of a hospital or clinic. The table does, however, provide insight into the industrial activity of the region.

Countries such as the Cook Islands, FSM, Kiribati, Niue, Tuvalu, RMI, and Palau all have very small industrial bases. There are only a few industries other than tourism represented in these countries. These industries are primarily involved in the processing of coconuts, fish and fruit. CNMI also has a fairly significant garment factory base. Yap, in the FSM, also has a small garment factory employing some 350 persons, though many of these are foreigners. The Cook Islands industrial base includes a small brewery. Except for the additional solid waste, the environmental impact from these activities is not well quantified.

Wastes from these industries typically include solid wastes and small quantities of wastewater. Note that higher wastewater flows can be expected where bottling and cleaning with water occurs. The pollutants that reach the marine environment, either through direct discharge or leachate from landfilled solid waste, include BOD, nitrogen, phosphorus, and solids. Oil and grease pollution may result from the storage of fuels and lubricating oils associated with these processes. In these countries with small industrial bases there are also printing shops, laundries, boat building, and other small commercial activities that utilise solvents and other hazardous chemicals. These wastes are usually disposed in domestic waste-

[8] Chester (1984); Mowbray (1988)
[9] Extracted from Convard (1993)

Table 3: Agricultural Chemical Use in the Region (tonnes)

COUNTRY	FERTILIZERS					PESTICIDES								
	Nitrogen Based	Phosphates	Potassic	Other	TOTAL	Insecti-cides	Fungi-cides	Herbi-cides	Rodenti-cides	Mineral oils	Fumi-gants	Mollusci-cides	Other	TOTAL
American Samoa														
Cook Islands[2]						3.65	2.44	2.44						8.53
FSM					0.00									
Fiji[2]	12.00	23.00	18.00		53.00	283.00	24.00	198.00	198.00					703.00
Kiribati					2.8									9.6
Marshall Islands														
Nauru														
Niue[5]							1.20	1.00			0.10			2.30
Palau														
PNG					20.55	143.00	2.10	467.00					6.00	618.10
Samoa[10]	150.00	150.00	150.00		14018.00	0.63	0.087 [10,11]							
Solomon Islands[7]		2238.00	160.00		2398.00	283.00	5.00	205.00					4.00	497.00
Tonga[8]	430.04	0.24			430.28	0.98	10.91		0.08			0.85		12.82
Tuvalu		2.00	5.00	17.00	24.00	1.00			1.00				2.00	4.00
Vanuatu[9]						1.00	0.30	10.00					30.00	41.30
TOTAL	**592.04**	**2413.24**	**333.00**	**17.00**	**16943.89**	**738.06**	**46.44** [10]	**885.54** [11]	**199.08**	**0.00**	**0.10**	**0.85**	**42.00**	2164.25 [13]

Notes:
Data from (1) Mowbray (1988); (2) United Nations (1989) for fertilisers; Mowbray (1988) for pesticides; (3) Mowbray (1988); (4) Tiaeke, N. Kiribati Environment Unit, MESD National Profile of Chemicals Management Infrastructure (Undated, 1999?); (5) United Nations (1990); (6) Pitcairn High Commissioner (1992); (7) Pesticide data from Mowbray (1988); fertiliser data from Stone (1990); (8) Foliaki (1991); (9) Albert William, Vanuatu representative to RPA Meeting (1999); Mowbray (1988) and Taylor (1991)
Additional small quantities: (12) + 0.585 kilolitres; (13) +43.56; +44.585 kilolitres

water drains or pits in the ground. These chemicals degrade very slowly and there is a potential for accumulation, even if the annual generation is small.

Countries with medium or small industrial bases have larger manufacturing facilities of a more diverse nature and/or larger facilities for other industries such as breweries and fish canning plants. The countries in the region that can be classified as having small to medium industrial bases include American Samoa, Solomon Islands, Tonga, Vanuatu, and Samoa. As with smaller industrial bases, BOD, solids, nutrients, solvents, and cleaning agents are found, but usually in much higher concentrations and total loadings.

Several countries also have small to medium sized abattoirs and meat processing facilities. Slaughtering and meat processing activities range from household activities to small all-manual slaughterhouses to the larger more modern facilities, such as those found in Vanuatu. Waste loads for the Apia, Samoa facilities were estimated as follows: estimated BOD five kg, nitrogen 0.45 kg; phosphorus 0.025 kg; and suspended solids four kg.[10] The Port Vila, Vanuatu facility discharges to land-based treatment facilities so no contamination of the marine environment is anticipated for that source. Discharge information for other facilities is not readily available.

Fiji and Papua New Guinea are the only two countries in the region with medium-sized industrial bases in the South Pacific Region. With inclusion of mining, Papua New Guinea's industrial base is considered to have a large industrial base. Nauru may be considered to have a medium sized industrial base, but this base is limited to phosphate mining. The major industrial complex in Papua New Guinea is primarily copper and gold mining, but also includes smaller scale industries in Port Moresby and other urban centres. The industrial complex in Fiji has a variety of manufacturing and industrial activities ranging in size from small family-owned operations to large exporting facilities.

Fish canneries, sugar refineries, breweries, and edible oil production are major sources of several pollutant constituents, including BOD, suspended solids, nitrogen, phosphorus, and oils and grease. POPS and other toxic chemicals result from power and energy production, and other smaller scale industrial operations such as printing, photo developing, metal plating, auto repair, paint factories, metal fabricating, manufacture of cleaning products, etc.

The industries found in the region's urban areas have been shown to contribute to marine pollution problems, particularly the potential cumulative effect of heavy metals, solvents, and other hazardous materials from these operations.[11] Several studies have documented the introduction of organic chemicals, heavy metals, and toxics into Suva Harbour that are clearly of industrial origin (Convard, 1993, Morrison, 1991; Morrison, 1992; Naidu *et al.* 1991). Similar pollution has been observed in marine waters near other regional urban centres (Morrison, 1990; Gangaiya and Green, 1991). The waste streams from most industrial facilities have little or no treatment. The most common type of treatment provided for almost all facility types is simple sedimentation. The presence of several contaminants in the marine environment is being increasingly documented. In one study of Suva Fiji, it was noted that of 39 industrial facilities surveyed 29 discharged directly into the port waters or its tributaries.[12]

TOURISM

Tourism Council of the South Pacific (TCSP) data clearly demonstrate this industry is an important economic sector for the region (Table 3), and it should also be noted that for 1996 tourist arrivals for the region increased by 6.1%, compared with 1.5% during 1995. In Fiji receipts increased from USD$283.8 million in 1994 to USD$326.4 million in 1995, and tourism is now the highest foreign exchange income earner ahead of sugar.[13]

[10] Convard (1993)
[11] IBID
[12] IBID
[13] From Howarth (1997)

The economic benefits of tourism are clear, however, the threats of the tourism industry to the environment, particularly coral reefs and water quality are numerous and significant. Sound management of tourism solid and liquid waste generation and its associated physical alterations to the coastal environment is vital in order to allow sustainable development of this important economic sector. The potential to destroy the same high quality resources that gave birth, and presently maintain, this industry is great.

Table 4: Estimated tourism receipts for selected countries for 1995

Country	1995 Tourist Receipts (USD$ millions)
Cook Islands	28.3
Fiji	326.4
Kiribati	1.2
Niue	1.6
Papua New Guinea	46.2
Samoa	30.7
Solomon Islands	6.5
Tonga	10.4
Tuvalu	0.4
Vanuatu	31.8

Source: Howarth (1997)

4. Mining

Presently, mineral mining activity in the region is limited to a few countries, namely, Papua New Guinea, Fiji, Nauru, and Solomon Islands. Four materials are mined in the Pacific region; these are phosphate, nickel, copper, and gold. Phosphate mining primarily occurs in Nauru. Both copper and gold are mined in Papua New Guinea and gold is also mined on a small to medium scale in Fiji, Solomon Islands, and Vanuatu. With prospecting occurring in a number of areas, mining may not be limited to these few countries in the future.

Mining is an extremely intrusive and disruptive activity and has major deleterious impacts on the environment. Many studies have reviewed the environmental impacts of mining in the region, particularly those in Papua New Guinea (Carpenter and Maragos, 1989; Brodie *et al.* 1990; Hughes, 1989). None of the mining activities have been without negative environmental impact, though the phosphate mining operation discharges little waste to the marine environment (Morrison, 1992a). Recently operators of the Ok Tedi Mine have states that environmental degradation has been even greater than anticipated.[14] Sediment loading to the Ok Tedi and Fly Rivers has been greater than anticipated and has exceeded the rivers' capacity to transport sediment. This has resulted in flooding and ecosystem changes (tree species changes) along riverbanks.

