



**Climate Change and  
Sea Level Rise Issues  
in the  
Federated States of Micronesia**

Report on a Preparatory Mission

by  
**John E. Hay**  
and  
**Kerry McGregor**

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HAY

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## Foreword

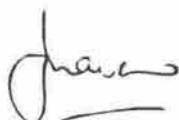
The first *Intergovernmental Meeting on Climate Change and Sea Level Rise for the South Pacific Region* was held in Majuro, Marshall Islands, in 1989. It was organised by the South Pacific Commission (SPC) and South Pacific Regional Environment Programme (SPREP) to create a public awareness on the future implications of these issues to the governments. Subsequently, necessary actions are being undertaken to address these issues in order to develop appropriate policies.

In this meeting, SPREP member governments gave the mandate to SPREP to coordinate and act as clearing house on all climate change and sea level activities for the region.

The *United Nation Environment Programme* (UNEP) then provided financial assistance through SPREP (use of SPREP Climate Change Task Team Group) to undertake preparatory missions to Tonga, Kiribati, Tuvalu, Cook Islands, Guam, Palau, Federated States of Micronesia, Western Samoa and Tokelau to discuss the study with the governments, and to prepare reports before undertaking in-depth studies on the impacts of climate change.

The main task of this mission to the Federated States of Micronesia was to prepare a report in close consultation with the government officials, identifying areas for in-depth study into the potential impacts of expected climate and sea level changes on the natural environment and the socio-economic structures and activities of Federated States of Micronesia. In addition, it identified suitable and available response options to avoid or mitigate the impacts of climatic changes.

It is anticipated that the Federated States of Micronesia government will have the opportunity to closely examine these recommendations in the report, and to advise SPREP and other organisations accordingly.



Vili A. Fuavao

Director

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## Executive Summary

The present report, prepared by the South Pacific Regional Environment Programme (SPREP), is in response to a request from the Government of the Federated States of Micronesia (FSM) to develop a proposal for a programme of assistance to under-take an in-depth study of the potential impact of expected climate changes on the FSM. The possible climate changes include sea level rise and increases in temperature and extreme events, such as tropical cyclones, storm surges, flooding and drought. The climate change impacts are considered for both the natural environment and the socio-economic systems in the FSM.

Agriculture and freshwater supplies are considered to be highly vulnerable to the anticipated changes in climate. Salt contamination, of groundwater due to reduction in the size of the freshwater lens or overwash under high seas and of vegetation due strong winds carrying salt spray inland, will damage crops and limit production. The already limited potable water supplies will also be impaired by these same conditions and by drought.

The existing concentration of development in close proximity to the shoreline enhances susceptibility to sea level rise and extreme events such as storm surges. Risks are greatest where reef mining and other human activities are reducing the protective effects of coral reefs and mangrove systems on shoreline erosion. Migratory and distribution patterns of economically important pelagic fishes may be altered by changes in ocean currents as a consequence of alterations to atmospheric conditions and processes. In this instance in particular, the lack of information and resulting uncertainty about present conditions emphasizes the need to adopt a precautionary approach in managing marine and other natural resources.

The important historical sites in the FSM, especially Nan Madol and Lelu, are already under considerable stress from natural processes and human interference. This will likely be exacerbated by the anticipated effects of climate change. These sites provide an excellent example of the rule that, relatively speaking, healthy environments (social, economic, cultural as well as bio-physical) and sustainably-managed resources (natural and human) will have high resilience and low vulnerability to environmental stresses, including those associated with climate change. Thus the report makes a number of recommendations which would address current environmental and resource use problems so that impacts brought about by future stresses on the environment will be lessened. Such an approach also addresses the issue of intra-generational equity.

The report recommends that the Nationwide Environmental Management Strategy (NEMS) be implemented in a timely and effective manner, and makes a number of suggestions for strengthening responses to climate variability and changes within the context of NEMS. Training, public awareness, improved flow of information and enhanced capacities for response in times of emergency are also identified as key strategies.

The diverse cultural and physical character of the FSM is noted in the report. Given the inability of the present study to include on-site assessments for areas other than the island of Pohnpei, it is also recommended that similar climate change/sea level rise vulnerability and response assessments be undertaken in the other three states - Yap, Chuuk and Kosrae.

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# 1. Introduction

## 1.1 Background

The present report is the result of a study requested by Government of the Federated States of Micronesia (FSM), an independent nation comprising the states of Yap, Chuuk, Pohnpei, and Kosrae. The FSM was created from the former US Trust Territory of the Pacific islands. The country lies approximately between 135° and 166° east longitude and between the equator and 13° north latitude, incorporating a marine area of over 2.6 million km<sup>2</sup> within its 320 km Exclusive Economic Zone (Figure 1). The FSM therefore includes the largest and most diverse part of the greater Micronesian region.

On the other hand, the total land area of the FSM is only 4,840 km<sup>2</sup>. There are four basic types of islands - high volcanic islands, low atoll associated coral islands, raised coral islands and low non-atoll coral islands. Details are presented in Table 1.

Current projections are that sea levels will rise globally by between 15 to 30 cm before 2030 as a consequence of global warming. If such increases materialise continued habitation of the low coral islands of the FSM may be impossible, not only as a consequence of direct

effects such as over-topping of the islands by waves and storm surges, but due also to indirect effects such as the destruction of freshwater lenses and crop damage due to salt spray.

It is important to recognize that such serious consequences are neither dependent on significant increases in global sea level some time in the future, nor are they limited to low coral islands. Regional variations in climate and oceanic conditions and changes in the frequency and intensity of extreme weather events have an immediate and possibly long-lasting impact on both low and high islands. Drought, flooding, coastal erosion, sedimentation, use of marginal lands and increased energy consumption are just a few of the many consequences with serious environmental and human significance.

In light of concerns related to these and other threats, at the Intergovernmental Meeting on Climate Change and Sea Level Rise in the South Pacific held in Majuro, Marshall Islands in July 1989 six small island states from the South Pacific requested the South Pacific Regional Environment Programme (SPREP) to organise teams of scientists to visit each country. They were to work with designated government officials to produce for each

Table 1: Island Numbers and Types and Land and Lagoon Areas. (from Gawel, 1993)

State	High volcanic	Atolls *	Island Type			Island Area (km <sup>2</sup> )	
			Atoll and reef coral	Lagoon-less coral	Raised coral	Land	Lagoon
Kosrae	2		3			42	
Pohnpei	9	9	154			133	279
Chuuk	15	12	273	2		39	822
Yap	4	12	141	3	1	48	405
<b>Total</b>	<b>30</b>	<b>33</b>	<b>571</b>	<b>5</b>	<b>1</b>	<b>262</b>	<b>1,506</b>

\* Each atoll has one to scores of motu which can change in area and number due to storm wave impacts.

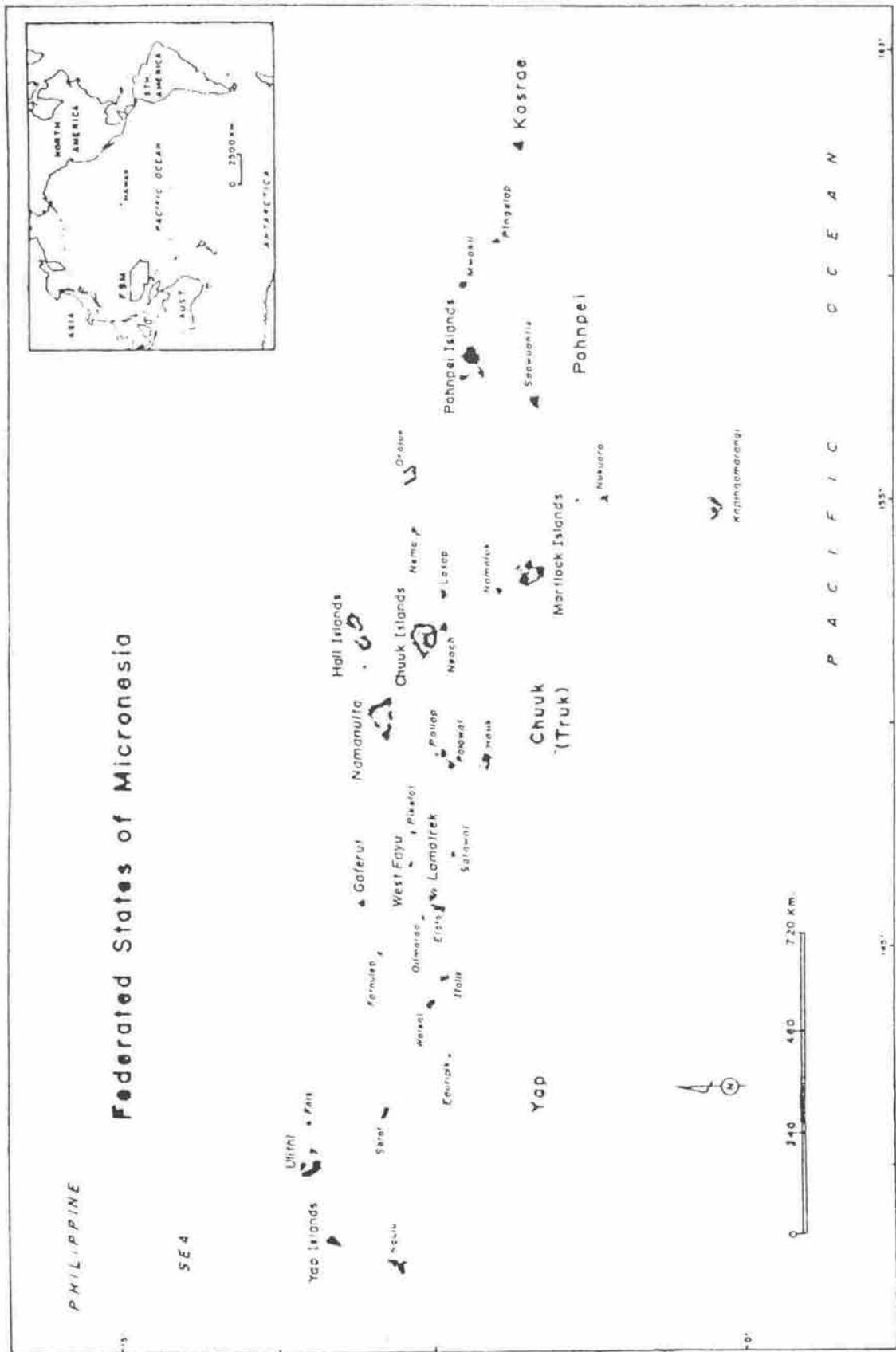


Fig. 1 The Federated States of Micronesia (after Gawel, 1993).

country a preliminary report on projected specific impacts of greenhouse-induced climate change and to suggest appropriate activities which could be undertaken to alleviate the impacts. The FSM was one of the six countries to request such a study and the present report is the result of that work.

While the present study concerns all four states of the FSM it was possible to visit only Pohnpei Proper (this term excludes the Outer Islands). This report, and its associated recommendations, are therefore constrained by the lack of interaction with the officials and people of the other three states and lack of first hand knowledge of their environments. On the other hand, the report has benefitted and drawn heavily from the numerous relevant reports that have appeared in the last few years, largely as a result of pre- and post-UNCED activities and with the support and encouragement of SPREP. The major reports of relevance here include Gawel (1993), Federated States of Micronesia (1993), SPREP (1992), Hay and Kaluwin (1993), Harding (1992) and Thislethwait and Votaw (1992).

## 1.2 Terms of Reference

The terms of reference under which this study operated were established by Dr. V. Fuavao, Director of the South Pacific Regional Environment Programme (SPREP). They were as follows:

1. Under the general supervision and guidance of the SPREP Secretariat a two/three person mission will visit the host country for approximately 7 days. The main purpose of the mission is to prepare, in close consultation with national counterparts identified by the host Government, a proposal for a programme of assistance to undertake an in-depth study of the potential impact of expected climatic changes (primarily sea level and temperature rise) on the natural environment and the socio-economic structure and activities of the host country, including the identification of response options which may be suitable and available to avoid or mitigate the expected negative impact of climatic changes.
2. Specifically, while in the host country, the mission, consisting of two/three senior experts from the SPREP Climate Change Task Team on climatic change will:
  - (a) examine and evaluate the available information affecting the physical and biological environment (terrestrial and marine) of the islands comprising the country;
  - (b) examine and carry out a preliminary assessment of the available demographic, social (including archaeological and cultural) and economic data;
  - (c) present, via a public lecture or radio broadcast as appropriate, an overview of the current state of knowledge concerning the greenhouse effect and its possible consequences for Pacific Island nations;
  - (d) present to the national authorities, organisations, institutions and experts the results of UNEP-sponsored studies, specifically those conducted in the South Pacific (e.g. Kiribati) and South Asian Seas areas outlining the potential applicability of these studies to the host country;
  - (e) discuss with the national authorities; organisations, institutions and experts their perceptions of the consequences of the potential impacts of climatic change and seek their views on the suitable response options; and
  - (f) identify national authorities, organisations, institutions and experts which may participate in the in-depth study expected to follow the mission, and determine the modalities of co-operation between the legal and administrative structures of the country with the team which will assist in the implementation of the in-depth study.
3. On the basis of the activities referred to in paragraph 2 above, as well as information collected by the experts prior to their mission to the host country, the experts will prepare a joint report containing:

- 
- (a) a general overview of the climatological, oceanographic, geological, biological and socio-economic factors which may be relevant to or affected by the potential impacts of expected climatic changes;
  - (b) a preliminary identification of the most vulnerable components and sites of the natural environment, as well as the socio-economic structures and activities which may be most critically affected by expected climatic changes;
  - (c) an overview of current environmental management problems in the country and an assessment of how such problems may be exacerbated by climatic changes;
  - (d) a detailed proposal for a joint programme of assistance to the host country for the in-depth evaluation of potential impacts of expected climatic changes on the natural environment and the socio-economic structures and activities of the country including the identification of policy or management options suitable to avoid or mitigate the impact of climatic changes; the proposal should identify the workplan, timetable and financial requirements of the in-depth evaluation as well as the possible institutional arrangements for carrying out the evaluation.
- 4. Prior to leaving the host country, the mission will present to and discuss with the authorities identified by the Government of the country, the outline of the proposed programme, as well as the major findings of the mission. The comments and suggestions of the authorities identified by the Government of the host country will be duly taken into account in preparing the final report of the mission.
  - 5. The final report of the mission, prepared as the experts joint report and as specified in paragraph above, will be simultaneously submitted to the Leader of the SPREP Climate Change Task Team, the Director of OCA/PAC and the SPREP Director of clearance. Submission of the report will be made no later than 30 days following the completion of the visit.
  - 6. The final report of the mission will be transmitted by SPREP to the Government of the host country together with the comments of SPREP, UNEP and the Leader of the SPREP Climate Change Task Team and will be used as the basis for subsequent assistance to the Government of the country in formulation and implementing suitable response options to the expected impacts of climatic change.

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## 2. State of the FSM Environment

Recently Gawel (1993) presented a comprehensive report on the state of the environment for the FSM. Some of the major findings will be presented here; readers are encouraged to consult the full report for further details.

### 2.1 Climate

Because of its tropical maritime setting, diurnal variations in temperature in the FSM are greater than those between seasons. Typically day time maxima are near 30°C with minima around 24°C. The humidity averages over 80 per cent and rainfall is typically abundant, with around 300 cm per year in drier islands and over 1,000 cm annually in the mountainous interior of Pohnpei.

Most islands have a marked dry trade-wind season from November to May and a wet variable wind season from June to October. Typhoons (severe tropical storms) are a serious threat in western areas of the FSM. They generally form between Pohnpei and Chuuk and move northwest, increasing in strength and significance.

### 2.2 Hydrology, Geology and Oceanography

Truly perennial streams are absent from all islands except Pohnpei and Kosrae, but fresh groundwater occurs to varying extent in all islands. Groundwater resources are extensive on the high volcanic and metamorphic rock islands. Even on the low sand islands there is a freshwater lens, this being of critical importance for food crops and other vegetation. The lens are also tapped by shallow wells to supplement that available for human use from rainwater catchments.

Earthquake effects are not historically significant in Kosrae, Pohnpei and Chuuk. Yap Proper has had minor earthquake impacts in the past.

