



The Federated States of Micronesia

state of the environment report

EOS

By
Michael J. Gawel
Local RETA Consultant
Federated States of Micronesia 1993



Gawel, Michael J.

The Federated States of Micronesia : state of the environment report / Michael Gawel.

1. Environmental impact analysis— Federated States of Micronesia 2. Environmental policy— Federated States of Micronesia I. South Pacific Regional Environment Programme II. Title

33.71
ISBN

AACR2

Prepared for publication by the South Pacific Regional Environment Programme, Apia, Western Samoa.

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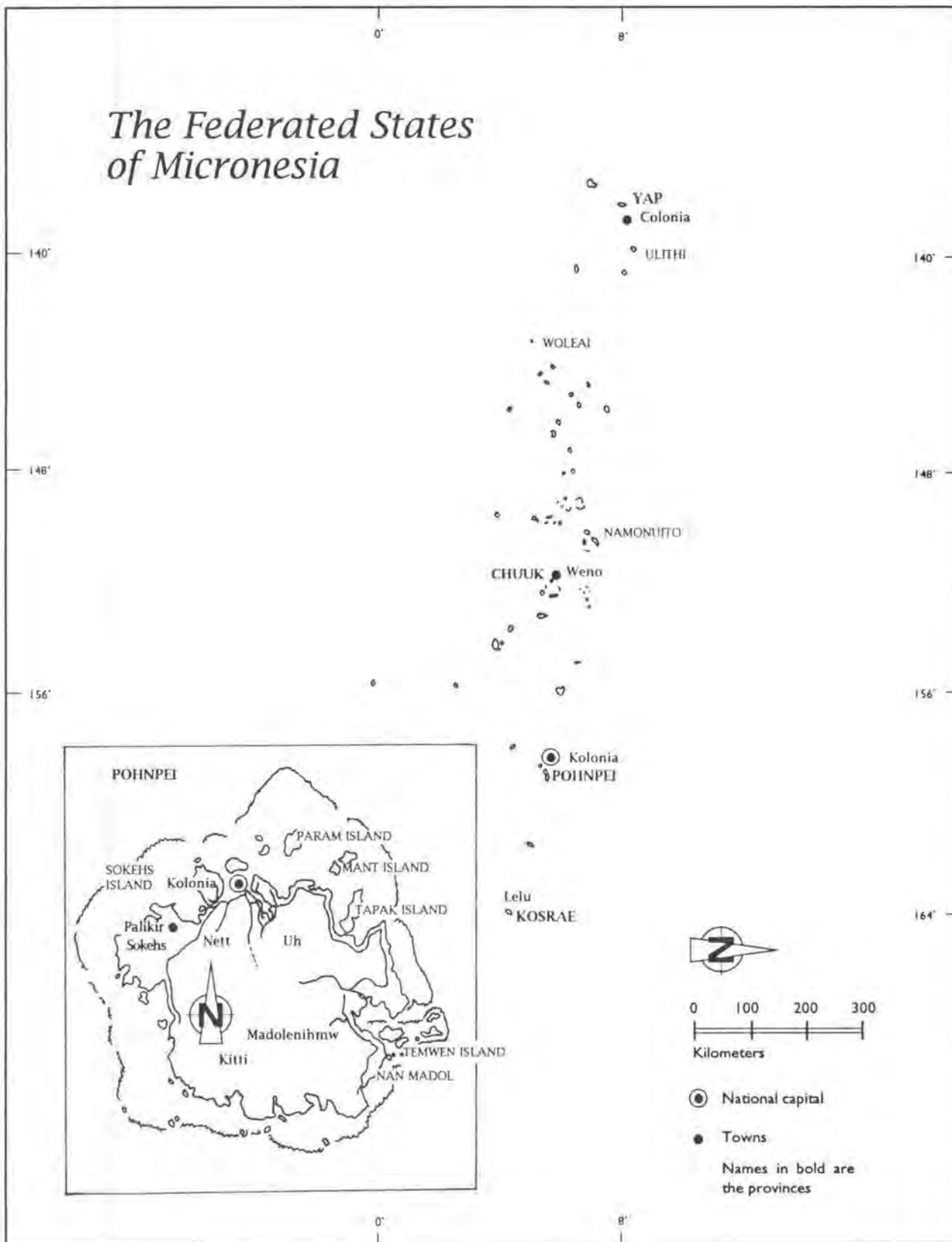
The Federated States of Micronesia

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The Federated States of Micronesia



Foreword

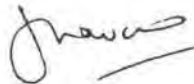
This document represents a concise report on the State of the Environment for the Federated States of Micronesia. It was prepared as a major element of the Regional Environment Technical Assistance (RETA) Project, one of the largest environmental projects implemented in the Pacific. The RETA Project has been made possible through the generous financial and technical assistance of the Asian Development Bank and the World Conservation Union. This assistance is gratefully acknowledged.