These mining operations can bring substantial socio-economic and financial benefits from royalties, infrastructure development, employment, training, medical and other services. These benefits must be weighed carefully against the inevitable environmental degradation. Mitigation of environmental degradation through planning, design and implementation of sound environmental controls must accompany economically necessary mining activities.

Another form of mining in the Pacific is the excavation of coral, sand, and aggregate from the region's coastal areas. For many of the smaller islands this is the only real source of construction materials. The only other real alternative to these islands is to use construction methods that do not require concrete or cement. Howarth (1997) prepared a review of non-living resources in the Pacific in preparation for the SAP consultative meetings that include a review of aggregate mining sources in the Pacific. This review is summarised below.

[14] Pacific Islands Monthly, September, 1999

There are three principal locations of aggregate and sand mining in the Pacific: quarries, riverbeds and in the coastal zone. In the coastal zone a beach, reef flat or lagoon location, mining by dredging, front-end loader or manual operation is likely. Table 5 shows coastal mining occurs in most countries of the region and is the only source of aggregates (other than importation) for atoll islands generally and the atoll countries of Kiribati, Marshall Islands and Tuvalu in particular.

Table 5: Source of Aggregate in Pacific Island Countries

Country	Quarry Source	River Source	Coastal Source
American Samoa[3]	X		X
Cook Islands	X		X[1]
FSM	X		X
Fiji	X	X	X[2]
Kiribati			X
Marshall Islands			X
Nauru	X		X
Niue			
PNG	X	X	
Samoa	X		X
Solomon Islands	X	X	X
Tonga	X		X
Tuvalu			X
Vanuatu	X		X

Notes:
1) Beach mining on Rarotonga is now banned
2) Includes dredging for carbonate reef sand for Portland Cement manufacture near Suva
3) American Samoa data added to Howorth data for this overview
Source: Howarth (1997)

In addition to aggregate mining in the coastal zone, since 1962 coral sand has been dredged from the reef in Laucala Bay, Suva, Fiji for use as the major ingredient in the manufacturing of Portland Cement by Fiji Industries Limited. This operation supplies Fiji as well as several others countries in the region. Quantities mined over the passed 5 years have averaged close to 70,000 cubic metres per year, at a value of almost FJD$1 million per year.[15]

Where quarry or river material are available as an alternative to a coastal source the former is usually better quality and hence more expensive. For example in Pohnpei, Federated States of Micronesia quarry material is currently USD$20 per cubic metre and dredged coral material USD$12 per cubic metre.[16]

[15] Howarth (1997)
[16] Ibid.

The problems associated with coastal aggregates mining are well documented and two major issues are that the proximity to shore often enhances the possibility of erosion, and that the extraction rates now far exceed natural replenishment rates, hence the whole operation is not sustainable. Other significant threats typically associated with reef flat dredging include the following:

- Heavy turbidity of the water in the working area increases the risk of degrading large portions of the reef and seagrass beds is high;
- At seabed level, the dredge workings produce craters, which complicates restoration of the area at a later date;
- Modification of the hydrologic regime, including poor flushing of semi-enclosed bodies of water;
- Potential risk of introducing ciguatera poisoning by promoting the spread of microscopic algae on the suspended fines; and
- Aesthetically displeasing remains of old workings, and associated rusting equipment. a common sight at old workings.

These problems associated with mining in the coastal zone are recognised. The most likely alternative source areas are further offshore in lagoon areas where the risk of inducing erosion is considered negligible, whilst other environmental problems are minimised rather than eliminated altogether. In recent years SOPAC surveys have been carried out in Tonga (Tongatapu and Vavau'u), Tuvalu (Funafuti), Marshall Islands (Majuro), and Pohnpei (Federated States of Micronesia).

Finally, PNG has proven commercial oil and gas. In 1996, the value of oil exports from Papua New Guinea just exceeded 1 billion Kina (approximately 0.4 billion US$). Outside of PNG, Fiji and Tonga have the best potential, mostly offshore, for hydrocarbons. Information on the effects of the PNG petroleum industry was not available for this review.

5. Physical Alterations

The implications of physical alterations of the coastal and interior land areas have been touched on in earlier discussions of urbanisation, mining, agriculture, sediment transport, and domestic discharges. Physical alterations and hydrological modifications have varied and potential significant environmental effects. Among the effects that have been documented or reasonably anticipated in the region involve threats to ecosystems, environmental quality and the sustainable use of resources and include the following:[17]

- Loss of natural productivity and biodiversity;
- Loss of natural storm barriers, natural filtration systems, and loss of environmental assimilative capacity;
- Coral reef degradation;
- Spread of disease and possible outbreaks of ciquatera;
- Loss of carbon sinks and release of carbon to the atmosphere;
- Changes in ecosystem stability;
- Loss of migratory species;
- Damages to endangered or threatened species;
- Spread of exotic species; and
- Other related health and ecosystem effects.

Physical alterations of inland and coastal areas are often necessary to economic development and provision of essential services. Yet the environmental effect of such physical alterations can be minimised through proper planning, development site selection, design and incorporation of environmental controls. Environmental impact assessment procedures are key to the planning and ultimate proper selection of sites, designs, and operational environmental controls.

[17] International Waters SAP page 27, 28

C. SOCIO-ECONOMIC IMPLICATIONS OF ANTHROPOGENIC ALTERATIONS

The marine environment is the foundation of society and economies of the region. Its importance to the region cannot be overstated. It is in the coastal area that most people live and in work. It is in the coastal region and the marine environment where most planning for expansion of economic base is focussed. Public health, sustainability of resources, and economic prosperity are all affected by land-based sources of anthropogenic alterations. It is imperative to the socio-economic well being of the region that the marine environment be protected from the adverse effects of land-based pollutants.

The economies of the region are based on the marine environment through a number of economic sectors including fisheries and other natural resource harvesting, coastal- and marine-based tourism, recreational activities, and subsistence lifestyles. For much of the region tourism and/or fisheries are the sole foundation to the local economy. Land-based pollution of the marine environment threatens these economic activities in a number of ways:

- Degradation of marine and fresh water quality;
- Destruction of habitats;
- Loss of tourism/recreation value;
- Loss of aesthetic values;
- Changes to fisheries value;
- Compromise of options for aquaculture;
- Eutrophication of lagoons and bays;
- Loss of property values;
- Increased costs of fish surveillance and processing for toxin prevention; and
- Reduced fish marketability.

Domestic sewage and solid waste, agricultural wastes, and industrial wastes threaten water supplies. Both surface water and groundwater resources are threatened. The degradation of water supply quality results in a number of health problems harming the overall public health and well being of the communities. As the public health is degraded, costs for health care and the protection of public health increase. Costs for the treatment and development of water supplies also increase with increasing contamination.

Degradation of both marine and fresh water qualities also effects the public health of the region through water contact diseases and contamination of food resources. Again, such deleterious impacts to public health also results in increased economic costs for their prevention and medical treatment.

The destruction of coastal habitats by the land-based activities also leads to the degradation of interdependent habitats. For example, destruction of seabeds and mangrove areas can reduce fish spawning, leading to reduced reef and pelagic fish catches. This has critical implications for both the subsistence and cash economies of the region. Similarly, destruction of inland habitats and ecosystems are linked with the coastal habitats. For example, inland land use changes have been identified as a significant source of sedimentation of marine areas.[18]

Overexploitation of freshwater resources has a number of socio-economic implications for the region. These implications are associated with damage to the existing infrastructure, need for improved treatment and new infrastructure, use conflicts, use restrictions, population migration, reduced waste assimilative capacity as well as increased vulnerability to sea level rise.

[18] Asquith *et al.* (1994)

II. Identification and Assessment of Problems

This section considers how significant land-based sources and activities affect both the local populations and the marine, coastal, and associated freshwater environment. It identifies, to the extent information are available, the nature and severity of the problem as related to food security, poverty, public health, ecosystem health, and economic and social benefits and uses (including cultural values). The assessment considers the sources of degradation and the contaminants of concern. Areas of concern addressed include some of the region's sensitive environments (e.g. coral reefs, seagrass beds, mangroves, and coastal wetlands).