Sea surface temperatures are between 28° and 30°C throughout the year. The north equatorial and equatorial countercurrents move vast masses of water between the islands of FSM. The currents along shores and reefs and in lagoons are mainly tidally driven, the normal diurnal tidal range being less than 2 m.

### 2.3 Terrestrial Ecosystems and Living Resources

The biological diversity of the FSM is higher than that of the Marshall Islands and the Northern Mariana Islands, to the east and north, but lower than that of Papua New Guinea and Palau, to the south and west. Eight different terrestrial ecological zones can be recognized:

- *beach strand* - well-drained, loose and porous soils; water table at 40-60 cm with fresh groundwater underlain by brackish and salt water; vegetation is somewhat resistant to salt spray, though other types may be present if spray is blocked by mangrove forests or where artificial planting has occurred.
- *swamp forest* - occurs extensively only in Kosrae and Pohnpei; soil is predominantly organic; numerous species of swamp trees dominate.
- *freshwater marsh* - this habitat, with its wet, nutrient rich soil, is used extensively for growing taro; larger areas in Pohnpei and Kosrae mean that original vegetation stands still exist.
- *grassland* - relatively extensive areas occur in the larger high islands of Yap, Chuuk and Pohnpei as a result of removal of primary forest by fire or clearing, or by topsoil removal through mudslides; grassland usually found on moderate slopes; area of grassland is expanding due to increased use of fire; some water is retained by the grasses even in the dry season and soil is held in place as long as fires have not killed the grasses; otherwise erosion occurs until grass regrows after burning; habitat not critical to any species of bird, lizard or mammal and prevalent grass species are not palatable to livestock.

- *secondary forest* - occurs in interior of all high islands; most vegetation was introduced after the clearing of the original forest, often centuries ago; now the site of traditional agro-forestry with coconut and breadfruit the most prevalent plants; bananas, mango, hibiscus, papayas, sweet potatoes, cassava and citrus plants also common.

In Pohnpei, *sakau* and in Yap, betel nut palm are also grown in this zone; some lumber, shade and wind protection are also provided and the forest plants also retain some water to inhibit flooding, droughts and spread of fires; in addition, roots help prevent erosion; bats, lizards and many birds are common; habitat of the endangered Micronesian pigeon.

- *primary forest* - found only in a few mountain top, cliff and ravine areas in Yap and Chuuk, but more extensive in the interiors of Pohnpei and Kosrae. Earlier extensive range now limited due to burning, land clearing and intensive farming; thick vegetation cover prevents soil drying out, thereby resisting spread of fires and helps retain organic matter and build up nutrients; rare and endangered species of flora and fauna occur in this zone; important for edible products, lumber and materials for local medicines, handicrafts and other traditional practices, scenic value for residents and tourists, scientific research, biological diversity preservation and worldwide conservation interests.
- *rain forest* - limited to interior peaks of Kosrae and Pohnpei, on steep slopes; dense, moss-covered vegetation and humus rich soil soak up rainfall that occurs almost daily; the cover, if left intact, provides an excellent water catchment.
- *crest forest* - occurs only on summits of Kosrae and Pohnpei mountains; vegetation is characteristically stunted, dense and wet due to high winds, exposure and high rainfall; infrequently visited by humans and hence impact is minimal.

## 2.4 Marine Ecosystems and Living Resources

Marine ecosystems in the FSM are associated with normal salinity, low-nutrient, clear, deep, oceanic waters with a relatively constant surface temperature of around 29°C.

Four marine ecological zones are recognized:

- *deep ocean* - although these extensive waters are low in nutrients and biological productivity, the quantity and value of harvestable fish, especially for migratory tuna, is high.
- *reef flat* - usually covered with salt water, but exposed at the lowest tides; therefore lacks living corals, but supports very high biological productivity through its plant cover. This is especially true for the seagrass habitat which provides food, shelter and spawning and nursery grounds.  
  
The inner parts of the reef flat are better protected from waves and currents and the densely vegetated areas are probably the most productive areas of all land and water zones; the layer of rubble, sand or silt, provide seagrasses and macroalgae with good anchoring ability. This allows them to survive and in turn prevent movement of sand and silt and the damage this might, in turn, do to living coral. It also provides habitat for bivalves and burrowing animals.
- *reef slope and lagoon* - these areas are subtidal, with a base of solid coral and a cover of rocks, rubble, sand silt or live corals; unconsolidated sediments may be covered with seagrass and algae; shallow areas may have complete cover of living coral, decreasing in the deeper lagoonal areas because of increased sand and sediment and decreased light and circulation; coral diversity in Micronesia is amongst the highest in the world and almost one thousand reef fish species have been recognized; deeper waters are the feeding areas for green and hawksbill turtles, porpoises and seabirds.
- *mangrove forest* - some of the healthiest and best-formed mangrove stands in the Pacific occur in Kosrae and Pohnpei.

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In the FSM, mangrove forest occurs along the shorelines of most high islands and a few atoll areas. Many species of marine life depend upon the mangroves for sheltered habitat, especially during the young and larval stages of many edible crabs and fishes. Epiphytic plants, birds, bats and lizards also occur in the mangrove. However, a crocodile species that was found some 20 years ago in the Pohnpei mangroves now appears to be extinct in the FSM.

## 2.5 Society, Culture and Administration

The original human settlers of the FSM arrived over 3000 years ago. They came from varied founding sources. Accelerated foreign impacts began with visits of European explorers in the 16th century. Pre-contact population levels were overall less than present and local distributions and impacts on the environment were very different. For example, in Yap Proper, pre-contact numbers and densities were much greater than present.

Generally pre-contact populations were concentrated in low and flat coastal areas of the high islands, but in Yap settlement and farming even extended inland. Traditionally resource use rights were distributed within the population under customary practices that varied greatly among the islands. In most cases chiefs had great power over resources. Rights could be given, earned and inherited either matrilineally or patrilineally.

Complex rights (e.g. owner of tree, user of its fruit) overlay actual site ownerships. Land tenure patterns generally involved communal ownership of a single plot, single ownership of several small and separate plots or use rights to land owned by traditional leadership. Shallow submerged lands and their resources normally belonged to owners of nearby land. This traditional ownership is no longer recognized in Kosrae and Pohnpei, but still persists in Chuuk and Yap.

Traditionally, lagoon, reef and pelagic fishing provided most dietary proteins, supplemented by dogs and wild birds. Pigs, deer and other large mammals were later introduced by Europeans. Pohnpei's agriculture was based on yams and breadfruit, Yap's on taro and sweet potato and that of the low islands and Kosrae on taro and breadfruit.

Heavier densities of settlement in Yap in prehistoric times required extensive and intensive farming. Some resources were not harvested sustainably and are now extinct - these include the sea cow or dugong, the marine crocodile, giant clam and easily hunted birds such as rails.

During the 19th century the numbers of Micronesians decreased rapidly due to introduced diseases and warfare related to new weapons and foreign-influenced power struggles. Prior to independence, occupation and administration has successively been by Spain, Germany, Japan and the United States.

Under the early colonial administration the mass development of coconut plantations for the copra trade involved all islands, both high and low. Along with minor trade in beche-de-mer and pearl shell, this introduced the monetary economy and non-traditional uses of renewable resources.

The greatest impacts resulted from Japanese colonial developments, including intensive agriculture, fish processing using local hardwoods for fuel, salt production, paper manufacturing and restricted phosphate mining. As supplies were cut off during World War II, the valuable trees were replaced in Chuuk by faster-growing crops, leading to soil loss. Abandoned war materials facilitated the practice of fishing with dynamite.

FSM was established as a self-governing nation in May 10, 1979, in a federation of four States, each with significant state-level powers. In 1986 a Compact of Free Association with the United States came into effect, the treaty providing financial assistance at guaranteed annual rates for fifteen years.

After World War II, due to improved health services and facilities, rapid natural population increases have occurred on many islands. The current rate of population increase is around 3.1 per cent. Changes in lifestyle and health services are expected to lower fertility and mortality rates in the future. There is increasing movement of people from the Outer Islands to the urban centres. In the 1950s Outer islanders made up 30 per cent of the total population while today only about 15 per cent reside there. Younger people dominate the FSM population, with 47 per cent being under fifteen years of age.

## 2.6 Natural Resource Use

Practically every FSM household participates in agricultural activities, except Chuukese. These result in production of over 60 per cent of all food consumed. About 40 per cent of the labour force is employed in farming, either full-time or seasonally. In the traditional society that still dominates most of the FSM, land is deeply linked to personal and family identity and is thus not a commodity to be sold or traded. Especially near development centres this attitude is gradually changing, with sales, trades and leases occurring. But the FSM Constitution limits land ownership to its citizens.

The dominant agricultural use of the land is agro-forestry, mainly subsistence or for copra. Production of the latter has declined in recent years, due mainly to reduced world prices. In Pohnpei vines produce pepper for the export gourmet market and small amounts of bananas are exported to Guam. Kosrae exports citrus fruits to neighbouring islands and bananas and taro to Guam and the Marshalls. Yap betel nut is sold to neighbouring islands.

Environmental impacts of agro-forestry are much lower than other developmental uses of land or more intensive kinds of farming. On many islands the secondary forest areas are being converted for residential and urban land use. By means of reclamation and discharges, these types of land use are also encroaching on mangrove and fringing reef habitats.

Forest areas are also being occupied as new roads provide access. Only in Pohnpei are the interior forest lands legally protected as catchment areas; elsewhere individuals encroach with farming and development of residences.

The national government is responsible for managing marine resources within the EEZ while the state manages resources from the outer reef slopes below 50 fathoms to 12 miles from islands and reefs. The major resource in the EEZ is tuna. Catch rates recorded by foreign tuna vessels fishing in the FSM waters in recent years has been relatively consistent. As yet no quotas have been imposed and there is a view that the purse seine and pole-and-line catches could be increased substantially without affecting the stocks of skipjack. Yellowfin and bigeye stocks do not appear endangered at this time.

Foreign boats are prohibited from fishing within the 12-mile zone, but their activities outside the zone undoubtedly affect stocks as tuna migrate through the zone. Traditional and subsistence fisheries have not exploited these stocks, but local boats do fish commercially for deep-bottom fishes in all states, for local sales and fresh chilled whole fish exports. The highest priced snappers and groupers from this fishery occur in very narrow bands on the deep slopes outside the reefs. These limited stocks have been rapidly fished out when commercialized and may not recover when overfished.

Throughout the FSM over 250 inshore species of finfish are harvested as food, mainly for subsistence. Reefs and lagoons also provide lobster, crabs, pearl shell, trochus, giant clams, sea cucumbers, aquarium fish, sponges, black coral and stony corals. Where surveys have been undertaken, in many cases stocks of these various marine resources are low and can easily be depleted by overharvesting. Popular reef fish are becoming more difficult to catch because of fishing pressure. As with the largest species of giant clam, the smaller species are also approaching extinction on most islands, often as a result of artisanal exploitation.

The coastal mangrove forests are a source of timber, firewood, materials for handicrafts, fish and crabs. They also protect shorelines, limiting erosion due to tidal currents, normal waves and storm waves. The mangrove communities also trap sediments and silt coming from eroding areas inland, thereby protecting coral reefs and other marine life from a major source of destruction around high islands. Mangroves are also important for natural treatment of human, animal and agricultural wastes.

## 2.7 Economy and Development

Economic development has been influenced by the use of land and natural resources, by capital and wealth distribution, by development goals, by past development activities and by sources of development assistance.

The major sources of employment and cash to fuel the FSM economy have been the national, state and municipal governments. This has been the result of comparatively little productive employment in the private sector and relatively large amounts of funding to the government sector. A large proportion (27 per cent in 1989) of the labour force is unemployed, and many of the 20 per cent in agriculture are normally in the subsistence sector.

Cash employment and the money economy are much less available to Outer Island residents than to those in or near state centres. In 1988 there were no wage incomes at all for an estimated 70 per cent of Outer Island households and 40 per cent of central area households. Nearly all Outer Island incomes were government-related. Outer Island expenditures were mainly on food (57 per cent) - 55 per cent of this was imported. Although in some islands women are traditionally the owners and inheritors of land, men have more employment.

There is only minor government intervention, through national income taxes maximizing at ten per cent of recorded income and gross receipts taxes of three per cent.

The majority of households on Kosrae, Pohnpei, Yap Proper and Weno have electricity. This is supplied and subsidized by the government. Diesel generators are used, except for a small hydroelectric power station on Pohnpei. Rainwater catchment on houses and community structures is common in outer islands and rural settlements where no distribution systems exist. Even in developed centres supply catchments are used to supplement central water supplies. Surface water from streams and reservoirs and well water are used in the distributed systems. In most rural locations individual water-sealed toilets are promoted. Only in Colonia, Weno, Palikir, Tofol and Kolonia are there systems for collecting and disposing of sewage.

Coastal roads have encircled Pohnpei, Weno, Tonowas and Fefan islands and the one for Kosrae is almost complete. The harbours and commercial ports in Colonia, Weno, Tonowas, Kolonia Lelu and Okat are able to handle container ships over 400 feet long as well as the largest tropical fishing vessels. There are major airfields in Kosrae, Yap, Pohnpei and Chuuk. These are capable of handling Boeing 727 jets. Several Outer Islands have small craft landing strips. The FSM Telecommunications Corporation operates local phone lines and international satellite linkages. The Outer Islands also have solar-powered radio systems. Commercial cable TV serves Pohnpei while a government station broadcasts over the air in Yap.

The small businesses that make up most of the FSM private sector are mainly service rather than production oriented. They include import, export, wholesale, retail, car rental, taxis, restaurants, hotels and construction firms. Many lack skilled staff, especially in the managerial area.

Essentially the only productive industries in the private sector are coconut oil and soap manufacturing, clothing manufacturing from imported textiles, pepper processing and trochus button manufacturing. Tourism is developing, with emphasis on diving. In all four states hotels and dive boats service thousands of scuba-diving visitors each year.

## 2.8 Public Institutions and Legislation

The FSM Government is a constitutional democracy with a single elected national legislative body. Four of the fourteen members of the FSM Congress are elected for four years, the remainder for two.

The National Government is responsible for foreign relations, taxes, duties, tariffs and regulation of immigration, foreign investment, interstate commerce, banking, navigation, health, environmental impact assessment, shipping, harmful substances control and natural resources in the EEZ. It distributes income and aid amongst the States. The National Fisheries Corporation was established to develop commercial large-scale fisheries and fish processing. The Coconut Development Authority assists nationwide in the transportation and marketing of copra.

State governments have jurisdiction over non-national matters. The control of government funds and promotion of health, education and law enforcement have concurrent state and nationwide jurisdictions.

## 2.9 Historic and Preservation Areas

The ancient ruins on Nan Madol in Pohnpei and Lelu in Kosrae are built in intertidal areas, with shallow canals traversing artificially created islands made of enormous basaltic crystal "logs". Despite their mass, the structures are vulnerable to both natural and human disturbance, particularly wave action. Historic sunken ships and planes, including whaling ships and numerous World War II relics are of special attraction to tourists, particularly divers.

Protected areas, either terrestrial or marine, are few in number in the FSM. A marine park for mangrove and lagoon areas exists at Enipein, Pohnpei and the State of Pohnpei has also placed land use controls on the interior catchments of the main island.

## 2.10 Major Environmental Impacts

In all of the FSM States much of the natural forest land has been replaced by secondary vegetation and agriculture. Mangrove forests in particular have been cut, while other forests have been lost due to human-caused fires, erosion and soil depletion. In both Yap and Pohnpei these are extensive, formerly forested areas where the soil has been degraded to the extent that only savannahs, grass and species of little value persist. Other disruptions to natural ecological processes are occurring. These include interruption of nutrient cycles in land vegetation and soils, interference with the migration of spawning aquatic species and increased turbidity of reef and lagoon waters preventing sunlight from reaching coral.

Land based sources of pollution and contamination create significant environmental problems, particularly near centres of development and where intensive agriculture is practised. Examples are the accidental release or inadequate disposal of gasoline, lubricating oils, asphaltic oil, polychlorinated-biphenols, chlorine, chlorofluorocarbons, ammonia, cleaning chemicals and sewage sludge.

In rural areas water supplies are contaminated by bacteria and soap from toilets, washing clothes and dishes and as a result of bathing. Chemicals in the form of pesticides and fertilizers are released into the environment.