The main aim of the RETA Project is to develop Nationwide Environmental Management Strategies (NEMS) in a number of Pacific countries. The NEMS is a practical document which aims to identify the major environmental issues in the Federated States of Micronesia and the priority environmental programmes required to address them. The emphasis has been on ownership of the document by the Government and people of the FSM. The process which resulted in the preparation of the NEMS has involved many people and has been directed by a Presidential Task Force on Environmental Management and Sustainable Development, comprising relevant government and non government organizations.

The State of the Environment Report for the Federated States of Micronesia was a major background document for the preparation of the NEMS. It summarises the current state of knowledge about the environment in areas such as geology, vegetation, fauna and marine resources. It represents a comprehensive reference document which formed the major background paper to the Nationwide Environmental Seminar, held in Palikir in February, 1992. The preparation of this report has also provided an important vehicle for raising awareness at the state and national level of the importance of environmental issues and how they could be integrated into decision making processes.

I would like to play particular tribute to the work of Mike Gawel, the RETA Local Consultant for the Federated States of Micronesia, who prepared its State of the Environment Report. Its comprehensive nature is a tribute to his efforts.

SPREP looks forward to working with the Federated States of Micronesia and with other regional and international organisations in tackling the environmental issues identified in this State of the Environment Report.



Vili A. Fuavao
Director

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Preface

The need to protect the environment while ensuring the sustainable use of natural resources has been clearly recognized in the South Pacific. In response to this need, the South Pacific Regional Environmental Programme established a Regional Environmental Technical Assistance (RETA) Project in 1990.

Using multi-year funding from the Asian Development Bank and the World Conservation Union, this RETA Project is assisting the FSM to develop its Nationwide Environmental Management Strategies (NEMS). The FSM Presidential Task Force on Environmental Management and Sustainable Development oversees production of this strategy. Under the direction of the Task Force and administration of the Department of Human Resources, this first State of the Environment Report for the Federated States of Micronesia has been produced to provide a basis for the preparation and approval of the Nationwide Environmental Management Strategy.

Acknowledgments

The author is grateful for the support and opportunity offered by the FSM Presidential Task Force on Environmental Management and Sustainable Development and by the South Pacific Regional Environment Programme's Regional Environmental Technical Assistance Project to produce this report. Editorial and advisory assistance was provided by Messrs Nachsa Siren, Moses Nelson, David Sheppard and Robert Thistlethwaite and Ms Donna Scheuring. Special reviews and background information were available from Misses Nancy Convard and Maureen Phelan.

Executive summary

This report reviews the past and present status of natural resources and their uses and indicates what trends are occurring to determine future resource uses and impacts of uses. It suggests possible priorities for incorporation into the FSM Nationwide Environmental Management Strategy. Optimal socio-economic development in the Federated States of Micronesia requires a long-term, inter-generational perspective on management of the limited but valuable natural resources and the environment.

The natural resources of the FSM are similar to those of other tropical Pacific islands, but have not been well assessed. A small number of endemic species are known, and some have become extinct. The coral reef habitats have particularly high diversity and pristine conditions, although they have been modified locally by human impacts. In past centuries these resources have supported human populations similar to today's, but in a self-sufficient, subsistence lifestyle in an ecological balance controlled by natural forces. Existing ecological zones include terrestrial zones (beach strand, swamp forest, secondary forest, marsh, grassland, primary forest, rain forest and crest forest) and marine zones (deep ocean, reef flat, reef slope and lagoon, and mangrove forest).