A. NATURE AND SEVERITY OF PROBLEMS

The nature and severity of the problems associated with land-based sources of pollutants varies with the source, type of contaminant, and particular geographic area. Environmental health is a major concern in the Pacific region. Environmental health problems in the region are closely linked to the supply and quality of freshwater and to the introduction of contaminants to the environment. Where there are problems with sewage disposal and solid waste, which has been identified as the most serious threat in the region to non-living resources and critical species and habitats[19], water-related diseases such as diarrhoea and other gastrointestinal illnesses are prevalent. Skin diseases and conjunctivitis are common in areas suffering from limited water supply and water quality degradation.[20] Sewage contamination of coastal areas, particularly near urban centres is common. The limited monitoring studies of water and shellfish in coastal areas shows that several urban areas meet international standards. Serious infectious disease outbreaks have occurred in the region and the potential remains for further outbreaks.[21]

There are increased stresses on the local food resources and deterioration on traditional agricultural systems as a result of environmental degradation, overexploitation, and habitat destruction. Changing lifestyles has also brought increased importation and use of imported processed foods. This has resulted in increases incidence of nutritional disorders and nutrition-related non-communicable diseases.[22]

Health and general social indicators, nor purely economic indicators are important to assessing the poverty issue in the region. This is because of the inseparable link between the marine environment and the socio-economic well being of the people in both the traditional subsistence system and the western monetary economy. Where increasing urbanisation has occurred and traditional resource systems have declined, i.e. in some urban areas, poverty is an emerging issue. Where subsistence lifestyles remain, there is a certain affluence in terms of health and well being. In both systems, maintenance of environmental quality is essential to maintaining the food supply and providing an economic base of development.

Ecosystem health and biodiversity is an important issue for the region. The very isolation and uniqueness of the region's ecosystems also makes them particularly susceptible to habitat loss or environmental degradation. The Islands biological diversity and its component species are among the most critically threatened in the world. It is estimated that approximately 75 percent of the mammals and birds that have become extinct in recent history were island dwelling species. More extinctions appear likely in the future. [23] The loss of habitats can rapidly lead to loss of biodiversity. Ecosystem damage can also occur through the release of chemical contaminants and nutrients to the environment. For example, tributyl tin contamination has seriously affected the

[19] International Waters SAP (1998)
[20] SPREP (1992) *(The Pacific Way)*
[21] Brodie *et al.* (1990)
[22] IBID
[23] SPREP (1992) op cit. *(The Pacific Way)*

shell fish population in Suva Harbour and eutrophication of the Port Vila Lagoon, respectively. [24]

The regions' critical species tend to share a number of the following characteristics (in no particular order). They are:

- Economically valuable;
- Nutritionally important;
- Relatively rare;
- Sedentary;
- Easy to catch or collect;
- Slow-growing;
- Slow to reach maturity and reproduce;
- Important to ecosystem maintenance (keystone species);
- Have few offspring; and
- Found towards the upper end of the food chain.

Because of their enormous economic and nutritional value, the region's fish are considered critical as a group. Other economically and nutritionally critical species[25] in the region are: turtles, sharks, trochus, green snail, bêche-de-mer, giant clams, spiny lobster, coconut and mangrove crabs, helmet, trumpet and conch shells. The species critical for other reasons listed above are: dugongs, marine mammals, saltwater crocodile, and certain seabirds. The latter groups of species, and at least two species of seabirds in the region are already classified as vulnerable, threatened or endangered.[26]

Traditional systems for the management of the environment and natural resources have also been threatened, though there has been a resurgence in the recognition of their value and use. As an example, the relatively recent (1998) reintroduction of the Ra'ui in the Cook Islands has apparently has had positive effects, and has resulted in increased numbers of invertebrate species in at least one area. The importance of traditional resource management systems should be maintained and strengthened both for the positive environmental benefit and to stop the current erosion of traditional knowledge.

B. SOURCES OF DEGRADATION

The GPA considers coastal and upstream point sources, coastal and upstream non-point (diffuse) sources, and atmospheric deposition. Coastal and upland sources are considered in terms of the major land-based activities described above. Figure 2 shows the relative pollutant contributions of each of the activities that have been quantified. It important to note that only agricultural chemicals have been included in the agricultural calculation. Sediments and nutrients from piggeries and other manure sources have not been quantified.

1. Domestic Sources and Urbanisation

The domestic sources of land-based pollution have been identified as domestic sewage, solid waste (including litter), land alterations from urbanisation. Table 6 summarises pollutant contributions from domestic wastewater calculated by the WHO Rapid Assessment method.[27] These may represent point or non-point sources. Virtually no quantitative data is available for non-point data or the pollution resulting from land, ecosystem, and hydrological modifications. Nevertheless, there is visual and anecdotal evidence of their effects from eutrophication of lagoons to completely removed and filled in wetlands. Solid waste generation from domestic sources has been included in the overall solid waste generation summarised in the contaminant discussion below.

2. Agricultural Sources

Agricultural activities primarily represent non-point sources of pollution, increasing the difficulty in the identification and quantitative assessment of the problem. Agriculture activities contribute to pollution of the marine environment through erosion of soils, runoff carrying agricultural chemicals, and run-

[24] Convard (1994)
[25] Preston (1997)
[26] This information was extracted from SAP
[27] WHO (1989) "Management and Control of the Environment"

Figure 2: Relative Pollutant Loading Major Source Contributions: Domestic Sources, Industrial Sources and Agricultural Chemicals

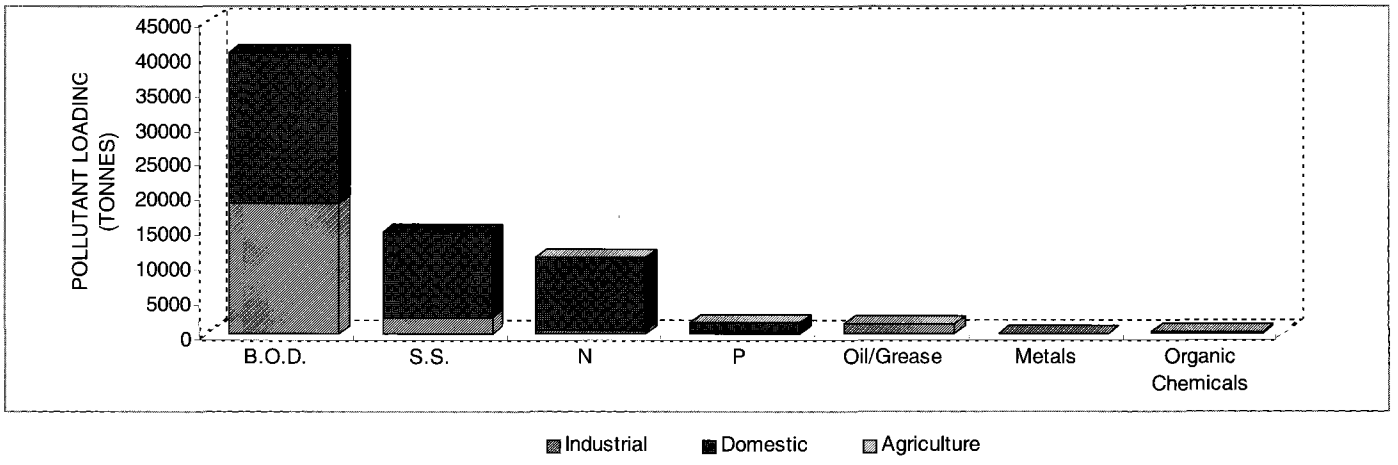

Table 6: Domestic Wastewater Loadings

Country	Pollutant Constituent (tonnes/yr)			
	BOD	**SS**	**N**	**P**
American Samoa	217.41	259.47	89.48	7.99
Cook Islands	831.02	15.28	53.27	6.46
Federated States of Micronesia	1010.93	1314.26	53.27	6.46
Fiji	3270.31	1390.78	2043.26	240.98
Kiribati	409.07	405.96	174.57	21.16
Marshall Islands	419.05	579.70	150.54	18.11
Nauru	102.13	160.84	26.54	3.22
Niue	9.78	0.00	6.35	0.77
Palau	73.29	73.33	38.63	3.78
Papua New Guinea	5665.54	2424.70	3106.91	374.49
Samoa	1170.04	584.53	739.50	83.04
Solomon Islands	2136.96	1762.56	979.15	139.21
Tonga	563.82	161.62	344.72	43.28
Tuvalu	36.48	16.92	23.00	2.79
Vanuatu	817.74	560.04	457.01	58.35
TOTAL	**16733.57**	**9709.99**	**8286.20**	**1010.09**

off from areas with animal wastes. Changing agriculture practices is increasing the potential for runoff, which brings with it increased nutrient loading to the surface water. In some areas of greater agricultural chemical use the runoff may also carry persistent organic pollutants to the marine area. The effects of these contaminants in the marine environment are not yet well understood. Pollutant loading to the marine environment from agricultural chemicals only has been estimated using the empirical assumption that about five percent of all applied chemicals will reach the marine environment.[28] This pollutant loading is summarised in Table 7.

3. Industrial Sources

The following information is extracted from a 1993 inventory of land-based sources of pollutants provides an understanding of the sources of industrial pollution, though the specific quantitative data must be viewed with caution.[29] The purpose of the land-based pollutant inventory was to identify the type and sources of the major pollutants entering the marine waters of the South Pacific. The quantitative results of the industrial portion of this study reflect only a small portion of the actual wastes produced. It does however, point to some of the areas of concern and the growing significance of industrial pollutants in the land-based pollutants waste management scheme.