Livestock production creates problems associated with the disposal of animal manure. Processing of crops, meat and fish creates organic waste with high biological oxygen demand (BOD).

Destructive fishing with explosives and poisons is carried out on a small scale, damaging habitats and reducing stock. Dredging and sand mining on shores and in lagoons have significantly damaged local marine habitats and contributed to coastal erosion. Uncontrolled dumping and disposal in local landfills of hazardous wastes (e.g. old medicines, chlorine containers, petroleum product containers and petroleum product tank bottom sludge contaminated with lead) is contaminating groundwater and threatening wells.

The current legally recognized endangered species in the FSM (Table 2) indicate the serious potential loss of genetic resources. Among those species with numbers in decline due to overharvest or loss of critical habitat are some that are traditionally very important as food sources. These include sea turtles, coconut crabs, mangrove crabs, giant clams, bump-headed parrotfish and native pigeons.

The nipa palms for roof thatching and certain hardwood trees used for construction are being lost due to harvesting without reforestation and to changes in land use.

Table 2: *Endangered Species of the Federated States of Micronesia. (From Gawel, 1993)*

Common Name	Scientific Name	Range in the FSM
Dugong (sea cow)	<i>Dugong dugon</i>	Straggler
Blue whale	<i>Balaenaptera musculus</i>	All seas
Sperm whale	<i>Physeter catadon</i>	All seas
Micronesian pigeon	<i>Ducula oceanica teraokai</i>	Chuuk
Nightingale reed warbler	<i>Acrocephalus luscini</i>	Chuuk, Pohnpei, Kosrae
Chuuk greater white-eye	<i>Rukia ruki</i>	Chuuk
Pohnpei greater white-eye	<i>Rukia longirostra</i>	Pohnpei
Pohnpei mountain starling	<i>Aplonis pelzelni</i>	Pohnpei
Hawksbill turtle	<i>Eretmochelys imbricata</i>	All seas
Leatherback turtle	<i>Dermochelys coriacea</i>	All seas
Chuuk palm	<i>Clinostigma carolinensis</i>	Chuuk
Chuuk poison tree	<i>Semecarpus fraeneri</i>	Tol, Chuuk

## 2.11 Future Environmental Threats

The International Panel on Climate Change (IPCC) predictions (Houghton et al., 1990), which have not changed in the 1992 update (IPCC, 1992), include a global temperature rise of 0.3°C per decade ( $\approx 2^\circ\text{C}$  by 2050) and a sea level rise of about 6 cm per decade ( $\approx 36$  cm by 2050) over the next century. These globally averaged figures were used as a basis of our discussions in the FSM.

It is acknowledged by the IPCC that significant uncertainties exist in their predictions ( $\pm 0.15^\circ\text{C}$  for their temperature predictions and  $\pm 3$  cm for sea level rise). Reasons for these uncertainties include difficulties in evaluating: i) the sources, sinks and ambient concentrations of greenhouse gases in the future; ii) the effects of clouds, especially in terms of their ability to enhance or suppress greenhouse gas-induced global warming; iii) the ways in which the oceans influence the timing and patterns of climate change particularly through thermal inertia and changes in circulation; and iv) the manner in which the polar ice sheets will influence future sea levels (IPCC, 1992).

In addition, it must be emphasised that the preceding data are average global figures and may differ substantially in any given area. It is generally agreed that temperature change will be less near the equator. This differential global warming is likely to cause changes in the general atmospheric circulation patterns as well as ocean currents. Some probable outcomes of relevance to Pacific countries are the weakening of trade winds, less pronounced El Niño episodes as well as a meridional shift in the position of wind belts. It is also expected that storminess will increase, in particular the occurrence and intensity of hurricanes.

At the regional scale of the South Pacific the situation is even more complex and the future fundamentally less certain. Basher et al. (1990) conclude that current climate models do not provide adequate simulations of a number of features of the present climate of the South Pacific (e.g. the position and intensity of major convergence zones and tropical cyclone intensities).

While there is some consistency between models in estimates of predicted temperature changes, rainfall estimates as a consequence of doubling atmospheric  $\text{CO}_2$  concentration show little agreement for the South Pacific. Improvements must await higher resolution models of both the ocean and atmospheric circulations. Moreover, predictions of systematic changes in climate resulting from anthropogenic influences are difficult to discern in an environment such as the South Pacific where there are large interannual variations and regional anomalies - especially in the present day patterns of precipitation, sea level, wind and tropical cyclone frequency.

For example, McLean (1989) has highlighted the considerable differences between the global and tropical Pacific sea level records over the past few decades. He therefore questioned the appropriateness of directly applying global trends in sea level to the tropical Pacific. Furthermore, he concluded that the high variability in local sea level, rather than a global sea level rise, is likely to continue to dominate the record of sea level change over the next few decades.

With annual extremes in sea level in the tropical Pacific region (sometimes as much as 40 cm) being of similar magnitude to the systematic changes predicted to occur in global sea level by 2050, McLean also acknowledged that it will be difficult to discern, at least in the short term, any enhanced greenhouse related change in the observed sea level record.

An appropriate way to accommodate such uncertainties in future environmental threats is to develop policies and adopt plans which incorporate appropriate precautions. This includes allowing for such contingencies such as prolonged drought, widespread flooding, accelerated coastal erosion, winds that are damaging due to their physical strength, the salt such winds carry inland and salt contamination of groundwater.

Furthermore, population growth and economic development are capable of placing additional stress on environmental systems. But they also represent an opportunity for enhancing the quality of the environment. For example, increased productive employment opportunities can lead to improvements in living conditions, health, education and welfare services. In addition, increased self-sufficiency in food and other supplies may bring about a reduction in solid waste (from packaging).

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### 3. Environmental Stresses

Key environmental issues and problems in FSM are examined by Harding (1992) and Gawel (1993). Problems arising from current environmental stresses in FSM may be exacerbated by the effects of climate change or sea level rise.

#### 3.1 Internal Stresses

##### 3.1.1 Population Pressure

According to Gawel (1993) and as noted earlier, the FSM's population underwent a period of rapid increase post World War II. This was due, in part, to improved health services and facilities. Population estimates based on 1979 census data and an overall mean growth rate of 3.1 per cent are given by Gawel (1993). Using Gawel's projections, which ignore migration, population in the FSM is expected to rise from 109,009 in 1993, to 132,373 by the end of the year 2000. As forty-seven percent of the population is less than 15 years of age, high rates of natural increase are expected to continue.

The largest proportion of each state's population resides in the state capitals (Gawel, 1993). Migrants from outlying islands are attracted to administration centers and to Pohnpei Island, site of the nation's capital. Outward migration to Guam and the United States is also significant (Gawel, 1993), particularly among young adults seeking further education, employment, or lifestyle changes.

Population statistics for selected atolls and islands of the FSM in 1980 are given in Table 3. Although the total population of many the outlying atolls and islands is relatively low, densities are sometimes very high and the amount of land available per household is small. As the FSM's population continues its high rate of growth, there will be continuing

pressure on scarce land resources for housing and food cultivation, greater demands on infrastructure and increased resource exploitation for both subsistence and cash. Unless current environmental management improves, environmental problems will undoubtedly worsen as population increases. Densely populated, outlying atolls and islands, which have limited infrastructural development, will be relatively less able to cope with the effects of environmental degradation and dwindling resources.

##### 3.1.2 Land Availability and Use

Scarce land resources are coming under increasing pressure. On many islands secondary forest is being converted to residential and urban land use (especially on Weno, Pohnpei and Kosrae), areas of mangrove and fringing reef are being reclaimed for housing, and residential areas are encroaching on watersheds (Gawel, 1993). The National Government is instituting a watershed protection scheme in a large, central area of government land on Pohnpei Island. Harding (1992) recommends that a similar area in central Kosrae Island also be set aside for this purpose. However, government ownership of the land is being contested by the traditional owners.

Land is also in demand for development purposes. Tourist resorts, golf courses, expanded airport facilities and fish processing plants are examples of potential competing land uses. Land use planning for each of the state island capitals was initiated by the U.S administration (HAE, 1968a,b,c & d), but apparently not implemented. Harding (1992) cites problems associated with traditional land tenure as a major obstacle to physical planning and enforcement of environmental regulations.

Table 3: Population Statistics for Selected Atolls and Islands in FSM - 1990\*

State	Location	Land Area (mile <sup>2</sup> )	Population	Average Population density (p/mile <sup>2</sup> )	No. of House-holds
<b>YAP</b>	Yap <sup>^</sup>	38.67	6,650	172	1,069
	Satawal <sup>^</sup>	0.51	465	912	79
	Ulithi <sup>~</sup>	1.80	847	471	140
	Woleai <sup>~</sup>	1.75	794	454	100
	Ifaluk <sup>~</sup>	0.57	475	833	52
	Lamotrek <sup>~</sup>	0.38	278	732	41
<b>CHUUK</b>	Weno <sup>^</sup>	7.52	15,253	2028	1,301
	Fefan <sup>^</sup>	5.18	3,902	753	425
	Tol <sup>^</sup>	6.29	4,846	770	871
	Komwin <sup>~</sup>	0.85	386	454	61
	Namonuito <sup>~</sup>	1.71	799	467	-
	Lukunoch <sup>~</sup>	1.01	745	738	147
	Satawan <sup>~</sup>	1.16	885	763	311
	Ettal <sup>~</sup>	0.73	420	575	72
	Nama <sup>^</sup>	0.29	897	3,093	156
	Losap <sup>~</sup>	0.33	475	1,439	90
	Namoluk <sup>~</sup>	0.32	310	969	49
<b>POHNPEI</b>	Pohnpei <sup>^</sup>	129.00	26,198	203	3,302
	Mwoakilloa <sup>~</sup>	0.48	289	602	73
	Pingelap <sup>~</sup>	0.68	737	1,083	70
	Sapwuahfik <sup>~</sup>	0.67	564	842	86
	Nukuoro <sup>~</sup>	0.64	393	614	73
	Kapingamarangi <sup>~</sup>	0.52	511	983	111
<b>KOSRAE</b>	Kosrae <sup>^</sup>	42.00	5,522	132	577

Source: FSM (1991)

**Legend:**

- \* Population and household statistics taken from the most recent census, 1989.
- = These densities assume an even spread of population over the entire land area. This is not true for many of the high islands, for example Pohnpei and Kosrae which have large, forested, unsettled interiors. In these cases, population densities in the settled areas would be higher than indicated.
- <sup>^</sup> denotes a high island;
- <sup>~</sup> denotes an atoll.

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### 3.1.3 Pollution and Waste Management

#### Refuse

Littering and solid refuse disposal is a serious problem throughout the FSM. Increasing population and the introduction of non-biodegradable packaging materials, such as plastic and polystyrene, are exacerbating the problem in the main centers (Harding, 1992).

Dump sites are not well managed and, in many areas, may be poorly located. For example, on Pohnpei Island the dump is located adjacent to the shoreline and refuse spills over into the mangroves. This pollutes the mangrove area and allows refuse to be flushed out onto the reef during high tides. In Yap, pollutants from the dump are leaching into the water reservoir creating a serious health risk (Federated States of Micronesia, 1993). Freshwater lenses on atolls are being contaminated by leachates from refuse dumps, graveyards and latrines and from polluted surface runoff entering wells (Federated States of Micronesia, 1993).

#### Pollutants

Pollutants from various sources are beginning to impact on the FSM's natural environment. As previously mentioned, Gawel (1993) lists several which are causing environmental damage to land and coastal areas. These include gasoline, oils, PCB's, chlorine, pesticides, fertilizers, organic wastes, CFCs, ammonia and cleaning chemicals.

Hazardous wastes are currently dumped in local landfills and household detergents are contaminating groundwater in rural areas (Gawel, 1993). Chuuk lagoon is being polluted by the breakdown of ordinance and chemicals from World War II wrecks.

#### Human Waste

Poor sanitation and inadequate disposal of human waste can lead to health problems, groundwater contamination and environmental pollution. Although it is illegal to dispose of treated or semi-treated sewage into any body of water in the FSM (Harding, 1992), this does occur. Gawel (1993) reports that sewage sludge pollutes coastal waters. In Pohnpei raw sewage is dumped into a confined recreational bay area and into local rivers (Federated States of Micronesia, 1993).

### 3.1.4 Earthmoving and Land Clearing

Land clearing, reef and beach mining for road and runway construction, are not well regulated in the FSM. Problems associated with enforcing earthmoving regulations are addressed in Section 6.1.1. Land clearing renders areas more vulnerable to erosion and can lead to increased sedimentation of rivers and reefs. Reef and beach mining damages habitats, causing negative impacts on marine life and increased vulnerability of shorelines to erosion.

The practice of clearing mangroves for reclamation can have disastrous consequences on coastal and marine habitats. Mangroves perform several useful functions including sediment trapping, nutrient recycling, shoreline protection and acting as fish nurseries. According to Harding (1992), there are no apparent controls on mangrove clearing or harvesting for timber in the FSM. Mangrove resources will come under increasing pressure as further developments are planned for the coastal zone.

### 3.1.5 Stresses on Coastal and Marine Habitats

Marine resources are highly valued throughout the FSM. Degradation of marine habitats is therefore a major concern. Nevertheless, many marine resources are coming under increasing pressure from over-exploitation or inappropriate methods of harvesting. *Tridacna spp.* (giant clams) are now absent from most reefs in the FSM. Mangrove crabs and lobster were reportedly becoming scarce in Chuuk in the early 1970's (Anon, 1970). Reefs in Chuuk are sustaining considerable damage from dynamite fishing (Anon, 1970; Gawel, 1993).

Many other human actions, including land-based activities being carried out within the coastal watershed, both directly and indirectly impact on coastal and marine environments. Sediment runoff from land is one of the most serious threats to coral reefs. Eutrophication in the marine environment caused by inappropriate sewage disposal and fertilizer runoff also endangers coral reefs. Areas of broken coral, attributed to anchor damage, and coral bleaching (an indication of environmental stress) were observed by the authors during a brief inspection of fringing reef at Pohnpei Island. A summary of stresses on coastal and marine environments is given in Table 4.

Table 4: Effects of Human Activities on the Coastal and Marine Environment in the FSM.

Motivation	Activity	Physical Effects	Implications for Humans
Development, forest harvesting.	Land clearing.	Increased sediment runoff to reef areas leading to increased coral mortality and habitat destruction.	Smaller fish catches, greater dependence on purchased foodstuffs, decreased tourism potential.
Land reclamation.	Mangrove clearing and land filling.	Increased sediment runoff to reefs, coral mortality, increased shoreline erosion, destruction of fish nurseries, increased phytoplankton and algal growth (eutrophication).	Smaller fish catches, greater dependence on purchased foodstuffs, decreased tourism potential.
Refuse disposal.	Location of dump sites in the coastal zone.	Fouling mangrove habitats, flushing of refuse into lagoon and reef areas leading to habitat destruction, fish and sea bird mortality, eutrophication.	Smaller fish catches, greater dependence on purchased foodstuffs, decreased tourism potential, loss of income.
Agricultural & industrial development.	Dumping, flushing, and runoff of fertilizers, pesticides and toxic substances into the marine environment.	Pollution and destruction of marine habitats, fish poisoning, bacterial growth and accumulation in the food chain, eutrophication.	Smaller fish catches, greater dependence on purchased foodstuffs, decreased tourism potential, loss of income, health risks.
	Poor sanitation and sewage disposal into the marine environment.	Bacterial growth and eutrophication.	Food poisoning from consuming contaminated shellfish, decreased tourism potential, loss of income.
Road and runway construction.	Reef mining.	Destruction of reef habitat with consequent decline in numbers and diversity of marine species, increased shoreline erosion.	Smaller fish catches. Greater dependence on purchased foodstuffs, decreased tourism potential, loss of income.
Exploitation of marine species for subsistence and cash.	Overfishing, use of destructive harvesting methods, eg. dynamite fishing, fish poisoning, using nets with inappropriate mesh sizes.	Local extinctions of some species e.g. <i>Tridacna</i> , <i>Dugong</i> . Waste -dynamiting causes many more fish to sink to the ocean floor than are actually harvested. Destruction of reef habitat and consequent decline in fish numbers and diversity.	Smaller fish catches, ultimate loss of income. Greater dependency on purchased foodstuffs.
Exploitation of marine species for subsistence and cash.	Careless boat anchoring.	Anchor damage to reefs, increased coral mortality and habitat destruction.	Smaller fish catches, decreased tourism potential, loss of income, greater dependency on purchased foodstuffs.