Recent economic and population pressures, combined with changes in residents' attitudes and desires and the inflow of new technologies, have resulted in human-induced changes to the environment. There has been a shift from self-sufficiency to a widespread dependence on outside assistance for attaining desired lifestyles, based on increasing purchase of imported goods. Resource-use trends beginning in the colonial period and persisting under self-rule reflect increased exploitation for external markets with little recognition of long-term impacts.

A democratic government has been formed by Micronesians in a federation of four States, each with significant state-level powers. The majority of funding for governmental operations comes from the United States under the terms of the Compact of Free Association, which is due to terminate in 2001, after periodic reductions in financial assistance. Institutions and laws are patterned after systems established during the US administration of the islands.

Environmental threats include the natural hazards of storms and typhoons, which locally are magnified by human influences; the global impact of climate change; local impacts of hazardous substance and waste product disposal; and water pollution and resource loss due to erosion, sedimentation and inadequately managed resource use.

Future priorities for environmental management and sustained development include:

- ◆ Participating in international activities for environmental management, such as international conventions;
- ◆ Improving and increasing capabilities for environmental management;
- ◆ Strengthening laws and government programs in environmental and resource protection, monitoring, assessment and management;
- ◆ Improving infrastructure related to quality of life and the environment;
- ◆ Expanding public understanding of environmental matters; and
- ◆ Developing individual and private organizational participation in environmental management and support for sustainable development.

chapter 1 ♦

The environment

The Federated States of Micronesia (FSM) is a new, independent democratic nation in the Caroline Islands of the tropical Pacific Ocean. Its history as a self-governing country began when on May 10, 1979, its people implemented their constitution, which they had written and approved by plebiscite. The country is composed of four states — Chuuk, Kosrae, Pohnpei and Yap (sometimes called Truk, Kusaie, Ponape, and Waab).

The FSM was included as a "strategic trust" in the United Nations Trust Territory of the Pacific Islands shortly after World War II. It concluded a Compact of Free Association with its former colonial administrator, the US Government, which came into effect as a treaty on November 3, 1986, and has progressively achieved international diplomatic recognition since then. In December 1990 the United Nations Security Council, which together with the UN Trusteeship Council had oversight of the Trust Territory islands, declared the UN trusteeship officially ended. The FSM became a full member of the United Nations on September 17, 1991.

The FSM is a member of the South Pacific Forum (the current President, the Honorable Bailey Olter, chaired the 1991 Forum Heads of Governments Meeting in Pohnpei), the Forum Fisheries Agency, the South Pacific Applied Geoscience Commission (SOPAC), and other regional organizations of independent South Pacific countries. It is also a member of the South Pacific Regional Environmental Programme (SPREP) and other worldwide organizations.

1.1 Physical environment

The FSM extends over an area of approximately 2,978,000 sq. km. of the tropical western Pacific Ocean. All of its islands are north of the equator, but its Exclusive Economic Zone (EEZ) ranges from approximately 1°S to 14°N latitude and 135°E to 166°E longitude. Its islands are included in the Caroline Archipelago. It is bordered to the west by the Republic of Palau and the Philippine Sea, to the north by the Territory of Guam, to the east by the Republic of the Marshall Islands and to the

south by Papua New Guinea and, more distantly, Irian Jaya, Solomon Islands, Nauru and Kiribati. The total land area of FSM is only 4,840 sq. km. (2,708 sq. m.). There are four basic types of islands in the FSM — high volcanic islands, low atoll-associated coral islands, raised coral islands and low non-atoll coral islands. The highest mountain peak, at Pohnpei, reaches 791 meters above sea level. Table 1 gives the numbers of island types in each State. Table 2 shows estimated areas of land and lagoon by State.

Table 1 Numbers of islands, by types, by State

State	High volcanic	Atolls *	Atoll & reef coral	Lagoon-less coral	Raised coral
Kosrae	2	-	3	-	-
Pohnpei	9	9	154	-	-
Chuuk	15	12	273	2	-
Yap	4	12	141	3	1
Total	30	33	571	5	1

* Each atoll has one to scores of individual small sandy islands, which can change in area and number due to storm wave impacts.

Table 2 Land & lagoon areas by State (in sq. m.)