Table 8 summarises the available quantitative information on industrial pollutant loadings reaching marine waters, excluding mining wastes. The information is structured so that the process from which they originated and the country that they are located in identifies the pollutant loadings. As was cautioned previously, care must be taken not to place too much importance on quantities of waste without considering the location of the discharge outfalls and the potential health and environmental impact of the pollutants. Indeed, many of the more hazardous and toxic wastes such as solvents and heavy metals associated with the medium scale industrial bases of Fiji and Papua New Guinea, are not well represented in the summary table. For example, the summary does not include most of industrial pollutant sources identified by Cripps (1992) for Suva Harbour due to the lack of production data and/or WHO method loading factors...

Fish canneries, as previously mentioned, exist in several countries and are planed for several others. In 1993 they contributed pollution in approximately the following quantities: BOD (26.77 tonnes), nitrogen (297.93 tonnes), phosphorus (167.3 tonnes), and suspended solids (194.75 tonnes). Canneries may be an appropriate industry for the region given its pelagic resources. Care must be taken, however, to plan for and implement adequate waste treatment. Pollutants can upset the coral reef environment including, perhaps, reef fisheries and ultimately the pelagic fisheries upon which the canneries rely. Many countries with canneries or plans for canneries also wish to promote tourism. Obviously, ill-managed or heavy polluting cannery operations are not compatible with the development of a successful visitor industry.

Breweries are also increasing in prominence in the industrial sector of the region. This industry can be relatively innocuous and simple treatment technologies provide adequate treatment, if adequately sized. Siting effluent discharges in non-sensitive areas with good circulation, and preferably below thermocline levels, minimises environmental problems. Sediments, BOD, and heated water are again the primary constituents of concern for this industry. Breweries were estimated to be the source of 337 tonnes of BOD and 427 tonnes of suspended solids.

Sugar milling is a critical part of the industrial base of Fiji. The suspended solids and BOD loadings to the marine environment, however, are quite high; visual observations in Lautoka confirmed this. In 1993, sugar milling was estimated as the source of 264 tonnes of BOD and 125 tonnes of suspended solids/yr.

[28] After Convard (1993) and is based on a number of empirical case studies.
[29] Convard op cit.

Table 7: Agricultural Chemical Pollutant Loading to the Marine Environment (tonnes)

COUNTRY	FERTILIZERS					PESTICIDES								
	Nitrogen Based	Phosphates	Potassic	Other	TOTAL	Insecti-cides	Fungi-cides	Herbi-cides	Rodenti-cides	Mineral oils	Fumi-gants	Molluscicides	Other	TOTAL
American Samoa														
Cook Islands						0.18	0.12	0.12						0.43
FSM														
Fiji	0.60	1.15	0.90		2.65	14.15	1.20	9.90	9.90					35.15
Kiribati					0.0031									
Marshall Islands														
Nauru														
Niue							0.06	0.05			0.01			0.12
Palau														
PNG					1.03	7.15	0.11	23.35					0.30	30.91
Samoa	7.50	7.50	7.50		22.50	0.03 [1]	0.04 [2]	[3]	0.04	12.50	0.05			12.66 [4]
Solomon Islands		111.90	8.00		119.90	14.15	0.25	10.25					0.20	24.85
Tonga	21.50	0.01			21.51	0.05	0.55		0.004			0.04		0.64
Tuvalu		0.10	0.25	0.85	1.20	0.05			0.05				0.10	0.20
Vanuatu					6.00	0.05	0.02	0.50					1.50	2.07
TOTAL	**29.60**	**120.66**	**16.65**	**0.85**	**174.79**	**36.91** [1]	**2.34** [2]	**44.28** [3]	**10.00**	**12.50**	**0.06**	**0.04**	**2.10**	**108.25** [4]

Source: Convard (1993)
Notes: All quantities are formulation quantities
1) + 0.02 kilolitres
2) + 0.029 kilolitres
3) + 2.18 kilolitres
4) + 2.23 kilolitres

Table 8: Industrial Pollutant Loadings by Country and Industry (for Industries where information was available to use rapid assessment method)

Country	Process	B.O.D.	S.S.	Oil	N	P	Other
		t/yr	t/yr	t/yr	t/yr	t/yr	t/yr
American Samoa	Fish Canning	4,53	179,18	64,71	255	167,3	
Cook Islands	Beer Production	no data					
Fiji	Beer Production	12,9	18,7				
	Fish Canning	8,18	6,35	4,52	25,63		
	Sugar Milling	263,81	124,58				
	Food Production		0,333	0,061		0,91	
	Brewery	129,7	187,1				
	Edible Oils	95,9	94,8	107,9			
	Soap Manufacturing	0,14	0,04	0,03	0,001		
	Paint Manufacture			0,04			Pb 0.04
	Battery Manufacture	0,001	0,006	0,03			
	Bulk Fuel Storage	0,001	0,007	0,032			
	TOTAL	510,632	431,916	112,613	25,631	0,91	0
Kiribati	none						
Marshall Islands	no data						
Nauru	no data						
Niue	Slaughter House	0	0	0	0	0	
Palau	no data						
Papua New Guinea	Edible Oil	246,6	974,6	765,3			
	Brewery	48,9	8				
	Sugar Milling	213,44	100,8				
	TOTAL	508,94	1083,4	765,3	0	0	
Samoa	Soft Drinks						
	Slaughterhouse						
	Beer Production	63,7	10,42				
	TOTAL	63,7	10,42	0	0	0	0
Solomon Islands	Slaughter House	9	1,12	1,04	1,4	0,1	
	Fish Processing	14,1	9,09	6,185	17,3		
	Edible Oil	490,5	484,6	553,6			
	Food Manufacture						
	Soft Drinks						
	TOTAL	513,6	494,81	560,825	18,7	0,1	0
Tonga	Fish Canning	0	0	0	0	0	0
Tuvalu	none						
Vanuatu	Beer Production	211,7	34,63				
	Soft Drinks Prod.	126	88,2				
	Slaughterhouse	152,69	101,99	98,03	117,21	42,72	
	Milk Production	57,7	16,6				
	Fish Processing	0	0	0	0	0	
	TOTAL	548,09	241,42	98,03	117,21	42,72	0
TOTAL		**2 149,5**	**2 441,1**	**1 601,5**	**416,5**	**211,0**	**0,0**

Source: Convard (1993)

Note: PNG also has other industries, including: oil palm processing, abattoirs, coffee pulping, food processing, and fish and meat canning

Table 8 provides a summary of pollutant loadings by industry for each of the major industrial sources above, beer production, edible oils, and sugar refining.

Sewage from tourism activities is not included in the summaries and represents a major source of pollutants that has not been well quantified. These sources can easily be estimated using number of rooms and average occupancy data together with typical wastewater generation and characteristic data.

4. Mining

The mining contribution to marine pollutant loadings is known to be great and is visually evident in the areas in which mining occurs. While rough quantitative estimates can be made with rapid assessment techniques, the scale of the problem is self-evident and not enhanced by such a rough calculation. As an example of the loads contributed by mining, however, Hughes (1990) has described the direct effects of the Misima mine (PNG) on the marine environment. There is a daily discharge of approximately 20,000 tonnes of soft waste rock and 15,000 tonnes of tailings per day. The tailings are washed to recover 75 percent of the process chemicals and then mixed with seawater and discharged at a depth of 75 to 100 meters on the outer edge of the coral reef. Discharges from PNG's Ok Tedi mine discharges to the Fly River and are carried to the marine environment.

Coastal mining for aggregates is less quantified except in terms of the numbers of countries that require the use of aggregate from coastal areas. Virtually every country in the region mines aggregate from the coastal region in some degree. Atoll countries rely upon this as their only source of such materials outside of importation. This activity results in both short- and long-term damage to the coastal and marine areas.

5. Atmospheric Deposition

Previous studies have also indicated that on a worldwide basis air contaminant input to the marine environment make up a significant contribution to marine pollutant loadings (GESAMP, 1990a, 1990b). Regional studies have found air contributions to be minimal for the South Pacific Region (Morrison, 1992a). Atmospheric contributions to the marine environment may be greatest from the region's urban area's where emissions from vehicles, power plants, cement plants, and other industrial sources may be great enough to result in local deposition of particulates and chemicals sorbed to the particulates.