## 3.2 External Stresses

### 3.2.1 Tourism

Tourism could significantly contribute to the FSM economy. However, if it is not wisely developed and managed, it could also be a source of environmental stress. Mass tourism developments catering for a high volume of "package" tourists are likely to cause the most impact, with much of the revenue destined overseas. Furthermore, the FSM cannot yet meet the infrastructural requirements of mass tourism.

Eco-tourism offers the best opportunity for generating revenue with the minimum environmental impact (Hay, 1992). However, monitoring and management are still required (Wells, 1993). For example, the impact of marine tourism on coral reefs should be carefully monitored.

Damage to reefs can be alleviated by creating marine parks and zoning for specific uses, such as has occurred in Australia's Great Barrier Reef Marine Park. Anchor damage by tourist boats can be minimised by the installation of permanent mooring buoys. Training workshops for tourist operators and dive guides will enable them to pass their knowledge on to tourists, thus enhancing appreciation for the environment.

Visitors should be discouraged from souvenir taking. This can be publicized through the use of information leaflets which explain the value of the reef environment to the people of the FSM.

The impact of tourist visits to historic sites such as Nan Madol should also be monitored to ascertain whether more formal management is required. Again, training workshops for tour guides would make them aware of potential problems and thus more able to guard against them.

### 3.2.2 Climatic Extremes

#### Typhoons

Typhoons are intense tropical cyclones with wind speeds of 74 m.p.h (64 kn.) or greater (Pielke, 1990). They typically form poleward of about 4-5° of latitude over warm (greater than 26°C) ocean surfaces and move in a north-westerly direction in the northern hemisphere.

Although the FSM is located within an area of cyclone genesis, most areas are outside the main cyclone tracks and storms do not often reach damaging intensity until they have moved further westward. Two recent exceptions were Tropical Storm Nina (November 1987), and Typhoon Owen (November, 1990). These caused extensive damage in some parts of Chuuk. The westernmost parts of Yap State may be directly hit by typhoons once every 20 years, but most cyclones pass to the north. Table 5 summarizes severe weather conditions recorded in Pohnpei State.

#### Drought

Severe droughts of short duration occasionally occur in the FSM. Low rainfall totals in the first 5 months of 1983 (only 13-28 percent of normal in some areas) were associated with a particularly intense El Niño event (Karolle, n.d). Annual rainfall for 1983 was the lowest recorded in 30 years for Pohnpei and Yap. Yap has also been experiencing drought from March 1993 to the present (September, 1993).

Drought most severely affects people on outlying atolls and islands who depend on rainwater collection and limited groundwater reserves. During a severe drought on Kapingamaringi Atoll (Pohnpei State), lasting from 1916-1918, sixty villagers died and ninety others were relocated to Pohnpei. A permanent settlement has long since been established on Pohnpei Island at Porakiet. Migration to and from the atoll and the village on Pohnpei continues.

#### Heavy Rainfall and Flooding

Flooding occurred in Pohnpei in 1989 (see Table 5). High rainfall experienced in Pohnpei throughout 1993 is believed to have been responsible for the poor performance of seasonal crops including breadfruit and mangoes. Heavy rainfall also exacerbates problems of soil erosion and washes silt into rivers, wells and marine areas.

Table 5: Tropical Storm, Typhoon and Severe Weather Conditions in Pohnpei State, FSM

Event	Dates	Velocity (knots)	Intensity at Pohnpei*
Typhoon Lola	Dec. 1957	60 (est.)	TS
Typhoon Ophelia	Jan. 1958	58	TS
Typhoon Storm Odessa	Mar. 1982	35	TS
Drought	Dec. 1982 - April 1983		
Tropical Storm Elsie	Jan. 1985	40-50	TS
Typhoon Lola	May 1986	46	TS
High Tide	Oct. - Dec. 1988		
Flooding	Mar. - Aug. 1989		
Typhoon Owen	Dec. 1990	30	TS
Typhoon Russ	Dec. 1990	49	TS
Typhoon Yuri	Nov. 1991	54-64	TY
Tropical Storm Axel	Jan. 1992	50	TS

(Source: FSM Weather Service Office, Pohnpei State.)

\* TS = Tropical storm; TY = Typhoon

## Responses to Climatic Extremes

A Special Assistant to the President on Disaster Preparedness is responsible for national disaster management and planning. State counterparts reportedly have a high level of commitment and cooperate well in disaster management and planning programs.

The FSM has a number of national plans including a preparedness plan, a natural hazard plan, a communication plan and a family plan. Implementation problems include an apparent lack of familiarity with plans and response strategies among officials and the public. Translation of plans into the vernacular may partially address this problem. Difficulties in communicating with remote areas also hinder plan implementation. An improved radio communications network has been proposed, and establishment is dependent on funding. In the proposed network outlying islands would be linked to state centers, which in turn would be linked to a national headquarters.

Alternative agricultural crops that are better able to withstand typhoons are being introduced in an attempt to reduce climatic vulnerability. This program has been well accepted in Yap and is about to begin in Chuuk and Pohnpei. Kosrae State feel the program is unnecessary due to the rarity of typhoons in that part of the country.

FIMA assists the FSM with emergency services and has provided food and housing in the aftermath of typhoon damage. A portable desalinator has sometimes been used in the region in order to combat water shortages. However, transportation costs are high and the FSM would like to develop these capabilities in-house.

Other priorities include public education on disaster response strategies, introduction of disaster preparedness into the school curriculum and the establishment of a regional climate center to act as a clearing house for scientific information.

### 3.2.3 Climate Change and Sea Level Rise

Concerns about climate change and sea level rise are similar to those identified for other Pacific Island countries (e.g. Sullivan & Gibson, 1991; Aalbersberg and Hay, 1992; Connel and Maata, 1992; Hay, 1991; Hay and Kaluwin, 1993).

Environments which are already stressed by inappropriate development and poor environmental management will be particularly vulnerable to adverse affects of climate change and sea level rise. Because most of the FSM's population and infrastructural development occurs in the coastal zone, sea level rise is probably the most serious concern. The possible effects of climate change and sea level rise for FSM are summarized in Box 1.

#### *BOX 1: A Summary of the Possible Effects of Climate Change and Sea Level Rise on FSM.*

1. Increased salinity of groundwater on atolls and small islands due to compression of freshwater lenses following sea level rise.
2. Changes in weather patterns - possible increased storminess due to greater climate variability.
3. Increased coastal erosion possible loss of land and increased sediment loading in reef systems.
4. Compression of mangrove habitats in a landward direction.
5. Increased thermal discomfort.
6. Changes in agricultural potential - some crops adversely affected by salinity - opportunities for introduction of more robust varieties and new crops.
7. Changes in fisheries potential and in other living marine resources.
8. Increased vulnerability of historical sites such as Nan Madol to storm damage.
9. Increasing vulnerability of coastal developments (e.g. airports, wharves, roads), to sea level rise and shoreline erosion.

#### **Possible Impacts on Agriculture and Water Supplies**

Sea level rise is likely to cause compression of freshwater lenses and salt water incursion into groundwater supplies (Connell and Maata, 1992). If changes in weather patterns result in increased storminess, storm wave overwash is predicted to increase soil and groundwater salinity. Such changes would have serious consequences for agriculture and water supply.

Greater exposure to salt spray and salt water incursion into taro patches and the root zones of other staple food crops, such as bananas and breadfruit, could severely affect productivity. The introduction of more salt tolerant cultivars or alternative crops may become necessary.

Many atolls and small islands in the FSM already have limited supplies of potable water. They must often rely on rainwater collection, and groundwater which can become brackish during droughts. Dwindling fresh water supplies could be partially offset by solar powered desalination plants. However, establishing these on all inhabited atolls and outlying islands would be costly. In addition, past experience indicates that equipment in remote locations, especially when exposed to the marine environment, quickly becomes inoperable due to lack of maintenance and the difficulty of obtaining spare parts. These problems would have to be addressed before desalination is a viable option.

#### **Implications for Coastal Development**

Roads, airports, wharves, and housing have been constructed on reclaimed mangrove habitat in many parts of the FSM. These, and other shoreline developments, may be vulnerable to sea level rise if alterations in coastal geomorphology allow sea water to flood or inundate terrestrial areas. Risks are highest where reef mining operations are reducing the protective effects of coral reefs on shoreline erosion.

Airport development is taking place in many locations throughout the FSM. In Pohnpei, extension of the main airport on Takatik Island is being considered. The airport is currently located on reclaimed mangrove forest and the runway is constructed of dredged coral rubble. Subsidence into a natural drainage feature, which runs transversely beneath the runway, necessitates temporary airport closure and repairs at approximately 3 yearly intervals. An alternative site at Sokehs has been proposed.

To date, climatic change risk factors have not been taken into account in any of the feasibility studies or impact assessments. Airstrips are also proposed for Kapingamaringi, Nukuoro and Sapwuahfik (Ngatik), atolls in Pohnpei State. In Weno and Chuuk, and on some of the smaller islands, storm waves occasionally wash over airport runways. The frequency of such occurrences is likely to increase given higher sea levels or if storm frequency or intensity increases.

Other coastal zone developments are likely to include fish processing plants and tourist resorts. The U.S. Environmental Protection Agency has advised against locating new developments close to the shoreline (Brook et al. 1991). Although mitigation costs could be lower than those incurred for future protection, governments are reportedly reluctant to consider the initially more expensive options due to financial constraints.

#### **Implications for Marine Ecosystems**

Studies on coral reef dynamics indicate that sustained reef vertical accretion can occur at rates up to 10 mm (0.39 inches) per year (Smith & Buddemeier, 1992). As predictions of sea level rise over the next century average only 6 mm (0.24 inches) per year, it appears that healthy coral reefs have the ability to keep pace with rising sea levels.

While it has been suggested that coral bleaching could be an early response to climate change (Goreau, 1990 after Smith & Buddemeier, 1992), it is known to be caused by a variety of factors and could therefore be interpreted as a more general bioindicator of environmental degradation (Smith & Buddemeier, 1992). Shallow fringing reefs could be affected by temperature and salinity changes or increased sedimentation (Ming, 1993).

Nevertheless, many researchers now agree that the impact of sea level rise on marine ecosystems is likely to be insignificant compared with anthropogenic factors operating in these areas (C. Birkeland, pers. comm.; Ming, 1993). A recent meeting of marine scientists in Miami, USA, concluded that the major causes of damage to coral reefs are sewage, siltation due to poorly planned land use and overfishing (Samarrai, 1993).

As sea level rises, mangroves can theoretically migrate landward provided the freshwater supply remains adequate. However, they may be stressed by increased temperatures (Ming, 1993). On some of the high islands in the FSM, landward migration may be constrained by topography, resulting in habitat compression with possible adverse effects on fish nurseries.

Migratory and distribution patterns of economically important pelagic fishes, such as tuna, may be altered by changes in ocean currents. It is not yet known whether such changes may be to the benefit or disadvantage of the FSM's fledgling fishing industry.

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In recognizing the importance of marine resources to the nation, the FSM National Government has designated research on the impact of climate change on fisheries as high priority.

#### **Implications for Historical Sites**

Important historical sites include the ancient ruins of Nan Madol (Temwen Island, Pohnpei) and Lelu (Kosrae). Nan Madol is built on tidal mud flats and protected from destructive wave energy by fringing reef and mangroves. Sea level rise and possible increases in storminess could increase damage to the ruins. Plans to control the invasion of mangroves onto the site (Federated States of Micronesia, 1993), should consider retaining a mangrove buffer zone to mitigate the effects of storm surges. The authors were unable to examine the ruins at Lelu.

#### **Thermal Discomfort**

Predicted temperature rise is likely to increase thermal discomfort and place greater demands on energy requirements for climate modification. The dominant form of modern construction in Pohnpei is solid, concrete structures, built at ground level. The buildings are designed to be cooled by air conditioning and often have little provision for natural ventilation. As building codes are developed, they should encourage more climatically suitable forms of construction which maximize natural ventilation for cooling. Energy demands could also be reduced by encouraging the use of solar energy for water heating.

#### **Priorities for Research**

The FSM National Office of Planning and Statistics has identified several research priorities with regard to climate change issues. These have been broken down into separate tasks for which a total funding of \$US600,000 has been sought.

Task 1: Workshop.

Task 2: Inventory of greenhouse emissions in FSM.

Task 3: Vulnerability analysis of 3 islands with specific studies on taro patches, freshwater lenses and fisheries.

Task 4: Air photo reconnaissance and baseline information gathering for future monitoring programs.

Task 5: Coastal zone management program development.

Of these, Tasks 1 and 3 have received funding:

Task 1: Workshop.

Task 3: Funding for one island, and studies on taro patches and fisheries only.

It is important that other donor agencies give favourable consideration to request to fund the remaining projects.

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## 4. Environmental Attitudes, Perceptions and Values

### 4.1 Environmental Awareness and Attitudes Amongst Government Officials

The recent initiatives in formulating a Nationwide Environmental Management Strategy (NEMS) demonstrates growing recognition of environmental issues at all levels of government. Nevertheless, government officials stressed their need for greater education and awareness regarding environmental issues, particularly those related to environmental impacts.

They believe this will better equip them to make informed decisions regarding appropriate development for the FSM. Furthermore, they requested that information be made available in an appropriate form for non-scientific users so that it can be more readily incorporated into practical policies.

Most of the officials interviewed demonstrated a desire to encourage developments that would be sustainable and have minimum environmental impact. They are generally wary of the push from some sectors for mass tourism and its associated demands on infrastructure and scarce land resources.

Although generally in favor of concepts such as low impact ecotourism, they are also conscious of many people's desire for rapid development. In reality, the foreign investor who promises quick cash returns is an attractive option in a country eager for development. With the lack of land zoning regulations, the high degree of autonomy of State Governments, and traditional land use rights, most officials are pessimistic about the National Government's ability to confine development to the most desirable options.

#### 4.1.1 Awareness of Climate Change Issues

Awareness of climate change issues was moderate to low among government officials. Although many of the FSM's major infrastructural developments (for example airports) are situated close to the shoreline, vulnerability to climate change/sea level rise is not routinely incorporated into planning or impact assessments.

Some policymakers are not convinced of the necessity to consider immediately, climatic risk factors. They offer as a reason the fact that most infrastructural developments have limited life spans (approximately 20 years for roads and ports). Because of financial constraints, cheaper, short term, development options are often preferred to the perhaps initially more expensive, but ultimately less vulnerable, alternatives.

Those directly involved with climate related issues, such as disaster management and weather forecasting, have had relatively more exposure to the climate change debate. However, much of the information received has been in a form which users find of little practical value. Other information which has filtered through to government officials has been of the sensational genre favored by the popular media. Government officials expressed a strong desire to be better informed on climate change issues.

### 4.2 Community Awareness, Perceptions and Attitudes

In the time available, we were unable to survey community environmental awareness and attitudes. The following impressions were gleaned from our interviews with government and limited discussions with members of the public.

#### 4.2.1 Cultural Issues

Although most of the people in the FSM are Micronesian, and to a large extent culturally similar, there is, nevertheless, considerable cultural variation within the country; the people of Kapingamaringi and Nukuoro atolls are of Polynesian descent. Accordingly, there are eight different language groups within the FSM, with no two states having the same local language. The need to translate educational materials into the vernacular was expressed by several of the government officials who were interviewed during the mission.

Cultural values must be taken into account in environmental management and community education programs. For example, open discussion of human waste disposal is culturally unacceptable in Chuuk and this issue therefore requires sensitive treatment for people to be receptive to suggested attitudinal and behavioural changes.

Also, different perceptions of the environment, which are partly determined by culture and lifestyle, influence the way people behave environmentally. For this reason we have included a recommendation for an environmental perception study to be carried out in each of the 4 states, targetting different cultural groups. Information gained from the study would aid in the development of more effective community education programs and give valuable insight into the environmental sensitivities of different communities.

#### **4.2.2 Awareness of Environmental Issues and Attitudes to Resource Exploitation**

From the limited discussions we had with members of the public, there seems to be a general community concern regarding obvious environmental problems such as litter and refuse disposal, and a desire to avoid environmental degradation through inappropriate development. However, the individuals we spoke with were mostly engaged in the tourism industry and may be more sensitive to these issues than others. Awareness of less obvious environmental impacts and climate change issues was generally low.