	Kosrae	Pohnpei	Chuuk	Yap	Total
Land	42	133	39	48	262
Lagoon	-	279	822	405	1,506

1.1.1 Climate

Temperatures in FSM are uniform, with differences between daily highs and lows being greater than seasonal differences in average daily temperatures. Because of the tropical oceanic influences the climate is one of the most equitable in the world. Evenings register approximately 24 degrees Centigrade (mid 70s Fahrenheit) and day temperatures reach 29 degrees C (mid 80s F). Humidity averages over 80

per cent and rainfall is generally heavy, with 304 cm (120 inches) per year in drier islands and over 1,016 cm (400 in.) per year in the mountainous interior of Pohnpei. Most islands have a pronounced dry trade-wind season (November to May) and a wet variable-wind season (June to October). Typhoons, harsh tropical storms comparable to hurricanes, are a serious threat in the western region, more commonly during the wet season. These storms generally begin forming between Pohnpei and Chuuk and move north-west, increasing in strength and impact. The westernmost parts of Yap can expect direct hits of typhoons with windspeeds in excess of 70 knots (130 km/hour) about once every 20 years. Such destructive storms are probably only one-tenth as likely to affect Kosrae. Flooding is associated with major storms. Estimated floodplains mapped for the US Government cover the most developed and heavily settled areas (Michael Baker Jr Inc. 1977).

1.1.2 Geology & geomorphology

Oceanic geological features characterize the FSM. It is the only developing country in the Pacific to possess all the following geological formations: volcanic hot spots, an oceanic island arc and Cretaceous seamounts. These major significant formations are also interspersed with abyssal plains and basins, deep sea trenches (the Yap Trench has been measured to below 8,000 meters), ridges, banks and seamounts as well as reefs, atolls, raised coral islands and volcanic islands. Besides the normal oceanic volcanic formations and sedimentary coral reef and lagoon deposits, the main islands of Yap are unique in Micronesia in possessing extensive metamorphic geological formations.

Soils of the islands of Kosrae, Pohnpei, Yap Proper and the Chuuk Lagoon islands of Weno (Moen), Tonowas (Duhlon), Fefan, Uman, Tol, Pata, Polle, Udot and Param, have been studied and described by the US Soil Conservation Service in the last decade (Laird 1982, 1983a, 1983b; Smith 1983). US Military Geology reports also cover most of these same islands, except Kosrae. The types of soils described include clays and stony clays; solid volcanic rocks and boulders; silts, peat and muck of marshes and swamps; loam; loamy sands and well-drained sand and coral rubble. The values of the soils for development, based on their bearing capacities, shrink/swell characteristics, permeability (percolation rate), groundwater levels, soil depths, stone content, erosional factors and agricultural value, are described in the *Land Use Guides* for many islands (OPS, TTP] 1978a, b, c & d; 1979; 1980). Earthquake effects are not historically significant in Kosrae, Pohnpei and Chuuk. Yap Proper (this term excludes Outer Islands) has had minor earthquake impacts in the past.

1.1.3 Hydrology & oceanography

Groundwater occurs to varying extents in all the islands. In low sand islands, raised coral islands and coastal areas made up of coral sand and lagoonal sedimentary or coral reef deposits, a freshwater lens floats on top of the denser seawater which infiltrates the permeous soil. This freshwater lens is critical to vegetation, especially food crops such as taro and breadfruit on atoll islands. It is also tapped by shallow wells to supplement rainwater catchments. Groundwater also occurs on the high volcanic and metamorphic rock islands of the FSM. Well water is an important source of water supply to central distribution systems in Pohnpei, Weno (Chuuk) and Yap Proper; before World War II, infiltration tunnels supplied groundwater to the large Japanese military and colonial settlement on Tonowas.

Truly perennial streams are absent from all islands except Pohnpei and Kosrae. Major streams have had flows gauged over many years by the US Geological Survey.

Seasonally, the gross oceanic north equatorial and equatorial countercurrents move water masses past the FSM islands and the tropical thermocline averages around 100 meters deep. Sea-surface temperatures remain between 28 and 30 degrees Celsius all year round. Currents along shores and reefs and in lagoons are mainly driven by the normally diurnal tides which have extreme ranges at less than two meters.

1.2 Ecosystems & living resources

The ecosystems and living resources of the FSM are unique to these islands and waters. In general terms, however, they are similar to those of neighboring island countries, which share many of the same species. 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. Pelagic migratory animals such as tuna and turtles move beyond the FSM waters, while most bottom- and reef-associated organisms are limited to restricted areas, as are the terrestrial life-forms.