Table 9: Regional Pollutant Generation for Several Major Industries -1992 (tonnes)

Industry	BOD	SS	N	P	Oil / grease
Beer Production	184.6	77.85	0	0	0
Sugar	477.25	225.38	0	0	0
Edible Oils	833	1554	0	80	1426
Fish Canning	26.77	194.75	297.93	167.3	0
TOTAL	1521.62	2051.98	297.93	247.3	1426

Source: Convard (1993)

C. CONTAMINANTS

The contaminants consider under the GPA by source category include persistent organic chemicals (POPs), sewage, radioactive substances, heavy metals, oils, nutrients, sediment mobilisation, litter, and physical alteration of the environment. Many of these contaminants have been discussed above in terms of activity source. In this section, the focus is on existing contamination issues; and, where appropriate, the management implications of the combined sources is addressed.

1. Persistent organic contaminants

POPs are defined by the international community as chemicals compounds that possess toxic characteristics, are persistent in the environment, bioaccumulate, are prone to long-range transport and deposition, and can result in adverse environmental and health effects. Recent and ongoing projects in the region include 'Management of Persistent Organic Pollutants in the Pacific'; and 'Development of Hazardous Waste Management Strategies in Pacific Island Countries (PICs)'. They, however, have utilised the term more broadly to include all hazardous and potentially hazardous chemicals such as pesticides, polychlorinated biphenyls (PCBs), industrial chemicals, medical wastes, laboratory chemicals, oil, bitumen, timber treatment chemicals, and fertilisers. This is appropriate as the use of many of these hazardous substances, while growing, is relatively small compared to other regions of the world. The limited resources of region require that the management of these substances be integrated and co-ordinated with other waste management activities. Thus, other categories of contaminants identified under the GPA are discussed in the context of POPs. For example the GPA category of oils (hydrocarbons and polyaromatic hydrocarbons) is included in the discussion of POPs, as are metals commonly found in pesticides such as arsenic.

To-date, the POPS in PICs project has focussed on the assessment of existing stockpiles and waste sites associated with POPs. Data extracted form the draft report for the project is summarised in Table 10.[30] Past waste management for outdated and waste POPs has generally been poor to very poor with wastes being dumped and buried in residential areas and even in residential homes. Some burial of waste can be effective in reducing in immediate risks, but the potential for contaminating of nearby groundwater is great and must be consider. There is also potential direct human health risk, depending on land use, if the site is not properly controlled. Remediation of 35 sites has been recommended by the POPs in PICs Project.[31]

Table 10: Existing Waste Quantities of POPs in the Pacific Region

Waste Type	Quantity
Waste Oil	180 tonnes
Potentially PCB Contaminated Oil	135 tonnes
Waste Bitumen	330 tonnes
Waste Timber Treatment Chemicals	160 tonnes
Waste Fertilisers	87 tonnes
Waste DDT	10 tonnes
Waste Pesticides (not including DDT)	47 tonnes
Buried Waste Pesticides	11 tonnes
Waste Medical Drugs	21 tonnes
Miscellaneous Special Wastes	38 tonnes
Oil Contaminated Sites	26 sites
Bitumen Contaminated Sites	9 sites1s
Hydrocarbon Contaminated Groundwater Lens	11 sites
Pesticide Contaminated Sites	21 sites
Buried Waste Pesticides Sites	7 sites
Timber Treatment Chemical Sites	7 sites
Miscellaneous Contaminated Sites	7 sites

Source: SPREP (1999) Draft report

[30] SPREP (1999) Guidelines for Solid Waste Planning in Small Island Developing States in the Pacific Region

[31] POPs in Pacific Island Countries Draft Report

From this identification of waste sites together with the POPs generation noted above from industrial and agricultural activities it can easily be seen that unless there is improved hazardous material use and management that there is great potential for an ever-increasing number of contaminated sites. This will result in increased degradation of the marine environment and freshwater supplies.

2. Metallic Compounds

Excessive levels of metals in the marine environment can affect marine biota and pose risks to consumers of seafood. Heavy metal compounds are found in many of the materials and processes of regional industrial activities and to a lesser extent agricultural activities.

Lead, cadmium, and chromium, which were used for anti-algae and fungi properties, are found in older paints and in anti-fouling paints for marine craft and structures. More toxic and of documented environmental degradation in the Pacific is the use of organotins, such as TBT in anti-fouling paints. The use of these paints has been generally banned in the United States and several other countries.

Sandblasting of ships in preparation of painting has also resulted in the release of heavy metals to the marine environment. In the Marshall Islands, heavy metals have been detected in marine sediments and shellfish. [32]

[32] Marshall Islands Country Report for the Workshop

Mining activities are major contributors to the region's environmental load of heavy metals. Other industrial operations such as foundries, metal plating and other processes involving combustion and use of petroleum products are also contributors. Batteries may also form a significant source of lead and mercury if their disposal is not properly managed.

3. Sewage discharges

Sewage discharges have been described above. The sewage discharges include other GPA contaminant categories including nutrients and solid waste. Again, it is important to consider sewage from tourism activities in the assessment of this contaminant.

4. Nutrients

Nutrients primarily result from agricultural and domestic waste sources. Domestic waste sources provide a direct point source for these contaminants while agricultural sources of nutrients generally result from non-point sources. Nutrient delivery from uncontaminated soils to the coastal zone via sediment transport from rivers and inland areas has also been found to be significant for the region. While the study noted the need for considerable caution with respect to the specific data presented in Table 11, it does provide a preliminary understanding of the role of sediments in delivering nutrients to the marine environment

Table 11: Country Average for Nutrient Movement via Sediments Entering the South Pacific Coastal Environment (tonnes)

Carbon	Nitrogen	C/N Ratio	Calcium	Manganese	Potassium	Sodium
326	21	16	77	61	19	44

Source: Asquith et al. (1994)

5. Sediments

Sedimentation and siltation are important natural processes in the marine environment but excessive sedimentation can severely degrade or destroy marine ecosystems and habitats. Coastal habitats require some sediment input but can be damaged by both too low and excessive sediment loads. Sediments can also carry other chemical contaminants harmful to the marine environment. The addition of nutrients to lagoons is a notable example of this in the region. Sedimentation of the marine environment results from a number of coastal and inland sources. Land use changes from multiple sources is biggest contributor of sediments to the marine environment.[33] Land use changes include any anthropogenic modifications to the land and include forestry operations, agricultural practices, construction activities, mining operations, dredging and filling (land reclamation) activities, coastal erosion, and other physical and hydrological modifications. Sewage and many industrial processes also contribute to sediment mobilisation.

Asquith *et al.* (1994) studied sediment transport and yields for the region. They noted the near total absence of published data for sediment loads and sediment transport in the region. They calculated a total sediment yield of approximately 2.3 to 2.5 x 10^9 tonnes for the region. A summary of their data is presented in Annex 2.

6. Radionuclides

Problems from radionuclides in the region are principally associated with past military activity and nuclear testing. There is no known dumping of nuclear wastes in the region at this time. Historically many of the islands were used for nuclear testing, including Bikini and Eniwetok in the Marshall Islands, Christmas Island in Kiribati, Mururoa in French Polynesia, and Johnston Atoll (United States).

[33] Asquith et al op. cit

Low level radionuclides sources such as those from medical waste (x-rays) have not been quantified. However, this is not believed to be a significant source.

7. Solid Waste and Litter

Solid waste generation in the South Pacific Region is increasing at a rapid rate. As urbanisation increases and the local economies are transformed from the traditional subsistence economies to cash economies there is an increased use of non-biodegradable materials and products. In the traditional economy wastes largely consisted of leftover or discarded organic wastes that degraded rapidly or were easily burned. In the insular environment with little excess land available to use as disposal sites, much of this solid waste is disposed directly into the marine environment. Others are located in coastal areas. This disposal occurs in the form of controlled dumping and littering. The dumping occurs, with few exceptions, in wetlands, e.g., mangrove swamps, and reefs flats.

Domestic and industrial solid wastes are usually co-disposed in the Pacific region. Industrial and commercial solid wastes often include process waste, solvents, cleaners, construction debris, metals, acids, petroleum products, etc. Household waste may also contain hazardous wastes from cleaners, pesticides, used oils, and infectious wastes. Leachate generated from solid waste landfills may contain a number of toxic chemicals and infectious agents. The leachate can adversely upset the ecosystems and may be injurious or fatal to a number of aquatic species. Fish and shellfish may bioaccumulate such toxins. Persons consuming these fish and shellfish are at risk for cancer and a variety of chemical-induced diseases and organ failures. Marine flora can be directly suffocated or injured by solid waste debris in the marine environment

Health, ecological and economic risks from improper solid waste disposal practices are important concerns. Much of the region has, or desires, tourism as a major economic component. Poorly managed solid

waste disposal resulting in water quality degradation or unsightly conditions adversely affects the potential to attract visitors and maintain repeat visitors. The region has earned substantial foreign exchange due to its image as an unspoiled, tropical vacation destination.