Historically, living natural resources have been abundant throughout the FSM, but this is changing as population increases and as modern methods of exploitation replace traditional ones (see Section 3 on environmental stresses). The modern cash economy is also a major contributing factor to diminishing resources. For example, *Tridacna* (giant clams), have been over-harvested for cash and are now locally extinct in many areas. People are apparently aware of the dangers of over-exploitation, but are reluctant to surrender opportunities to earn cash in favor of resource sustainability. Attempts to re-seed reefs with clam spat have met with limited success, due largely to the general lack of community support for government sponsored projects.

Future efforts are likely to be more successful if a community-based approach is adopted. Traditional leaders could play a valuable role in encouraging general community support. There is also an urgent need for community education on the consequences of environmentally unsound practices such as dynamite fishing and mangrove clearing. Regulation of these practices could be enhanced by encouraging villagers to monitor and protect their traditionally owned areas of reef.

#### **4.2.3 Traditional Knowledge and Values**

Until recently, most Micronesians led a completely subsistence lifestyle. Many people, particularly those living on the outer islands and atolls, still do. Through tradition, terrestrial and marine resources are highly valued as sources of food and security. Traditional means of exploitation by relatively small populations posed little threat to sustainability of most resources. However, the extinction of dugong, marine crocodiles and some easily hunted bird species, shows that where resources could be easily harvested by traditional means, the tendency was still to over-exploit.

Some communities guarded against over-exploitation by fallowing both terrestrial and marine areas. In others, such as Yap, traditional control over apportioning community resources also favored sustainable use. As discussed in Section 4.2.2 above, such practices are being undermined by the adoption of modern methods of exploitation, the advent of the cash economy and the consequent shift in focus from community welfare to individual benefit. In addition, traditional knowledge and ethics are becoming less valued by the younger generation, who turn to modern education to equip them for employment.

Traditional knowledge and practices are most effective when the goal of resource exploitation is subsistence. They may not lend themselves to the fulfillment of modern aspirations. Not all traditional practices are necessarily the most appropriate in the context of a evolving physical, social and economic conditions. Because many of the current environmental problems are those of the modern world, for example the disposal of non-biodegradable substances, there are no traditional practices to cope with them. However, systems combining the most desirable features of traditional and modern management are potentially well suited to achieving optimum resource use and sustainability.

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## 5. Governance, Decision Making and Land Tenure

### 5.1 Governance

The FSM's history of colonization by foreign powers spans nearly 3 centuries. As a former Trust Territory of the United States, the political development of the FSM has been strongly influenced by the USA. Historical ties with other Micronesian countries persist as informal, co-operative arrangements between individual public servants. Before discussing the present government of the FSM, it is useful to reflect on the region's political history and the emergence of the FSM as a separate nation in Micronesia.

#### 5.1.1 A Brief History of Foreign Rule

Foreign rule in Micronesia began with Spanish colonization in 1668, the first missionaries arriving in the Caroline Islands in the early 1700's. Various whaling and trading interests from Britain, Europe and America used the islands throughout the 1800s.

By 1885 Germany controlled 80% of the trade in the Caroline Islands and the German Government supported companies which had trading stations in Yap, Kosrae and Pohnpei. At this time Germany negotiated a treaty with the 5 main chiefs of Pohnpei who surrendered their sovereignty to the Kaiser. A dispute over ownership between Spain and Germany ensued. In 1886 Pope Leo XIII decided the matter in favor of Spain and a Spanish Governor was installed in Pohnpei.

Following the Spanish-American war of 1898, islands of the Marshalls, Carolines and Marianas groups were sold to Germany and the region was divided into 5 sectors. Accordingly, governors were installed in Saipan, Yap, Truk, Pohnpei and the Marshalls. The German colonial administration lasted only 15 years. After failing to make significant profits from the region, and being largely unsuccessful in attracting German colonists, the Germans surrendered their occupation to the Japanese in 1914 at the beginning of World War I.

In 1920, after Japan joined the League of Nations at the insistence of the United States, control of Micronesia was formally mandated to the Japanese. Under Japanese colonial administration the economy and infrastructure of the region was rapidly developed. Agriculture, copra and fishing industries were established, as were medical facilities, schools providing three years compulsory education, air and sea ports, roads, water and electricity supplies.

Japan withdrew from the League of Nations in 1935 as tensions grew over questions related to Japanese administration in Micronesia. The Japanese military took control of the islands. It was not until 1944 that they were finally ousted by American forces.

In 1947, a Trusteeship Agreement with the United Nations was signed by the U.S. President, and the Trust Territory of the Pacific Islands (TTPI) was established. The TTPI comprised 6 districts: the Northern Marianas, Pohnpei (including Kosrae), Truk, Yap, the Marshalls and Palau. Under the first years of American military administration some schools and military bases were established, but little was done to further develop infrastructure or economy. In 1951, administration of the territories (except Northern Marianas which followed in 1962) was transferred from the U.S. Department of the Navy to the U.S. Department of the Interior.

In 1962 a more vigorous program of development was undertaken, including political reforms. In 1965 a Congress of Micronesia was formed, comprising elected representatives from all island groups. Executive authority remained under the control of the American High Commissioner. In 1969 political status negotiations began. These eventually resulted in Compacts of Free Association being signed by the former TTPI districts. In 1978 the Marianas district became the Commonwealth of the Northern Marianas Islands. Kosrae, Pohnpei, Truk and Yap voted in favor of a common constitution, and in 1979 became the Federated States of Micronesia. The Marshalls and Palau became separate republics in 1979 and 1981, respectively.

In 1982 each of the new nations signed separate Compacts of Free Association with USA. The individual Compacts had to be approved by the people of respective nation in a general referendum, by the legislatures of each nation, by the US Congress and by the UN Security Council. FSM's 15-year Compact was officially implemented in 1986.

As will be described in the following section, the FSM has 3 levels of government: national, state and municipal. Their respective jurisdictional responsibilities will be described in Section 5.1.5.

### 5.1.2 FSM National Government and National Constitution

The National Government of FSM is unicameral, with a total of 14 senators. They make up the FSM Congress. One senator at-large is elected by each state, the remaining 10 are elected based on population apportionment (Chuuk - 5, Pohnpei - 3, Kosrae - 1, Yap - 1). The at-large senators serve 4 year terms; all others serve 2 year terms. The President and Vice-President, who must be from different states, are elected by Congress from the four at-large senators.

The government is divided into executive, legislative and judicial branches (refer Annex II). The executive branch consists of 10 departments, each with a number of divisions. Legislative powers are vested in the Congress. The judiciary consists of a Chief Justice and up to 5 associate justices who are appointed for life. The National Capital is located at Palikir on Pohnpei Island.

The FSM National Constitution establishes a system of democratic governance at the national, state and municipal levels while also recognizing traditional aspects of governance (Harding, 1992).

### 5.1.3 State Governments

Each state has an elected Governor who serves a four year term, an elected legislature and a judiciary. The composition of Pohnpei and Kosrae State Governments is summarized in Annex III. State legislatures in Yap, Chuuk and Kosrae are made up of 9, 30 and 14 elected members, respectively. State governments are highly autonomous and have their own constitutions separate from the National Constitution.

### 5.1.4 Municipal Governments

Municipal governments are comprised of an elected executive (whose title may be Mayor, High Commissioner or Chief Magistrate according to the municipality) and a council of elected members. The number of municipalities in each state is as follows;

Yap	-	15
Chuuk	-	40
Pohnpei	-	10
Kosrae	-	4

### 5.1.5 Jurisdiction of National, State and Municipal Governments

The National Government is responsible for upholding the National Constitution, for foreign affairs and for formulating national policies and guidelines. External aid and regional organizations are required to deal with the National Government rather than directly with state governments.

Most internal matters are the responsibility of individual state governments. The relationship between the National and state governments is based on a policy of non-interference, with the National Government adopting an advisory rather than regulatory role. Decisions on the siting of air and sea ports, roads and other infrastructural developments are all made at the state level.

The National Government has jurisdiction over the 12-200 mile economic zone, but all inshore areas are under state control. Development projects, including the associated environmental impact assessments, are sometimes approved at national and sometimes state levels, depending on the extent of foreign involvement. Responsibilities in these areas will be clarified once the proposed Environmental Board is established (see Section 6).

Municipal governments are independent of state governments. They may legislate for their own communities providing their laws do not conflict with those of the state. They have jurisdiction over local affairs, property and government, but may not pronounce enactments on subjects covered by state law (Harding, 1992). Traditional leaders retain considerable influence in municipal governments.

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## 5.2 Decision Making Related to Land Use and Resource Development

Government jurisdiction over land use and development only applies to government land. Traditional landowners have complete control over the use of their own land and are free to develop it as they see fit. Indirectly, the National Government has limited control over land development if foreign interests are involved.

Realistically, any major developments in the FSM would currently require the injection of foreign capital through joint venture arrangements with local partners. Foreign businesses are required to file financial statements with the Department of Research and Development. These are assessed to determine their eligibility for a business licence. Licenses may be refused if the business plan is unacceptable or if the venture is deemed inappropriate to the interests of the FSM.

While the Department is required to take environmental considerations into account, they do not have the necessary in-house expertise to do so. This situation will probably be addressed by the proposed Environmental Board which is likely to implement mandatory EIAs for all developments (see Section 6).

In cases where foreign investment is not required, National and state governments have limited authority to control land development. Currently control can be exercised only through earthmoving regulations. The National Government requires permits to be issued for any alterations to the land surface, but state governments have their own regulations and the overlap is confusing (Harding, 1992). The result is that earthmoving regulations are not well applied. Because environmental protection has been under the auspices of Health Departments, the focus has been largely on public health and sanitation matters. The agencies concerned lack the expertise to deal with broader considerations.

## 5.3 Land Tenure

Although the complex mechanisms of land tenure vary between and within states, the importance of land to the people of the FSM does not. Throughout the FSM land is a scarce and highly valued commodity which determines status. It is also associated with economic and social security.

Colonial administrations have influenced patterns of land ownership in some areas of FSM by issuing land deeds and altering traditional mechanisms of land acquisition. Such actions weakened, to some extent, the power of traditional leaders over land distribution. In addition, colonial governments acquired tracts of land which were typically passed on to following administrations. Since independence, traditional owners have lodged claims for the return of some of this land.

The National Constitution universally forbids the sale of land to non-FSM citizens. Articles in the various state constitutions set out the modern (but incorporate traditional) principles of land use and acquisition (Harding, 1992). Government rights to acquire land for public use vary from state to state. Traditional ownership of riparian rights is recognized in some states. A summary of land tenure in each of the states follows.

### 5.3.1 Yap

A detailed explanation of land tenure in Yap is given by Labby, 1976. The clan (*ganong*) is the basic unit of social organization in Yap. Membership of a clan is determined by matrilineal descent. There are about 30-40 clans on the main island of Yap.

Land is organized into estates (*tabinaw*) and all non-government land on Yap belongs to a particular estate. *Tabinaws* also include areas of reef adjacent to estate land. Estates do not belong to a particular clan, but pass from one clan to another according to the movement of women as they marry and move to their husband's estate. For example, a man (Clan A) will remain on the estate where he was born. Eventually he may marry a woman from another clan (Clan B). Their son, who is a member of his mother's clan, will inherit the estate which will then pass from Clan A to Clan B. Thus individual clans have no permanent rights to particular pieces of land and individuals have no permanent claim to the land on which they were born.

If a man has more than one son, the eldest will inherit the father's house. Younger sons may be given plots from the original estate which thus becomes subdivided. In this way new estates are started.

Title to the family landholding is vested in all males and unmarried females in the family unit. In practice, most privileges of ownership are exercised by the family head, (usually the oldest male), although he is expected to consult all family members on land dispositions. He cannot alienate the land without unanimous family consent, nor can he completely disinherit a member of the family. Land is never sold outright. Although others may be granted rights to use the land, title remains with the traditional owners.

### 5.3.2 Chuuk

Chuukese are strongly attached to their land, identifying it as a source of wealth and food. Land is acquired through the family lineage, by inheritance from the parents, by gift or exchange. Land is rarely sold outright. Arrangements concerning rights to use the land, with the traditional owners retaining the title, are favored.

Inheritance is traditionally matrilineal, although islanders can also hold land on a bilateral or patrilineal basis. Most land belongs to the local lineage of a particular clan and is not the property of the whole clan. Trees are also very important to the Chuukese. On any given piece of family land, single trees or clumps of trees may be owned by individual family members (HAE, 1968). Although family land is owned jointly by the family, the eldest male usually apportions it among family members in consultation with the group. Most land transfers occur prior to death; transfer by will is rare (Harding, 1992).

Land ownership in Chuuk also includes mangrove swamps, coastal reefs, and isolated coral heads in lagoons. Structures, trees and fish can be owned independently of the land or reef on which they are found (Harding, 1992).

A complex system of reversionary rights exists in Chuuk. Land in Chuuk may be appropriated for public use by the State Government on payment of compensation. However this land may have to be returned to the original landowner once the public use ceases to exist. In private land sales, the original owner has the right to re-purchase his/her land in certain circumstances.

The Chuuk State Government currently owns approximately one percent of land in Chuuk, but this consists of filled areas. Other land is leased by the state Government at increasingly high rates (Harding, 1992).

Varied interpretations of customary law often lead to land disputes in Chuuk. Those that cannot be resolved by traditional means are dealt with through the courts by the Land Commission. The Land Commission is also responsible for surveying and registering land throughout the State, but so far only about 80% of the land in Weno has been surveyed with little progress in outlying areas (Harding, 1992).

Land registration is not compulsory. Therefore no comprehensive record of traditional land tenure exists (Harding, 1992). The Office of Land Management is responsible for assessing the State Government's needs and for returning areas no longer required to the original owners. The Office assists foreign investors with lease arrangements and encourages traditional landowners to enter into joint venture arrangements (Harding, 1992).

### 5.3.3 Pohnpei

In pre-colonial times, a feudal system of land tenure operated on Pohnpei. The island was divided into 5 culturally and politically independent districts which closely correspond with the present day municipalities. Each district was ruled by two lines of chiefs, *Nahnmwarkis* and *Nanikens*. They owned all land, including the adjacent marine areas. Land title traditionally passes matrilineally, although patrilineal land inheritance increased with foreign contact. Commoners were allowed to use land for subsistence agriculture providing they paid a portion of their crops to the landowner.

Around 1910, the German Governor of the day introduced a system of private land ownership under which individuals or family groups could hold title to a piece of land. Women were forbidden land ownership under the new system. The Japanese largely ignored the German land code. The U.S administration which followed, reinstated women's rights to own land. Although the traditional leaders are no longer the sole land owners, they retain considerable influence over land matters.

In the past, land in Pohnpei State could be leased for indefinite periods. Now, Article 12 of the Pohnpei Constitution states that no land may be leased for more than 25 years, unless it is leased from the State or special provisions are made by the legislature. In addition, only Pohnpei State citizens may be permanent title holders. Indefinite land use agreements are prohibited, and land sales are prohibited except as authorized by statute. The State Government may appropriate land for public purposes, but only after consultation with the local government and landowners and upon payment of an agreed amount of compensation or an exchange of land of comparable value (Harding, 1992). The Public Lands Act 1987 provides for a board of 9 trustees, appointed by the Governor, to oversee all rights, title and interest to Pohnpei State public lands (Harding, 1992). The Public Trust Lands Distribution Act of 1980 provides for land, previously held in trust by past colonial administrations, to be redistributed to state residents who developed the land, or to their successors.

A 1968 TTPI physical planning report (HAE, 1968), stated that three-fourths or more of the land on Pohnpei Island belonged to the government. The report highlights the confusion surrounding land ownership on Pohnpei Island due to the lack of a standard system of locating and recording land owners. It is suggested that this will be a major hindrance to economic development. Land use rights held by people other than the traditional owners were cited as one source of confusion.

Land tenure systems vary on the outer islands of Pohnpei State. On Mwoakilloa, a system of land titles was also introduced by the German administration. Because this required formal applications and the completion of forms, some people believe that land was distributed unequally in favor of church workers who were presumably better educated (Ashby et al, 1993). Land was previously bequeathed to the eldest son, but now it is often divided equally amongst family members.