1.2.1 Terrestrial

Terrestrial ecological zones stretch from high tide level to the tops of the highest mountains. They include eight different zones, as follows:

The **beach strand** is found in all vegetated islands of the FSM. It is characterized by soils on coral sand which are well-drained, loose and porous. The water table is usually 40-60 cm (16-24 inches) below the surface, and fresh groundwater is underlain by brackish and salt water. Natural beach strand vegetation consists of plants which are somewhat resistant to salt spray, although vegetation types can

blend in with those of other zones, especially where salt spray is blocked by mangrove forests or where artificial planting has been done. Typical of the beach strand are such trees as breadfruit, coconut, fish poison tree, *Calophyllum*, *Casuarina* (ironwood pine), *Cordia*, zebra wood tree, *Heritiera*, *Hernandia*, hau (*Hibiscus tiliaceus*), *Messerschmidia*, *Morinda*, *Pandanus*, *Pisonia*, Indian almond (*Terminalia*) and milo (*Thespesia populnea*). Also typically the strand has the shrubs *Pemphis* and *Scaevola* (half-flower); the herbs and vines *Cassytha* (dodder), spiderlily, beach morning glory, beach pea-vine (*Vigna*) and the beach grasses *Eragrostis*, *Lepturus*, *Paspalum*, and *Sporobolus*. The most noticeable beach strand animals are the shorebirds *Pluvialis dominica*, *Charadrius mongolus*, *Actitis hypoleucas*, *Numenius phaeopus*, *Tringa nebularia*, *Heteroscelus incanus*, *Arenaria interpres*, and *Calidris acuminata*. On many islands, especially smaller ones, the reef egret *Egretta sacra* and terns *Gygis alba*, *Anous stolidus* and *A. minutus* are very abundant in the beach strand.

The **swamp forest** only occurs extensively in Kosrae and Pohnpei. Its soil is black and wet and mainly made of decomposing vegetation. It is defined largely by the presence of the swamp trees *Barringtonia racemosa*, *Terminalia carolinensis*, *Hibiscus tiliaceus*, *Metroxylon amicarum*, *Erythrina fusca*, and *Campnosperma brevipetiolata*.

The **freshwater marsh** in inhabited islands of Yap and Chuuk and outer islands of all States is heavily utilized for growing taro. Many of the marsh zones of Pohnpei and Kosrae, which are more extensive than those of other islands, are also planted with taro, but some maintain original vegetation stands, usually dominated by *Phragmites karka*. The soft, black wet soil of the marshes is not solid but is rich with nutrients from rotting vegetation and is often covered by stagnant water.

Grassland is relatively extensive as a result of human impacts in the larger high islands of Yap, Chuuk and Pohnpei. Typical grassland areas have developed after removal of primary forests by fire or clearing or by topsoil removal through mudslides. The grassland vegetation lacks trees and bushes and dries out each dry season. It is usually found on moderate slopes with clay, rock or stony clay soils. Some water is retained by grasses and soil is held in place as long as fires have not killed the grasses. Otherwise, erosion occurs until grass regrows after burning.

Grasslands have been increasing because of fires which destroy forests and prevent trees from regrowing in grassy areas. The dominant vegetation in grasslands consists of different species of grasses including *Paspalum* (hilo grass), *Dimertia* and *Ischaemum*, and staghorn ferns (*Dicranopteris*). Certain birds such as rails and parrotfinches occur in the grasslands, but this habitat does not seem to be critically needed by any species of bird, lizard or mammal and is not suitable pasture for livestock, which will not eat the prevalent grass species. The small native owl of Pohnpei may occur in this zone.