Several per capita solid waste generation rates are available for different regions and community types and generally range between 0.35 t 0.7 kg/person/day. Convard (1993) utilised an estimate of 1 kg/per capita/per day to estimate both residential and commercial contributions to solid waste generation. This may also help to as account for wastes such as green waste, which are often not considered in the waste generation surveys because it is assumed that this waste does not reach the landfill. However, as waste management practices develop and central landfills are in greater use, increasing volumes of green waste will enter the management system. Table 12 presents country and regional waste generation estimates based on the assumed generation rate.

Leachate from landfills also is a serious concern. Leachate production has not been quantified; however, leachate contributions to the marine environment are likely to be significant.

Table 12: Solid Waste Generation

Country	**Population**	**Annual Generation** (Tonnes/year)
American Samoa	46,773	17,072
Cook Islands	46,800	17,082
Federated States of Micronesia	105,506	38,510
Fiji	772,655	282,019
Kiribati	77,658	28,345
Marshall Islands	43,380	15,834
Nauru	9,191	3,355
Niue	2,082	760
Palau	17,725	6,470
Papua New Guinea	3,607,954	1,316,903
Samoa	161,298	58,874
Solomon Islands	285,176	104,089
Tonga	97,784	35,691
Tuvalu	9,043	3,301
Vanuatu	142,419	51,983
TOTAL	**5,425,444**	**1,980,287**

Note: Per capita generation rates have been calculated for the Pacific between 0.35 and 0.7 kg/person/day; however, Convard (1993) used a value of 1 kg/pers/day to account for commercial wastes and often-unmeasured green wastes.
Source: Updated from Convard (1993)

Littering is also a concern in the region. Litter enters marine waters in all of the region's countries. Litter thrown along and in streambeds is washed down to the coastal area during heavy rains. The effects of the litter on the marine environment are well documented.

Litter entering the marine environment is difficult to quantify. The contribution of litter to pollution of the marine environment may be demonstrated by the collection of solid waste from Pago Harbour in American Samoa. In 1992, the government enlisted a contractor to periodically pick up the floating rubbish in the harbour. The contractor reported collecting some 2,000 pounds or 0.9 tonnes per month.

8. Heat

Thermal discharges in the region are primarily associated with power production and certain industrial processes. Notable regional industries that discharge wastewater with elevated temperature include the breweries and food processing/packaging operations. Many of these facilities utilise individual treatment facilities that may provide adequate treatment if adequately sized. Sensitive ecosystems are particularly vulnerable to discharge of heated wastewater. Little data exists to define the extent of this problem.

9. Physical Alterations / Habitat Modifications

The sedimentation and pollutant loading carried with sediment laden runoff as well as the direct habitat modifications that occur with physical alterations has numerous and serious detrimental effects on the marine environment. Many of these effects were identified in Section I-B and can be generally associated with major effects of sedimentation, habitat destruction or degradation, and release of chemicals and nutrients to surface waters and marine environment. Physical alterations encompass the wide range of land use changes that occur in the region, including construction, agriculture (including forestry/logging), aquaculture, land reclamation and mineral and aggregate (sand and gravel) mining. These physical alterations occur with in the domestic, industrial and agricultural activities. The interrelationship between inland alterations and marine degradation are strong. In this region, the "coastal" area actually encompasses the entire island, as the effects of inland activities on the marine area can be very direct.

Sedimentation of reefs and coastal areas is considered very serious problem for Pacific Island countries.[34] The problems resulting from sedimentation associated with these physical alterations occur throughout the region, though are of greater concern to the high islands. Sedimentation on high islands frequently results from the above land described land use changes. The problems associated with sedimentation on low islands are primarily associated with land reclamation and aggregate mining.

Physical alterations of inland and coastal areas are often necessary to economic development and provision of essential services. Yet the environmental effect of such physical alterations can be minimised through proper planning, development site selection, design and incorporation of environmental controls.

Management of environmental effects associated with physical alterations, e.g. sedimentation, from all activities needs to be addressed by integrated management and co-ordination among all the government agencies and private sector involvement.

D. AREAS OF CONCERN

All of the ecosystems and habitats found in the region are critical importance to the well being of the marine environment and socio-economic well being of the region. They are inextricably linked. It is not possible to single out one habitat or species for separate management in our region.[35]

[34] Morrison *et al.* (1990)

[35] Pacific Regional Report on the Issues and Activities Associated with Coral Reefs and Related Ecosystems (1996)

It is appropriate here to note the special problems of Small Island Developing States (SIDS). The success of national development planning for the region's SIDS is wholly dependent on the continued health of the marine environment yet the financial and human resources available to manage and sustain these resources are limited. SIDS are particularly vulnerable to the anthropogenic threats described in this report and other threats such as marine-based sources, climatic change, and natural disasters such as cyclones, tsunami, earthquakes, etc. These challenges and constraints to SIDS requires greater regional co-operation and study, which has been a long-term characteristic of the Pacific

E. ADDITIONAL ISSUES OF CONCERN

Many other issues of environmental concern included in the GPA are closely related to the issues discussed above. Expanding coastal populations and tourism, toxic algae blooms, and eutrophication are believed to result, singularly or in some combination, from the land-based activities and contaminants described earlier. Energy and turbidity changes likely result from coastal development, hydrologic modifications, and/or industrial and domestic discharges. It is important to remember the interrelationships of the various concerns when developing and implementing management programmes.

Marine transport issues are also a concern. Spills of petroleum and other hazardous materials along with the physical damage to coral reefs and other ecosystems caused by marine accidents are of particular concern. The required construction and maintenance of marine infrastructure and maintenance of navigation channels also results in increased sedimentation.

III. Emerging and Foreseeable Problems

Emerging and foreseeable problems for the region are related to the intensification of the activity and contaminant concerns noted above as well as related marine discharges, coral reef diseases, climatic change, and other influences to the natural processes that are also affected by land-based sources. Of these, the most serious environmental threat to the region is climatic change and sea level rise. The Pacific Islands are particularly vulnerable because they include hundreds of low islands and the coastal zone houses most of the population and most important economic activities occur in the coastal areas. The region is already at great risk from extreme natural events such as cyclones, earthquakes, tsunami, droughts, and volcanic eruptions. An illustration of the regions' vulnerability is the near inundation of Majuro, RMI that occurs during the largest spring tides and storm surges. The greatest risk is the potential for loss of entire islands.

The risks to human health from sea level rise are also significant, as already limited freshwater resources will be at risk. Limited land area and soil for the growth of staple food resources such as taro and coconuts may be lost. The risks to the economic well being of the region from climatic changes are obvious as these areas become unavailable, and/or the fear of their being unavailable, will limit economic investment in the area.

Recent 1999 research by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) carried for SPREP concluded that human greenhouse gas emissions up to 1995 have already built in an inevitable 5 –12 cm rise into the natural systems. The report also warned that the region also faced a moderate risk of an increase in the intensity of cyclones and storm surges by the 2020. This could result in serious socio-economic damage in the region.[36]

[36] Draft Pacific Islands Regional Statement to the United Nations Framework Convention of Climate Change, Fifth Meeting of the Conference of the Parties, October 1999

IV. Priorities for Action

Sewage, solid waste, agricultural, and industrial activities, urban runoff and physical alterations have been identified as primary sources of land-based pollution of the marine environment. The main problems and barriers to addressing these problems, include, but were not limited to:

- Issues of policy, regulation and enforcement;
- Technical capacity;
- Data gaps;
- Inadequate infrastructure;
- Economic valuation of the resources;
- Land tenure;
- Resource pricing;
- Loss of traditional management systems;
- Development pressures;
- Lack of community awareness and education;
- Lack of community involvement;
- Lack of planning; and
- Other management issues.

Annex 3 provides a summary of the problems, solutions, barriers, assistance and country needs that were identified in Workshop workgroup discussions and in country reports.

The source of concern and associated GPA contaminants that have been identified for priority action are found to be the following:

- Sewage – addresses GPA source categories of sewage, nutrients, and sediments;
- Solid Waste – addresses GPA source categories of litter, POPs, nutrients, and lesser extent heavy metals;
- Agricultural – addresses GPA source categories of sediments, nutrients, and POPs;
- Industrial – addresses GPA source categories of sediments, heavy metals, and POPs; and
- Physical Alterations/habitat destruction, degradation and modification – addresses GPA source categories of sediments.

Of these priority sources, sewage was seen as the most important problem on a regional basis. These priorities for action must be addressed through resolution of the root causes, including but not limited to management, understanding, public education and awareness, technology availability, technical capacity, financing, and lack of high quality information and data.

Areas for priority action that have been identified through this overview are consistent with those of another regional consultation, the International Waters SAP. The priority activity areas related to land-based activities identified by the SAP for immediate intervention were improved waste management and better water quality. Thus, the overall conclusions of this with recent previous consultations are consistent

Improved integrated waste management must address solid and liquid wastes and its effect on water quality and potential for habitat degradation and sustainability of resource use. The various activities and sources contributing to solid and liquid waste must also be considered. Domestic, industrial, and agricultural activities contribute to waste generation and this waste in the region includes sewage, nutrients, POPs, heavy metals, and hydrocarbons.