German influence did not reach as far as Sapwuahfik atoll and land deeds were not issued here. The islanders set up their own 7 man committee to set boundaries and adjudicate on matters of land ownership. This committee was later replaced by municipal councilmen. In Sapwuahfik, land is customarily divided equally amongst the children on the death of their father.

In Kapingamaringi and Nukuoro Atolls all land, other than sacred and community land, is individually owned by both men and women. Land may be inherited or received as a gift and may be used by other family members and friends (Harding, 1992).

#### 5.3.4 Kosrae

Traditionally, land in Kosrae State was owned by the absolute ruler (*Tokosra*) who assigned titles to the local chiefs of approximately 57 districts. Commoners held land rights subject to the approval of the chief or *Tokosra* (Harding, 1992). Land rights could be extended by reclaiming land previously covered by water. The modern system is more flexible due to the diminishing power of traditional leaders (Harding, 1992). Land may now be acquired through inheritance, which is patrilineal, by gift, purchase or exchange or as part of a dowry. Land can be owned by individuals or collectively by a lineage or clan.

Constitutional provisions for land use and acquisition are set out in Article XI (Land and the Environment) of the Kosrae State Constitution. This provides for the State Government to acquire interests in public land for public purpose without the consent of landowners, provided a suitable compensation is paid and the land is shown to be "highly suited" for the intended use (Harding, 1992). Only FSM citizens who are domiciled in Kosrae, or corporations which are wholly owned by such citizens, can hold permanent title to land in the State.

The State Land Commission registers title in the name of one person and administers land disputes. More than half of the occupied land in Kosrae State is now registered. However, less than half the land in the state is currently occupied. Ownership of approximately 80% of the middle of Kosrae Island, a mountainous area unsuitable for farming, was previously claimed by the Japanese administration with rights transferred through the U.S to the present administration.

The claim is unsubstantiated by documentation and the land is currently in dispute, with the possibility that it may be returned to traditional owners. Most other land in Kosrae State is privately owned. However, the six main rivers and all land below the high tide mark are public property.

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## 6. Environmental Management

### 6.1 Current Management

The FSM has a number of national and state environmental laws and regulations. These are summarized by Harding (1992) and Gawel (1993). Responsibility for environmental management and protection rests largely with state governments, but in practice, traditional land rights make regulation and enforcement difficult. The National Government assumes broader responsibilities for issues which affect the entire nation.

#### 6.1.1 Environmental Management by the National Government

The responsibilities of the National Government include the control of radioactive and hazardous waste, regulation of natural resources within the 12-200 mile zone, regulation of navigation and shipping (except within lagoons, lakes and rivers), and the nationwide promotion of health. The National Government is also a signatory to the UN Law of the Sea Treaty and the regional South Pacific conventions on the environment (Gawel, 1993).

A Presidential Task Force on Environmental Management and Sustainable Development (EMSD), was set up in 1991. Its charter to develop a nationwide policy on environment and development matters culminated in the NEMS and moves to establish a National Environmental Board (refer Section 6.2.1).

Until recently, environmental matters have been linked with health and sanitation. Accordingly, most environmental concerns at the national level are currently handled within the Department of Human Resources by the Environmental Health Coordinator. Because government officials now recognize a broader range of environmental issues, other departments are becoming involved in environmental matters. However, this largely occurs on an *ad hoc* basis and without inter-departmental coordination on related issues (Harding, 1992) (see Table 6).

Selection of representatives to attend regional and international environmental meetings is not always based on relevant expertise. The FSM is often represented by personnel from Foreign Affairs (Harding, 1992), or by various officials on a rotating basis. This process favors a lack of consistency in the Government's approach to environmental issues.

#### Environmental Impact Assessment (EIA)

Environmental impact assessments of National Government projects, including those undertaken by its agencies and those wholly or partly funded by the National Government, are required by the Secretary of Human Resources. This does not apply to private or state sponsored projects (see Section 5.2). The Department of Resources and Development is required to consider adverse environmental impacts when granting foreign investment permits (see Section 5.2), but may do so without relevant advice from other departments (Harding, 1992).

As noted previously, the FSM has national earthmoving regulations which apply to all persons, including governmental bodies, engaged in earth moving throughout the FSM. These regulations, which cover any disturbance or alteration of surfaces on land, reefs and in lagoons, are not well applied. The overlap with state regulations is confusing (Harding, 1992). EIA's to date have largely ignored possible effects of climate change/sea level rise.

#### National Government Policy on Global Warming

In 1991, the FSM Congress passed Resolution No. 7-24. This expressed concern over the threat to the FSM posed by the consequences of global warming. The resolution points to possible catastrophic consequences to FSM and warns that FSM citizens may be among the first to become the victims of sea-level rise, intensified storms, salt water intrusion and destruction of marine life.

The President, Department of Human Resources and the Department of External Affairs were urged to work closely with the Alliance of Small Island States to encourage greater recognition of the Pacific Island view during the formulation of the Framework Convention on Climate Change (Harding, 1992).

### 6.1.2 Environmental Management within States

State governments produce 5-year development plans as well as more specific plans concerning environmental management and development activities. Table 7 summarizes the agencies responsible for environmental management in each of the states.

An Environmental Protection Board was established in Kosrae State in 1985. However, Harding (1992) states that the Board has been inactive since 1988. There are plans to replace the Board by a Development Review Commission which will oversee the use and protection of Kosrae resources (Harding, 1992). An important development in Pohnpei has been the requirement for EIA's to be carried out for private, as well as public, projects (Harding, 1992). To date, climate change/sea level rise issues have not been considered in EIA's.

#### Municipal Authorities and Non-Governmental Organizations

Municipal authorities have limited powers to deal with resource and environmental management. Non-governmental organizations (NGO's) interested in environmental matters include the Yap Institute of Natural Science (Colonia, Yap) and Micronesia Islands Conservation (Community College of Micronesia, Pohnpei). The Coral Reef Research Foundation (CRRF), based in Chuuk, is primarily involved in the collection of specimens for cancer research but occasionally conducts marine awareness programs in local schools.

## 6.2 Proposed National Environmental Management

### 6.2.1 Nationwide Environmental Management Strategies (NEMS)

The EMSD, in conjunction with state governments, and with the assistance of other local and regional organizations, formulated the first Nationwide Environmental Strategies (NEMS) for the FSM. Federated States of Micronesia (1993) has identified four broad environmental objectives in Box 2.

#### BOX 2: *Broad environmental objectives for FSM.*

1. To integrate environmental considerations in economic development.
2. To improve environmental awareness and education.
3. To manage and protect natural resources.
4. To improve waste management pollution and control.

To achieve these objectives, NEMS proposes 18 strategies. Each strategy is addressed by one or more programs of action, totalling 39 in all. NEMS has been endorsed by the FSM President, but with provisos on funding and the extent of National Government involvement in state environmental protection.

### 6.2.2 Nationwide Board on Environment and Sustainable Development

As part of a strategy to "establish a nationwide administrative system and agencies for environmental management", Federated States of Micronesia (1993) proposes the establishment of a national board. The Board would replace the EMSD and coordinate environmental management and sustainable development in the FSM.

Table 6: National Agencies Responsible for Environmental Matters

Issue	Agency Responsible	Comment
Pollution control	Dept. of Human Resources (DHR)	Administers the FSM Environmental Protection Act (FSMEPA) (1984)
Water quality	DHR	FSMEPA subsidiary regulations apply.
Waste management	DHR	FSMEPA subsidiary regulations apply.
Zoning, earthmoving & EIA	DHR Dept. Resources & Development (DRD)	FSMEPA subsidiary regulations apply. DRD administers Foreign Investment Act (see D.1.1)
Fisheries	Micronesian Maritime Authority National Fisheries Corp. DRD, Div. of Marine Resources	Regulates marine resources within 12-200 mile EEZ Fisheries development.
Agriculture	DRD, Div. of Agriculture Coconut Development Authority	-
Forestry	-	No national legislation.
Mining & minerals	DRD, Div. of Marine Resources	Within 12-200 mile EEZ. No national legislation for development of mineral resources.
Biodiversity conservation	DRD	No appropriate legislation exists for establishing protected areas.
Tourism	DRD, Div. of Commerce & Industry	-
Cultural heritage	Office of Administrative Services, Div. of Archives & Historic Preservation.	-

(Source: Harding, 1992)

The Board's specific functions are wide-ranging, incorporating the formulation of national environmental and development policies (including minimum standards and EIA guidelines), monitoring the "environmental performance" of states, encouraging uniformity between national and state environmental law, environmental education and protection of the environment and cultural heritage. In addition, NEMS encourages the establishment of State Task Forces which would advise state governments on community concerns relating to the environment and development. Accordingly, members are to be selected from a broad cross section of the community.

Membership of the National Board will be limited to 9 members comprising 3 national, 4 state, and 2 community representatives. The Secretary's of the Departments of Human Resources, Resources and Development, and the National Planner, will represent the National Government.

Representatives from each state will be appointed by State Governors. Community representatives, 1 from the commerce and industry sector and a community or religious leader, will be selected by the President from a short-list of nominations compiled by Governors. NEMS proposes an annual budget for the Board of \$290,000. However, the President has limited the sum to \$100,000.

Table 7: State Agencies Responsible for Environmental Management in FSM.

Issue	Yap	Chuuk	Pohnpei	Kosrae
<b>Pollution</b>	Environmental Protection Agency (EPA)	Dept. Health Services (DHS); State Transportation Div.	Environmental Protection Agency (EPA)	Environmental Protection Board  (proposed Development Review Commission)
<b>Water quality</b>	EPA	Dept. Public Works (DPW); DHS	Dept. of Health Services (DHS), Div. of Public Health	Dept. of Health Services (DHS), Div. of Environmental Health and Sanitation
<b>Waste management</b>	EPA	Dept. Planning & Statistics; DPW; DHS; Chuuk Visitors Bureau(CVB)	DHS	DHS, Div. of Environmental Health and Sanitation
<b>Zoning, earthmoving &amp; EIA</b>	EPA	DHS	EPA	-
<b>Fisheries</b>	Yap Fishing Authority; Dept. Resources & Development (DRD), Marine Resources Management Div.	Dept. of Marine Resources (DMR); Dept. of Commerce & Industry (DCI)	Dept. of Conservation & Resource Surveillance (DCRS), Marine Resources Div.	Dept. of Conservation & Development (DCD), Div. of Marine Resources
<b>Agriculture &amp; forestry</b>	Agriculture Extension Agents	Dept. of Agriculture (DA)	DCRS, Div. of Agriculture & Div. of Forestry	DCD, Div. of Agriculture & Forestry
<b>Mining &amp; minerals</b>	-	DCI	-	-
<b>Coastal zone, marine &amp; reef protection</b>	DRD, Marine Resources Management Div.	-	-	-
<b>Biodiversity conservation</b>	DRD, Marine Resources Management Div. for marine sp.	DMR; DA; DHS	Dept. of Land (DL), Parks Div.; DCRS	DCD
<b>Tourism</b>	-	CVB	State Tourism Commission	DCD, Div. of Tourism
<b>Cultural heritage</b>	-	DCI; DHS; CVB	DL, Historic Preservation Div.	DCD, Div. of History & Culture

(Source: Harding, 1992)

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## 7. Vulnerability and Resilience to Environmental Change

Environmental systems may react adversely to a hazardous event and in this sense "vulnerability" is taken to be the potential for damage to a system by a hazardous event. On the other hand, there are attributes within environmental systems which act to reduce the impact of hazardous events.

These inherent characteristics, or "resiliences", are adjustment and adaptation mechanisms to both internally and externally generated stresses (Kay and Hay, 1993). Figure 2 presents a framework for the discussion of vulnerability and resilience to environmental change, in this instance the context being the coastal environment. The assessment can be undertaken in terms of environmental systems, sub-systems and sub-system elements where, as indicated in Figure 2, the "environment" is defined in the broadest terms to include both natural and human factors. The assessment can also be undertaken for anticipated future as well as existing stresses on the environment.

Previously in the FSM, the environment and resources supported human populations similar to those of the present, but in a self-sufficient subsistence lifestyle in an ecological balance dominated by natural processes. Recent economic and social changes have resulted in non-sustainable exploitation of resources, the generation and disposal of large amounts of waste, and significant changes to the environment, many of which are likely to be irreversible. Rapid increases in, and redistribution of, population, changes in people's attitudes and aspirations, exposure to new technologies, goods and services and a movement from self-sufficiency to widespread dependence on external assistance for achieving desired lifestyles have all contributed.

The exploitation of resources for external markets that began in the colonial period continues today, with little consideration being given to the long-term impacts of such practices. In addition to these internally generated pressures there are locally imposed stresses associated with external factors. These include local manifestations of global changes in climate and oceanic conditions, foreign exploitation of migratory

fish and other marine species, accidental and intentional release of materials on the high seas and the off-shore disposal through incineration, and other means, of toxic and radioactive wastes.

Vulnerable ecosystems include those of the reef, lagoon, mangrove and steeper slopes of the high islands. Non-sustainable rates of harvesting, destructive removal of natural cover and excessive cultivation, use of fire and inputs of sediment, pollutants and other contaminants are sources of extreme stress for such systems. Large natural variations in migratory fish stocks due to availability of feed and changes in ocean currents mean that it is difficult to establish sustainable catch levels and thereby avoid over-fishing.

The societies and cultures of the FSM are undergoing rapid changes as a result of both internal and external pressures. The complex social hierarchy and the integrity of the extended family are both being weakened as individuals strive to increase their independence and fulfil their personal aspirations. Traditional practices and means of sustenance are giving way to use of foreign methods and technology and imported foodstuffs and methods of food preparation. Collectively these changes are placing a burden on individuals, families and larger communities. Substance abuse and a high suicide rate, particularly amongst young males, are evidence of the magnitude of these pressures and the seriousness of the consequences.

Not surprisingly, most of the economic activity and infrastructure of the FSM are concentrated in coastal areas. These include ports (air and sea), commercial, administrative and service facilities, waste treatment and disposal sites, wells and roads. Because of their coastal and low-lying location the facilities are, even now, often highly vulnerable to extreme events such as storm surges and damaging winds. Their vulnerability to longer-term changes such as coastal retreat, sea level rise and salt water intrusion is similarly great.

Institutional arrangements are vigorously tested when the systems they are designed to serve and control are stressed as a result of undergoing rapid change. Currently in the FSM the institutions and laws are patterned after systems established during the US administration of the islands. In a review of environmental legislation, Harding (1992) noted a number of regulatory gaps and concluded that some regulations drawn from US mainland experience were ill-suited to the needs of the FSM.

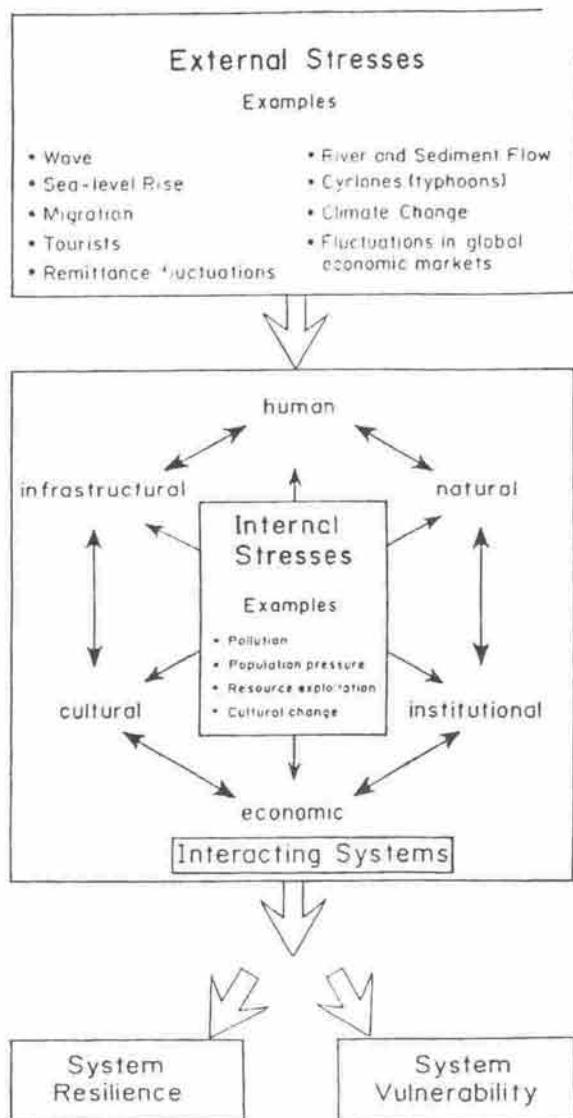


Fig. 2 Framework for consideration of vulnerability and resilience to environmental change

(from Kay and Hay, 1993).