Nutrients and sediments are difficult categories to address because they often result from non-point sources. Thus, research to assess the quantities and types of chemicals and activities contributing to these categories, as well as means of mitigating their release to the marine environment is needed. Without waiting for the results of such assessments, however, improved construction and agriculture practices should be promoted. These measures may include implementation of best management practices to minimise erosion and runoff, more rational use of fertilisers, and minimise urban runoff.

Toxics management will require regional co-operation and dialogue to allow appropriate shipment of wastes from countries without appropriate treatment technologies to those with appropriate technology with the permission of the receiving country. Sustainable long-term management of toxics will require implementation of pollution prevention and waste minimisation programmes.

Better water quality means preventing the degradation of water quality by addressing the root causes of water quality degradation, which include, sewage, solid waste, nutrients, sediments, and toxic wastes from point and non-point sources. Clearly the priority areas for improved waste management and better water quality are closely linked.

The need for improved management, both in the governance and understanding subsets, must be stressed. Without improved management and public understanding sustainable improvements cannot be achieved. This need must be implicit in each of the priority areas for action.

V. Strategies and Measures

The SAP provided a useful analytical framework for identifying and evaluating measures for management of international waters that is directly applicable to the GPA and the RPA which will be developed as a result of the regional workshop. A number of strategies and measures exist to address the threats and identified priority actions for the region. This review and the RPA workshop benefited from the previous regional consultations for the International Waters SAP. This has been modified to focus on land-based sources of pollution but otherwise is the same framework as identified for the SAP.

Similar to the SAP, the solutions and strategies to address the priority action the barriers that must be addressed and the strategies for action can be grouped into five categories:

- Management;
- Capacity-building;
- Awareness / education;
- Research / information for decision-making; and
- Investment (infrastructure, technology, project and programme development).

Institutional strengthening is included under management & capacity building.

Overall Framework for Management and Protection of the Marine Environment From Land-Based Sources of Pollution – Modified from International Water SAP

Priority Concerns:	Degradation of marine environment/water quality Degradation of associated critical habitats
Imminent Threats:	Pollution from land-based activities
Ultimate Root Causes:	Management deficiencies a) Governance b) Understanding
Solutions:	Integrated Waste Management Watershed and Coastal Management
RPA Activity Areas:	Sewage Solid waste Agricultural Sources Industrial Sources Physical Alterations / habitat modification, degradation, destruction
Targeted Actions:	Management / institutional strengthening Capacity-building Awareness / education Research / information for decision-making Investment

These categories are meant to encourage strategies and measures, as well as specific projects, with diverse applications. The categorisation provides a way to link proposed measures with the identified problems and root causes the known environmental and socio-economic concerns.

Each country will be responsible for developing and implementing projects that meet the need of individual national socio-cultural systems and values. The overall strategies and measures described below address the technical, management, and community awareness components of the five categories noted above. Successful improvements require the understanding of the linkages amongst the categories. Achieving management in the government/institutional sector requires the understanding of the community to ensure participation and assist with enforcement management decisions. Appropriate technology decisions resulting in effective infrastructure systems will improve public understanding and enhance management improvement opportunities.

To address the identified priority areas it is necessary for the countries of the region to continue to co-operate and improve this co-operation in a number of areas including:

- Sharing of experience to enable rapid regional learning;
- Development of regional capabilities to address institutional strengthening and capacity building within individual countries;
- Development of regional programmes and clearinghouses for exchanging and sharing of technical information;
- Development of regional databases for environmental quality information;
- Development of educational and community awareness programs that are adaptable to individual countries; and
- Development of technical information and facility designs.

Individual countries must develop waste management polices and the associated institutional and regulatory structure to support waste management improvements. They must also be committed to providing and maintaining systems and infrastructure for waste management. In doing this they should provide for governance and management, understanding, economic, and technical issues:

- Harmonisation of laws and regulations;
- Development and enhancement of community understanding and awareness;
- Consideration of issues of traditional and customary property and user rights practices;
- Inclusion of economic incentives, where appropriate;
- Sufficient financing of waste management;
- Selection of appropriate technologies;
- Development of decision-maker knowledge and understanding;
- Inclusion of pollution prevention, waste minimisation, and recycling components;
- Collection of additional information and data;
- Maintenance of infrastructure;
- Development and enhancement of the understanding of user pays in both government, business, and public sectors; and
- Consideration of the economic value of environmental goods and services.

Provision and maintenance of waste management services can be direct, through contracting of private vendors, or other institutional arrangement appropriate to the individual country's need, but the government must ensure that it is provided and maintained.

Individual countries through the improvement of waste management, identification and development of water supply sources and systems, and improvement of watershed management, and monitoring of water quality should address better water quality. Governments should initiate monitoring of both fresh

water and marine water quality to assess the extent of existing contamination and provide information to identify sources of contamination and appropriate mitigative measures. The governments should identify and implement management measures to protect water resource and develop appropriate legislative and institutional measures to protect both coastal and inland watersheds.

As with improved waste management, better water quality will depend on an improvement of watershed management systems and improved community understanding and awareness. The considerations listed above for waste management also apply to water supply/water quality management. In particular, the entire coastal area and watershed should be considered in their entirety considering all pollutant sources (point and non-point), treatment options, land uses, and potential water uses.

Technical and financial assistance from regional and international organisations may be necessary to fully develop all components of the management strategies. The establishment of waste management policies and general frameworks as well revitalisation of the county commitment to these issues, however, are important steps that each county may take without technical assistance.

VI. Main Conclusions and Recommendations

The Pacific region encompasses an extremely diverse range of physical, climatic, and ecological diversity yet all of the islands rely on the marine environment for its existence. The coastal and marine environment houses its population and the most important economic activities occur in the coastal areas. Land-based activities such as agricultural and industry, urbanisation, and mining disturb essential natural processes. A number of activities and specific contaminant sources have been identified as potentially detrimental to environmental quality and the social and economic well being of the countries in the region.

A number of information gaps were noted that were relevant to the needs of decision-makers in developing ways to address root causes and to respond to imminent threats. It is particularly important that these data gaps also represent a lack of strategic information in an appropriate form to decision-makers, resource managers, and communities to evaluate costs and benefits of proposed management alternatives. The data gaps, however, do not prevent action from being taken, as there are substantial anecdotal evidence to confirm the threats and are an important reminder to take a precautionary approach. The prevention of environmental problems costs less than their remediation.

This overview and previous reviews and regional consultations have identified the following overarching threats from land-based sources of pollution to the marine environment:

- Pollution from land-based activities; and
- Physical, ecological, and hydrological modification of critical habitats.

It is important to note that this and previous regional consultations (SAP) have considered prioritisation of these threats to be inappropriate. This is due to the linkages amongst the threats. Pollution from land-based activities threatens water quality, critical habitats and sustainable use of resources. These linkages require comprehensive measures to address the concerns effectively. The recognition of the need for integrated management is essential both on technical and on practical resource considerations. Integrated management is necessitated by the linkages and the limited resources of the individual countries and the region as a whole do no allow disconnected management programmes.

Sewage, sedimentation, and agricultural activities were identified as primary threats to critical species and habitats as well as non-living resources. The root causes of these threats included, but were not limited to:

- Issues of policy, regulation and enforcement;
- Technical capacity;
- Data gaps;
- Inadequate infrastructure;
- Economic valuation of the resources;
- Land tenure;
- Resource pricing;
- Loss of traditional management systems;
- Development pressures;
- Lack of community awareness and education;
- Lack of community involvement;
- Lack of planning; and
- Other management issues.

Importantly, the ultimate root cause of the imminent threats was identified as deficiencies in management, which are grouped in terms of governance and understanding.

Areas for priority action to address land-based activities that have been identified through this overview are consistent with those of the International Waters SAP. These priority activity areas for rapid intervention are found to be the following:

- Sewage – addresses GPA source categories of sewage, nutrients, and sediments;
- Solid Waste – addresses GPA source

categories of litter, POPs, nutrients, and lesser extent heavy metals;
- Agricultural – addresses GPA source categories of sediments, nutrients, and POPs;
- Industrial – addresses GPA source categories of sediments, heavy metals, and POPs; and
- Physical Alterations / habitat destruction, degradation and modification – addresses GPA source categories of sediments.

These priorities for action must be addressed through resolution of the root causes. Strategies and measures for addressing the management of priority action and addressing root causes of the threats to the marine environment have been identified. These strategies are grouped into five categories:

- Management;
- Capacity building;
- Awareness / education;
- Research / information for decision-making; and
- Investment.