The report also states that there appears to be conflicting and often competing environmental management responsibilities dispersed between different government agencies and embodied in widely varied legislative

instruments. These factors, combined with a practice to view environment in a somewhat narrow context as pertaining primarily to public health issues, mean that institutional arrangements often fall short of those required to ensure the wise use of resources and protection of the environment.

But the natural and human systems of the FSM also include many adjustment and adaptation mechanisms that collectively enhance their resilience to environmental change and excessive use. For example, healthy coral will grow vertically in response to increased sea level (D'Elia et al., 1991).

Lagoon and reef systems are also capable of accommodating reasonable inputs of sediment from inland catchments, often as a result of sediments being trapped by mangrove communities. The latter expand as the extent of unconsolidated sediments increases. Similarly, excessive sediments may be effectively removed from the marine system by the formation of sand bars and other features. People and communities also increase their ability to withstand real or perceived environmental threats by making conscious decisions and undertaking preventative actions such as ensuring adequate supplies of food and water for emergency situations.

In such cases the extended family and cultural linkages will also assist individuals and communities to withstand natural and other hazards. In many cases traditional methods of harvesting, cropping and husbandry were far more dependable and less damaging to the valued resources and environment. Plant varieties able to withstand deteriorating environmental conditions, such as increasing salinity, can also increase the ability to withstand adverse environmental changes. Infrastructure such as sea walls and breakwaters can be used to enhance the resilience of natural systems.

In addition, the ability of buildings and other structures to endure environmental stresses can be increased through the incorporation of appropriate design features, including setbacks from active coastlines and strengthening to withstand high wind loads. Governance systems that ensure effective environmental management and the adoption and enforcement of appropriate legislation will help to ensure that the environment and resources are maintained in a healthy state and hence more capable of withstanding abnormal stresses.

## 8. Response Options

### 8.1 Background

Overall a healthy environment and well managed resources will have high resilience and low vulnerability to environmental stresses. Such a situation will prevail if both the public at large and individuals with formal responsibilities for environmental and resource management are encouraged, equipped and empowered to use and manage the environment and resources in a wise and sustainable manner.

Response options related to impacts associated with climate change and sea level rise fall into two categories - limitation and adaptation (see figure 3). Limitation responses seek to limit the processes of climate change themselves, by such actions as reducing the rate of increase of greenhouse gases in the atmosphere.

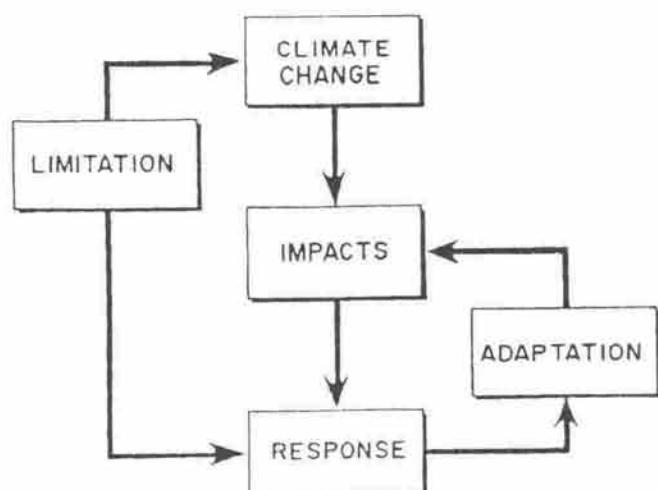


Fig. 3 *Response options related to climate change*

(from Campbell, 1993).

Adaptation responses seek to modify the impacts of climate change and sea level rise. Campbell (1993) describes three classes of adaptive response: i) to postpone any action until an impact occurs and a response is forced or until increased certainty deems a response to be justified; ii) to modify the environment to reduce impacts and/or enhance benefits (i.e. to buffer people from the impacts); and iii) to modify people's activities to reduce impacts and/or enhance benefits. Examples of the latter two options are construction of sea walls and the improvement of warning and response systems for natural disasters, respectively.

Optimal management responses should enhance the resilience of environmental systems and reduce vulnerability to abnormal stresses; in sum such actions will enhance the "Sustainable Capacity Index" (SCI) for a given environmental system (Kay and Hay, 1993). This can be achieved through active and integrated programmes of development planning, environmental management and disaster management (Figure 4).

The "present day Sustainable Capacity Threshold" (Figure 5a) defines the boundary between environmental systems that are being used sustainably or unsustainably under present conditions. Future conditions (Figure 5c) might well include stresses that, even for a given probability of occurrence, redefine the sustainable threshold curve so that only at higher values of the SCI will the given environmental system achieve a sustainable status.

Optimal management responses (Figure 5b) are those which act to decrease the threshold value of the SCI at which systems are sustainable. This can be achieved by enhancing the resilience and/or reducing vulnerability of environmental systems to both internal and external stresses. As demonstrated above, climate and sea level variability are only one of many such stresses.

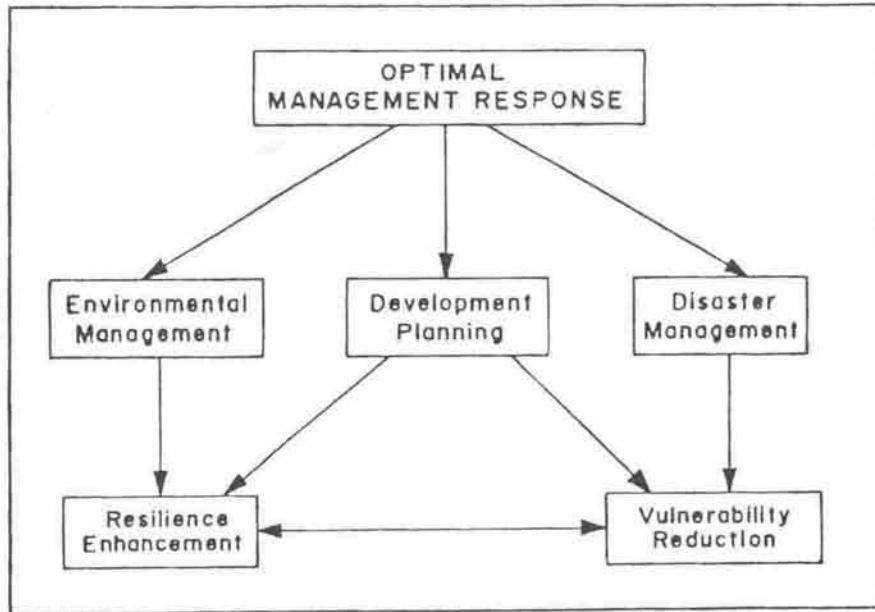


Fig. 4 Optimal management responses - development planning, environmental management and disaster management.  
(from Kay et al., 1993).

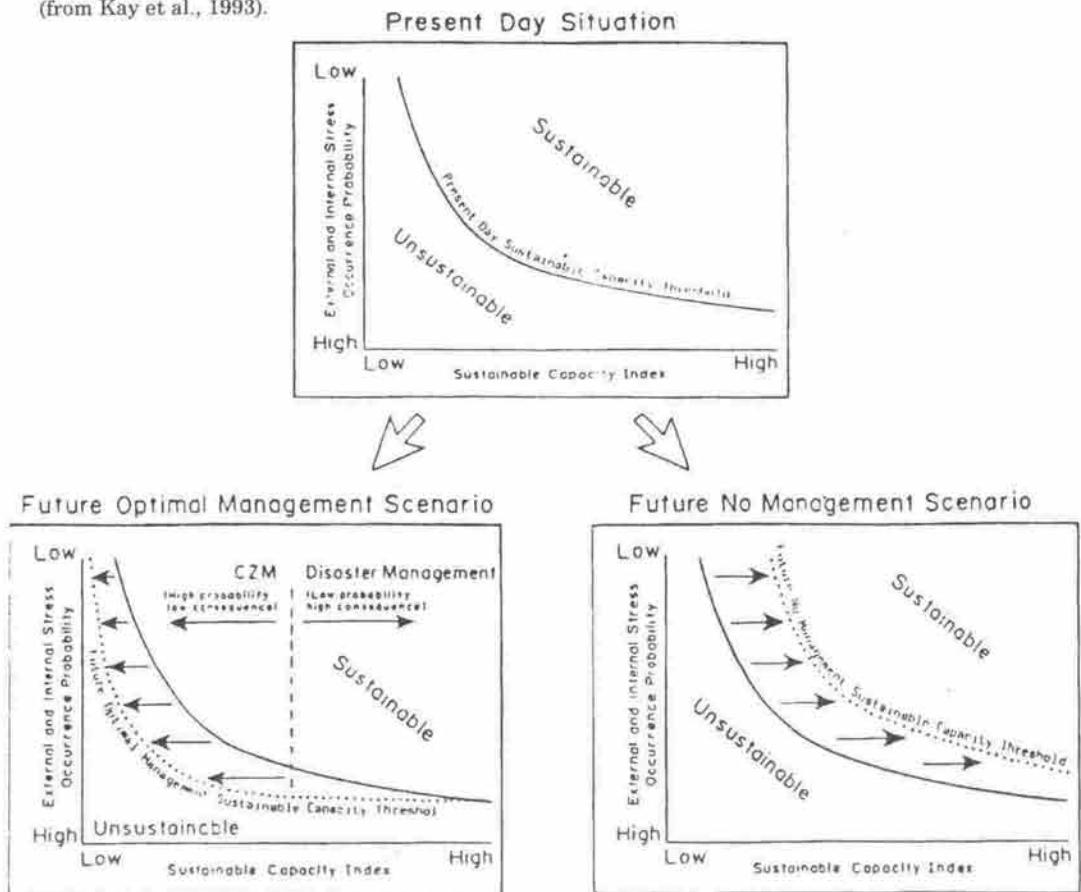


Fig. 5 Probability of occurrence versus Sustainable Capacity Index for a) present day, b) future optimal management scenario and c) future no management scenario.  
(from Kay and Hay, 1993).

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## 8.2 Response Options for the FSM

While countries such as the FSM are not major or even significant contributors to global climate change, by demonstrating their own commitment to limitation strategies they will enhance their credibility when urging the major contributing nations to adopt such measures. Thus the FSM should consider taking all appropriate steps to limit emissions of greenhouse gases such as carbon dioxide and ozone depleting substances such as CFCs.

It is beyond the scope of the current study to develop detailed adaptive responses, but some general points can be made. Firstly, by addressing current environmental and resource use problems the impacts brought about by future stresses on the environment will be lessened. Healthy environments and living resources are more resilient and less vulnerable to stress. This extends beyond the biophysical environment and includes socio-economic and cultural conditions as well.

The future well-being of the FSM society and its ability to withstand natural hazards such as tropical cyclones and drought and possible long-term changes such as sea level rise will also be enhanced if the present quality of life is improved. In addition, protection of the biophysical environment and resources will help ensure that the needs of future generations are addressed and also do much to safeguard the assets on which tourism and other economic activities are so dependent.

Secondly, in terms of the three categories of adaptive response a number of actions are of great importance.

- By liaising closely with appropriate international and regional organizations, countries must ensure that they are provided with the latest information regarding developments in our understanding of global environmental change and related issues; countries should initiate and maintain appropriate monitoring programmes so that they become aware, as early as possible, that undesirable impacts are occurring as a consequence of stresses being placed on the environment and/or resources.

- It is appropriate for countries to undertake assessments of their vulnerability to future environmental changes and to establish policies and implement plans to protect those vulnerable elements which are of sufficient value (monetary or otherwise) to justify such actions. Similarly, opportunities that might materialise as a consequence of future environmental changes should be identified and again policies and programmes established to take advantage of such situations.
- As noted above, healthy biophysical environments and resources, a sound economy, a progressive society and a strong culture will, in combination, provide resilience to the pressures associated with global environmental changes such as variations in climate and sea level. Much of this robustness to change will depend on the environmental awareness and commitment of people, either in their professional capacities or as members of the community at large. Thus education and training, at all levels and both formal and informal, are critical to the development of a population which recognises the current and future environmental consequences of their present and planned actions.

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## 9. Recommendations

1. *Implement the programs of the Nationwide Environmental Management Strategy in a timely and effective manner.*

**Action - National and State Governments, with international support.**

While the Nationwide Environmental Management Strategy (NEMS) for the FSM (Federated States of Micronesia, 1993) is seen primarily as a means of combining development and conservation, it is obvious that implementation of its relevant programmes will enhance the ability of the FSM to withstand the impacts resulting from global environmental changes such as climate and sea level variations. An integrated rather than a piecemeal approach is required. Hence the overall scheme described in the NEMS is endorsed.

2. *Within the context of the National Environmental Management Strategy:*

- *increase awareness and understanding of climate change and sea level rise issues in the community and amongst government officials and politicians by means of both formal and informal education programs;*

**Action - National and State Governments, with support of regional organizations**

- support environmental education through the development and dissemination of instructional materials related to:
  - natural hazards,
  - impacts of current resource exploitation,
  - guidelines for sustainable use of the environment and resources,
  - global, regional and national environmental and development issues,
  - preservation of historic and cultural heritage of the nation;

**Action - National and State Governments, with support of regional organizations**

- undertake baseline and post project monitoring in support of environmental impact assessments (for example, surface and groundwater quantity and quality monitoring, baseline marine surveys and aerial photograph reconnaissance) in order to ensure an adequate framework for consideration of appropriate responses to climate and sea level variability in association with development and other projects;

**Action - National and State Governments, with support of regional organizations**

- SPREP is urged to provide regulatory agencies within FSM with assistance to define the scope of work for environmental impact assessments (EIA's) and to evaluate EIA reports commissioned by developers;

**Action - SPREP**

- encourage the retention of traditional knowledge and the adoption of appropriate traditional practices which will, be conducive to sustainable resource use, reduce vulnerability to extreme events and enhance the ability to adapt to environmental, economic, and social changes;

**Action - State Governments and non-governmental organizations**

- appoint a Scientific Officer who would interpret scientific and other information, prepare it in a form which is appropriate for use in FSM, and advise Government on various issues including those related to climate and sea level variability and to extreme natural events;

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**Action - National Government,  
with support of regional  
organizations and donors.**

- increase public access to information on appropriate responses in emergency situations by making available relevant educational materials in local languages; recommended presentation formats are small durable cards for personal use, video leaders and trailers, posters and calendars.

**Action - National and State  
Governments, with support of  
regional organizations**

Public awareness of environmental issues results in people being more aware of the consequences of their individual and collective actions, reduces unjustified concerns based on misinformation and also increases support for politicians and other decision makers who are developing appropriate policies and ensuring that they are both adequately resourced and implemented effectively.

Environmental education requires access to supportive materials to ensure that accurate and relevant information is available to instructors and conveyed to the recipients. Considerable information and instructional materials already exist, but much is not in a form or in a style which lends itself to use in formal and informal environmental education programmes in the FSM. Materials of relevance to the various target groups and addressing specific issues and concerns should be more widely available and in local languages.

Decisions regarding social, economic and cultural developments usually impact on or are dependent on the biophysical environment and natural resources. In order that such decisions are well-based there is a need for adequate information on the present and continuing status of the environment and natural resources. Such information is critical to the success of environmental impact assessments. Much of the needed information is currently not monitored in the FSM; the monitoring which does occur is somewhat uncoordinated, intermittent and the results are not readily accessible.

Technical guidance is also required by regulatory agencies within the FSM to assist them to meet their current and strengthened responsibilities regarding environmental impact assessment. SPREP is the most appropriate regional organization to coordinate the provision of such assistance. With such support it will be possible to ensure that the FSM has the appropriate instruments with which to include concerns related to climate and sea level variability when considering development and other proposals.

The early cultures of the FSM demonstrated an ability to survive in the face of adverse environmental conditions, through wise use of resources and a respect for the environment. Many of these practices are still of relevance today. Those that are still remembered and relevant should be recorded and every effort made to incorporate them in the lifestyles of the present population.

Much of the scientific and technical information reaching the FSM is in a form which is not of great use to the country. Likewise, politicians, other decision makers and managers are frequently in need of advice regarding the impact of the environment on their areas of responsibility and the impact of their actions and decisions on the environment. A National Climate Change Officer would strengthen the national capacity to address such issues.

Appropriate actions prior to and during emergency situations can alleviate much of the physical damage and human suffering. Public awareness of both preventive and emergency response actions is of critical importance. Planning at a government level is wasted if there is no public awareness of their responsibilities in an emergency. Relevant education programmes will require the use of innovative methods in order to ensure the message reaches those most in need of such information and assistance.

3. *Implement a training program for national and state climate officers, using a strategy similar to the current training program for meteorologists in the FSM Weather Service Offices. These officers would be responsible for the collation and analysis of climate data for planning and development purposes.*

**Action - State Governments, Training Institutions and regional organizations.**

The FSM appears to have an excellent programme for training local people as meteorologists. A similar approach should be used to train climate officers for employment by the national and state governments. At the state level the officers would support efforts related to social and economic development. The role of the national climate officer has been described above.

4. *Enhance national and regional weather monitoring and forecasting by acquiring meteorological satellite receiving, processing and interpretation facilities and the trained staff required to operate and maintain such a facility.*

**Action - National Government, World Meteorological Organization and donor agencies.**

Awareness and preparedness are critical to the successful mitigation of adverse environmental impacts. Weather and climate impacts require both comprehensive monitoring and forecasting capabilities. Considerable relevant data to support these activities can be obtained by interpretation of meteorological satellite data. This in turn requires trained personnel, for equipment maintenance as well as data archiving and analysis. This recommendation relates to both technical and human resources capacity building.

5. *Ensure the timely receipt and dissemination of natural hazard and other warnings by upgrading the internal and international mass communications (e.g. radio) systems and by taking all reasonable efforts to ensure their continued operation under adverse conditions.*

**Action - National Government, regional organizations and donor agencies.**

Warnings concerning natural hazards such as cyclones and tidal waves must be credible, timely and disseminated widely to recipients who are aware of the appropriate actions to take. Ongoing communications are also critical as needs must be identified and support efforts coordinated if impacts are to be minimized. A robust communications system which provides widespread coverage is therefore essential. The present systems for communications require considerable upgrading.

6. *Ensure that the priority studies related to climate change, as already identified by the National Office of Planning and Statistics (Government of the FSM), be funded and implemented as a matter of importance.*

**Action - National Government, regional organizations and donor agencies.**

The FSM Office of Planning and Statistics has identified several research priorities consistent with the responses identified in the Framework Convention for Climate Change. To date, only partial funding has been received, allowing only a small number of the proposed studies to proceed. There is an urgent need to undertake the remainder of the studies that have been identified, namely -

- an inventory of greenhouse gas emissions in the FSM;
- analyses of vulnerability to climate change for selected islands;
- impact of climate change and sea level rise on freshwater lenses;
- air photo reconnaissance and other baseline information gathering to support future monitoring programs; and
- assistance with the development of an integrated coastal zone management program.

7. *Ensure that funding agencies incorporate the training of local counterparts and acknowledge the need for ongoing maintenance of equipment in programs designed to monitor and to enhance the ability to accommodate variations in climate and sea level.*

**Action - National Government, regional organizations and donor agencies.**

Many examples can be found where equipment and other facilities have been provided with good intentions, but their utility to the recipients is soon compromised by a lack of local personnel who can make use of the resources long-term and maintain it appropriately. It is recognised that localization and such long-term commitments as ongoing equipment maintenance are often given little recognition in present aid programmes. But donors must be made to recognise that in many cases the effectiveness of their programmes is being impaired as a result, and ways found to overcome the real and perceived problems related to funding localization programmes and meeting longer-term costs.

8. *Adopt and enforce a requirement that, on completion of studies undertaken by non-nationals or external organizations, copies of data, reports and other relevant information be lodged with an appropriate office of the national government.*

**Action - National Government.**

Much valuable information is currently being lost and duplication of effort is occurring as a result of the failure to ensure that information arising from investigations within the FSM is retained and made available within the country. Appropriate regulations should thus be introduced and enforced. But, in order for such a practice to yield the desired results, the FSM must, in turn, recognize the need for it to ensure that the information is stored in an appropriate manner and made accessible to those who can benefit from its use.

9. *Enhance, at both the national and state levels, the capacity to respond to natural disasters by;*

- i) ensuring that those with formally recognised responsibilities are aware of their obligations as defined in the national disaster plans and have the appropriate resources to fulfil them and,*
- ii) upgrading present facilities and developing new methods which will allow people in outlying islands to better withstand periods of hardship resulting from natural events such as drought, floods, damaging winds, tidal waves and storm surges; appropriate initiatives might include increased household water storage capability, adoption of more appropriate cultivation methods, and use of more salt tolerant cultivars.*

**Action - National and State Governments and donor agencies.**

The FSM has developed a number of plans to guide decision makers and others with responsibility during and subsequent to natural disasters and other life and property threatening situations. But the value of these plans relies on the availability of an aware and adequately resourced group of people who carry the responsibility for implementation. Currently there are serious deficiencies in this respect.

In addition, the resilience of communities can be increased through the provision of appropriate facilities, materials and knowledge. Further measures are required in this regard, given that outlying communities may face even greater hardships in the future,

10. *In planning for and constructing large infrastructure such as sea ports and airports, SPREP and other relevant organisations be consulted for information and advice regarding the significance of climate and sea level variations.*

**Action - National and State Governments, SPREP and other organizations.**

There is evidence to suggest that, currently, consideration of future environmental stresses and changes is not being incorporated adequately in infrastructure planning, at either the national or state levels.

Awareness of the need to include the local consequences of global environmental change must be recognised by those responsible for planning and designing infrastructure. Provision of relevant information to such individuals and organizations would be facilitated by the climate officers at the state and national levels.

*11. National and state environmental policies should include controls on such activities as beach and reef mining and the use of buffer zones to protect mangroves; such provisions would reduce the tendency for human activity to increase the vulnerability of natural systems to such external stresses as climate change and sea level rise.*

**Action - National and State Governments, with advice from regional organizations.**

Wise use of resources and sound environmental management today will enhance the ability of natural systems to withstand the local impacts of global environmental change. Policies should reflect this principle.

*12. The FSM Government might wish to consider the advantages of membership of the World Meteorological Organization.*

**Action - National Government**

In recognition of the fact that appropriate planning is enhanced by having access to and making prudent use of all relevant information, the FSM Government may see considerable advantage in having greater access than at present to the information and expertise available through the World Meteorological Organization

*13. The impacts likely to occur as a consequence of climate change and sea level rise are one of many reasons for formulating management plans for the coastal zone; integrated management plans should be prepared for all coastal areas of the FSM, based, in part, on assessments of vulnerability to climate change and sea level rise and land use capability following the USDA or FAO systems and incorporating such instruments as land use zoning and building codes.*

**Action - National and State Governments.**

Coastal areas are of greatest value to the FSM, when measured in either monetary or non-monetary terms. They therefore deserve special effort to ensure the appropriate use of the resources in this zone. An integrated approach is required due to the strong linkages between all systems in the coastal zone and their important ties with inland and marine areas. Integrated planning and management will not only help optimise decisions for the present day but also assist in ensuring that future conditions and needs are considered.

*14. SPREP is requested to advise and assist the Government of the FSM regarding the proposed installation of a tide gauge.*

**Action - SPREP**

Considerable interest exists in the identifying current variations in sea level, as a base against which to assess estimates of future changes. Concern was expressed about the failure, to date, to install a tide gauge in the FSM as part of the SPREP coordinated sea level monitoring programme.

*15. Given the diverse cultural and physical character of the FSM and the inability of the present mission to make on-site assessments for areas other than the island of Pohnpei, similar climate change/sea level rise assessments be extended to the remaining three states of Yap, Chuuk and Kosrae.*

**Action - SPREP in response to request from the National Government.**

Both the members of the study team and most of the officials interviewed during the visit to Pohnpei were mindful of the fact that the mission was to consider the implications of climate change and sea level rise for all of the FSM. On the other hand, only the island and State of Pohnpei were visited. This places a severe constraint on the ability of the study to identify issues related to the other three States of Yap, Chuuk and Kosrae.

*16. The national and state governments are urged to facilitate the development of local scale and based and sustainable tourist ventures (ecotourism) and place appropriate and effective controls on mass based tourism that makes little use of the natural environment and provides relatively few net benefits to the local community*

**Action - National and State Governments, with support of regional organizations.**

Tourism has major current and future importance to the economy and people of the FSM. There is a need to protect the very features which make the country an important and growing tourist destination. The short and long term advantages of ecotourism to island nations of the Pacific are described in Hay (1992).

*17. An environmental perception survey, including climatic risk perception, should be conducted in each of the states in order to gain a better understanding of the diversity in people's attitudes to such issues as climate change, sea level rise and sustainable use of resources and the environment.*

**Action - SPREP and other relevant regional organizations, in response to request from National and State Governments.**

The need for community education on environmental issues has been identified in the NEMS. To ensure that the content and format of community education programmes is appropriate and targeted to the relevant groups, it is important that current environmental attitudes and perceptions be understood. In addition, environmental perception research can provide insight into human behaviour, identify sensitivities (for example, to climate variability and change and to reference to specific actions or substances), and provide information which will enable decision makers to incorporate the values and concerns of the community in public policy.

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## Annexes

### Annex I: Program of Visit

#### August 11

- 12.50pm Arrival at Pohnpei via Guam.
- 2.30pm Meeting with Dr E.K. Pretrick, Secretary and Mr N. Siren, both Department of Health Services, Government of the FSM
- 4.00pm Field reconnaissance - Pohpei Proper

#### August 12

- 9.20am Meeting with Mr J.A. Mangefel, Deputy Secretary, Department of External Affairs, Government of the FSM
- 11.00am Field reconnaissance - Pohpei Proper
- 2.30pm Meeting with Hon. A. Takesy, Secretary, Department of Resources and Development, Government of the FSM
- 4.00pm Field reconnaissance - Pohpei Proper

#### August 13

- 9.00am Meeting with Mr A. Suzuki, Official in Charge, FSM Weather Service Office
- 10.30am Field reconnaissance - Pohpei Proper
- 2.30pm Meeting with Messrs. R. Goodwin and R. Abraham, Office of Planning and Statistics, Government of the FSM

#### August 14

Visit to Enipein Marine Park, Pohnpei

#### August 15

Visit to Nan Madol and adjacent islands, Pohnpei

#### August 16

- 9.00am Meeting with Mr P. Rodriguez, Acting Secretary, Department of Transportation and Communications, Government of the FSM
- 10.00am Meeting with Mr C. Nimues, Disaster Control Officer and Special Assistant to the President on Disaster Preparedness and Control
- 1.00pm Meeting with Mr T. Boyle, Pohnpei Tourist Commission
- 2.00pm Meeting with Mr E. Hellan and Ms D. Scheuring, Environmental Protection Agency, Pohnpei State Government
- 3.30pm Meeting with Mr Y. Suta, Administrator, Division of Community Services, Federal and Foreign Programmes, Department of Education, Government of the FSM

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**August 17**

- 9.30am Taped interview for radio and television with T. Gamabruw, E. Thomas, E. Rospel and Esikiel Lippwe
- 11.00am Meeting with Mr N. Siren, Department of Health Services, Government of the FSM
- 1.30pm Meeting with Mr M. Darra, Acting Aiport Manager, Pohnpei State Ports Authority
- 2.30pm Preparation of Draft Recommendations

**August 18**

- 9.30am Discussion of proposed content of report and draft recommendations with Dr E.K. Pretrick, Secretary, Department of Health Services, Government of the FSM
- Afternoon/ Departure of members of study team.  
Evening

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## Annex II: Composition of the FSM National Government

**Executives** - President & Vice President

**Judiciary** - Chief Justice and not more than 5 Associate Justices appointed by the President.

**Legislature** - 4 at-large senators (1 from each state) elected to 4 year terms plus 10 senators elected from all states, based on population apportionment, serving 2 year terms.

### Executive Branch

Department of External Affairs

Division of United States Relations

Division of International Affairs

Department of Finance

Division of Accounting

Division of Revenue

Division of Data Processing

Division of Investment Management

Division of Customs

Department of Resources and Development

Division of Agriculture

Division of Marine Resources

Division of Commerce and Industry

Division of Labor

Department of Transport and

Communications

Division of Marine Transportation and  
Communication Affairs

Division of communications

Division of Civil Aviation

Office of the Attorney General

Division of Law

Division of International Law

Division of Litigation

Division of Security and Investigation

Division of Marine Surveillance

Division of Immigration

Office of Budget

Division of Budget Preparation

Division of Administrative Management

Division of Grants Management

Office of Administrative Services

Division of Personnel Administration

Division of Training

Division of Property and Supply

Division of Archives and Historic  
Preservation

Division of Maintenance

Office of Planning and Statistics

Division of Planning

Division of Statistics

Division of Construction Review

Department of Human Resources

Division of post-Secondary Educational  
Development

Division of the Educational Program  
Development and Research

Division of Medical Care

Division of Preventive Health

Division of Community Services

Office of the Public Defender

(Source: Harding, 1992.)

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## Annex III: Composition of Pohnpei State Government

**2 Executives** - Governor & Lieutenant  
Governor elected for 4 year terms

**Judiciary** - 4 judges appointed to 12 year  
(renewable) terms by Governor

**Legislature** - elected unicameral body of 23  
members based on population. Present  
composition;

Madolenihmw	4 members
Sokehs	4 members
Kitti	4 members
U	2 members
Kolonia	2 members
Nett	2 members
Outer islands	1 member each

### Executive Branch\* -

Department of Treasury  
Division of Public Finance  
Division of Revenue and Taxation  
Division of Procurement and Property  
Management

Department of Justice  
Division of Legal Affairs  
Division of Public Safety  
Division of Corrections and Rehabilitation  
Division of Fire

Department of Public Works  
Division of Construction Management  
Division of Operations and Maintenance  
Division of Public Utilities  
Division of Sea and Air Transportation

Department of Education  
Division of Elementary Education  
Division of Secondary Education  
Division of Educational Services and  
Development

Department of Land  
Division of Survey and Mapping  
Division of Management and  
Administration  
Division of Historic Preservation  
Division of Parks and Recreation

Department of Health Services  
Division of Medical Services  
Division of Public Health  
Division of Administration and Health  
Development  
Division of Environmental Protection

Department of Conservation and Resource  
Surveillance  
Division of Agriculture  
Division of Marine Resources  
Division of Forestry  
Division of Economic Planning  
Division of Energy

Executive Branch Offices  
Budget and Planning  
Public Affairs  
Federal and Foreign Relations  
Youth and Social Affairs  
Personnel  
Island Affairs

Authorities, Commissions and Agencies  
Economic Development Authority  
Transportation Authority  
Tourist Commission  
Price Control Commission  
Foreign Investment Board  
Board of Presidential Properties and  
Utilities  
Land Planning Commission

\* A reorganization of the Executive Branch  
of the Pohnpei State Government in 1992  
proposed the following departments and  
divisions.

(Source: Harding, 1992)

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## **Annex IV: Composition of Kosrae State Government**

**Executive** - Governor - 4 year term of office

**Judiciary** - Chief Justice and Associate Justices - nominated by the Governor and serve 6 year terms.

**Legislature** - 14 Senators from 4 electoral districts; Lelu, Malem, Tafunsak, Utwe.

### **Executive Branch -**

Office of the Attorney General

Office of Budget and Planning

Office of Finance and Treasury

Office of Personnel and Employment Services

Department of Conservation and Development

Division of Agriculture and Forestry

Division of History and Culture

Division of Land Management

Division of Marine Resources

Division of Production and Marketing

Division of Tourism

Department of Education

Department of Health Services

Division of Administrative Services

Division of Clinical Services

Division of Dental Services

Division of Environmental Health and Sanitation

Division of Medical Services

Division of Public Health and Nursing

Department of Public Affairs

Department of Public Works

Kosrae State Agencies

The Broadcast Authority

The Election Commission

The Environmental Protection Board

Executive service Appeals Board

The Health Council

The Land Commission

The Parole Board

The Sports Council

The Scholarship Board

(Source: Harding, 1992)