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ANNEX 1: INDUSTRIES REPRESENTED IN THE REGION

Industries	Am Sam	Cook Isl.	FSM	Fiji	Kir	RMI	Naur	Niue	Pal	PNG	Sam	Sol Isl.	Tong	Tuv	Van
Agricultural Services and Chemicals	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Health Services and Pharmaceutical Storage or Production	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Other Chemicals Storage Manufacture & Use	X		X	X	X	X			X	X	X	X	X		X
Fuel or Oil Storage	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wood Treatment				X						X		X	X		X
Wood Products Manufacture	X	X		X						X	X	X			X
Furniture and Fixtures Manufacture	X	X		X						X	X	X			
Paper Production					X										
Metal Mining / Refining										X		X			X
Metal Fabrication				X									X		
Machinery & Transport Equipment Manufacturing		X	X	X											
Electric / Electronic Equipment Manufacturing, Maintenance & Use	X			X	X						X				
Minerals Mining				X			X		X	X		X			
Minerals Processing				X					X	X		X			
Paint & Allied Products Storage, Manufacturing and Use	X		X	X			X		X	X	X	X	X		X
Ship Building / Repair	X	X	X	X	X	X			X	X	X	X	X	X	X
Printing and Publishing	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Plastic Production (includes Fibreglass manufacturing)										X					
Cement Production, Construction				X											
Food Processing	X		X	X					X	X			X		X
Oil Palm Processing										X					
Coffee Processing		X								X					
Automobile / Equipment Repair	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fish Canneries	X		X							X		X			
Coconut/Palm Products Processing		X	X	X	X	X		X	X	X	X	X	X	X	X
Brewery				X						X	X				X
Sugar Refining				X						X					

ANNEX 2: SEDIMENT TRANSPORT SUMMARY

Results of the Regional Sediment Yield Calculations for the South Pacific, Using the Fournier (1960) Method.

Islands and Island Groups	Drainage Area, km^2	Calculated Sediment Yield				
		Volume m^3/km^2	Minimum $t/km^2/yr$	Maximum $t/km^2/yr$	Total Min tonne/year	Total Max. tonne/year
AMERICAN SAMOA						
Tutuila	145	1741	3657	4428	530265	656596
Ofu	0					
Olosega	0					
Tau	0					
COOK ISLANDS						
Atiu	0					
Mangaia	0					
Rarotonga	67	1425	2992	3705	201096	248972
FEDERATED STATES OF MICRONESIA						
Kosrae	108	2951	6197	7672	669276	828676
Pohnpei	334	2330	4894	6058	1634429	2023372
Chuuk	61	1166	2449	3932	149389	184928
Yap	98	2111	4437	5489	436660	540627
FIJI						
Viti Levu	10389	3434	7211	8928	74915079	92758174
Vanua Levu	5538	2731	5734	7099	31754892	39314262
Taveuni	435	2268	4764	5898	2072300	2565600
Ovalau	125	1953	4103	5079	410300	507900
Koro	108	1953	4103	5079	443124	548532
Gau	100	1953	4103	5079	512875	634875
Kadavu	408	1833	3851	3768	1571208	1945443
FRENCH POLYNESIA						
Tahiti & Moorea	1052	3056	6417	7945	6750680	8358140
Tahaa	88	1376	2889	3577	254232	314776
Raiatea	194	1376	2889	3577	560466	694054
Rurutu	28	0	0	0	0	0
Nukuhiva & Uapou	435	508	1068	1322	446580	575070
Hivaoa & Tauhata	370	954	2003	2480	741110	917600
MARSHALL ISLANDS	0					
NAURU	0					
NEW CALEDONIA	17130	1694	3557	4404	61274010	75440520

ANNEX 2 continued:						
Islands and Island Groups	**Drainage Area, km^2**	**Calculated Sediment Yield**				
		Volume m^3/km^2	Minimum $t/km^2/yr$	Maximum $t/km^2/yr$	Total Min tonne/year	Total Max. tonne/year
NIUE	0					
NORTHERN MARIANAS						
Saipan	5	2426	5094	6308	25470	31540
PALAU						
Babelthuap	396	2268	4762	5898	1886068	2337200
PAPUA NEW GUINEA						
Mainland Provinces						
Oro	22800	2556	5368	6647	122390400	151551600
Milne Bay	14000	1901	3994	4945	55916000	69230000
Central & North Capital	29740	1801	3783	4684	112506420	139302160
Morobe	34500	1196	2511	3109	86629500	107260500
East Sepic & Sanduan	79100	1299	2728	3348	215784800	267152340
Mandang	29000	2438	5102	6339	147958000	183831000
West Highlands & Enga	21300	1507	3165	3919	67414500	83474700
South Highlands	23800	1472	3091	3827	73565800	91082600
East Highlands & Simbu	17380	1539	3237	4003	56259060	6924280
Gulf	34500		1727		59581500	
Western	99300		1058		105124463	
Island Provinces						
New Britain	39807	6055	12715	15743	506146005	626681601
New Ireland	9974	2304	4839	5991	48264186	59754234
Bouganville	9300	1899	3988	4938	37088400	45923400
Lorengau / Manus	1943	1654	3473	4300	6748039	8354900
PITCAIRN	0					
SOLOMON ISLANDS						
Choiseul	2590	1323	2780	3442	7200200	8914780
Santa Isabel	4122	2452	5150	6376	21228300	26281872
Malaita & Marimasike	4900	3489	7327	9071	35902300	44447900
San Cristobal	3125	2268	4764	5898	14887500	18431250
Guadalcanal	6400	2478	5202	6444	33292800	41241600
New Georgia Group	4250	2410	5691	7046	24186750	29945500
TOKELAU	0					

ANNEX 2 continued:						
Islands and Island Groups	**Drainage Area, km^2**	**Calculated Sediment Yield**				
		Volume m^3/km^2	Minimum $t/km^2/yr$	Maximum $t/km^2/yr$	Total Min tonne/year	Total Max. tonne/year
TONGA						
Eua	15	1061	2229	2759	33435	41398
Tofua	28	1995	4106	5083	114968	142345
Kao	1	1995	4106	5083	4106	5083
TUVALU	0					
VANUATU						
Espirito Santo	3680	1638	3439	4258	12655520	15669440
Malekula	2023	2111	4433	5488	8967959	11102224
Tanna	549	1954	4103	5085	2252547	2791665
Aneityum	65	2373	4984	6171	323900	401162
Ambrym	665	3108	6526	8080	4339790	5373732
Epi	444	1533	3219	3985	1429236	1763405
Erromanga	975	1953	4101	5077	3998767	4950075
Efate	915	2426	5094	6307	461010	5770905
Pentecost	438	3699	7768	9618	3402617	4212764
Aoba	339	3039	6383	7902	2163709	2678878
Maewo	269	2504	5258	6510	1414619	1751433
Vanua Lava	308	2111	4433	5488	1365364	1690304
WESTERN SAMOA						
Savaii	503	2609	5480	6785	2756440	3412855
Upolu	708	2898	6087	7536	4309596	5335488
REGIONAL MEAN		**2331**	**4631**	**5762**		
REGIONAL TOTAL					**2,015,673,053**	**2,486,186,626**

ANNEX 3: SUMMARY OF WORKSHOP PRESENTATIONS OF COUNTRY / REGIONAL CONCERNS

The problems, solutions, barriers, assistance and needs identified during the workgroups sessions and in country reports. No priority order is intended. General areas of concern and several specific subsets of these concerns are noted. Identified solutions, barriers, assistance and needs do not correspond to specific problems.

Problems	Solutions	Barriers	Assistance	Needs
Sewage	Development and implementation of pollution control regulations/permit systems	Lack of effective legislation and regulations	Clearinghouse mechanisms	Legal assistance to upgrade legislation
Solid waste	Established and implemented EIA procedures	Lack of technical resources	Capacity building	Training at all levels
Litter	Enforcement	Poor enforcement	Identification of funding sources	Appropriate treatment options for medical waste
Sedimentation	Industry involvement	Limited community understanding and awareness	Education and awareness	Proper solid waste management
Agricultural runoff	Enhanced public awareness	Lack of financial resources	Regional Organisations	Upgrading landfill sites
Piggeries	Regional assistance	Lack of proper environmental standards	SPREP, SPC, SOPAC	Financial support
Soil erosion	Environmental standards for discharges	Lack of infrastructure	AusAID, NZODA	Technical support
Physical alterations	Environmental standards for water quality		EU, USEPA	Advice and information
Medical wastes	Coordination with other government departments	Land tenure issues	International organisations	Coordination among other regions
Sand (aggregate)mining	Regional co-operation	Cultural issues	Bilateral assistance	Formulate & implement national waste management plans