The **secondary forest zone** consists of all the interior areas of high islands inland of the mangrove swamps and beach strand, but excluding the marshes, grassland, swamp forest, and primary, rain and crest forests. It is called "secondary" because most of its vegetation was introduced after clearing the original forest which occupied this land, perhaps centuries ago. It is the site of traditional agro-forestry and is often called the coconut-breadfruit secondary forest, after the plants most characteristic of this zone. Also commonly found here are bananas, mango, hibiscus, kapok trees, papayas, sweet potatoes, cassava, ivory nut trees and citrus. In Pohnpei, sakau (*Piper methysticum*), and, in Yap, betel nut palm are grown in this zone. The soils supporting this plant growth are predominantly clays and stony clays. Most of the rain which is not taken up by the plants runs off this area because of slopes and the soils' inability to absorb much water. Bats, lizards and many birds are common in this zone, including the Micronesian pigeon, an endangered species. Besides providing food, some lumber, shade and wind protection, the secondary forest plants retain some rainwater to prevent flooding and droughts and bind the soil with their roots to control erosion. Their year-round greenness and water retention helps prevent the spread of fires.

Although all non-secondary forest areas can strictly be called **primary forest**, this name is here used for the primary forest zone of high islands excluding those distinctive zones of swamp, rain and crest forests. The primary forests on most islands have been exterminated from much of their earlier extensive ranges by burning, land clearing and intensive farming. Only a few mountain top, cliff and ravine areas in Yap and Chuuk retain this forest. It is still very extensive in the interiors of Pohnpei and Kosrae. It covers soil types of clays, stony clays and loams, as well as rocky substrates and is usually on steep slopes. The thick cover of vegetation keeps this soil from drying out and retains organic matter to build up nutrients while resisting the spread of fires. Characteristic vegetation includes banyan trees, pandanus, climbing screw-pine, unique palms (*Clinostigma*) and hardwoods (*Elaeocarpus*, *Camptosperma* etc.) and the poison tree (*Semecarpus*). Certain rare and endangered species of flora and fauna occur in this zone, such as the Chuuk poison tree, the Chuuk greater white-eye, the Kosrae rail, fruit bats, doves and native pigeons. Besides being a habitat of rare and endangered species, this ecological zone provides edible products, lumber and materials for local medicines, handicrafts and other traditional practices. It has scenic value for residents and tourists and is important for scientific research, biological diversity preservation and worldwide conservation interests.

The **rain forest** in the FSM is limited to the interior peaks of Kosrae and Pohnpei. It occurs on steep slopes of mostly greater than 20 per cent, with soils of clay, stony clay and thin organic soil over bare rock. Its surface soil and vegetation retain rainwater, which falls there most days of the year. Common plants include banyans,

tree ferns, mosses, bird's-nest fern and other ferns, orchids, pepper vines, *Elaeocarpus*, *Freycinetia* and *Psychotria*. It is frequented by bats, tropic birds, junglefowl, white terns, doves, pigeons, cuckoos, swiftlets, white-eyes, honeyeaters, parrotfinches and starlings. In Pohnpei it also hosts introduced wild pigs and Philippine deer, which degrade the native species of vegetation through their trampling, digging and browsing. This zone's blanket of dense, moss-covered vegetation, with its accumulation of humus, acts like a sponge to soak up the water that precipitates almost daily. Where this cover is left intact, it provides an excellent watershed.

Crest forest occurs only on the summits of Kosrae and Pohnpei mountains. This zone's vegetation is characterized by its dwarf stature and dense, wet nature. As with the rain forest zone, this forest is dependent on high rainfall, but also faces high winds and extreme exposure. Many of the plants are dwarfed specimens of the vegetation of the forests below, with an abundance of others characteristic of such exposed areas. Projecting rocks are topped by ferns and an assortment of mosses and liverworts. The zone's slopes, soils and wildlife are similar to those of the rain forest. Human visits to these areas and so human impacts there are very rare.

1.2.2 Marine

Marine ecosystems in the FSM are based on the normal salinity (33 parts per thousand), low-nutrient, clear, deep, oceanic waters with fairly constant surface temperature of about 29 degrees C. Surrounding the reefs and islands, these parameters are modified by the influences of fresh water and the nutrients and particles which it carries from the land, and by the coral reefs and organisms which they contain. Interactions of chemical, physical and biological aspects of the FSM marine environment are influenced by seasonally shifting oceanic currents and the inshore tidal currents caused by the normally diurnal tides, with maximum ranges of no more than two meters.

Like the terrestrial environment, the marine environment is regularly divided into ecological zones based on the occurrence of characteristic species groups. Four marine zones are readily distinguishable:

The **deep ocean** zone makes up most of the global area controlled by the FSM. It has stable temperature, salinity and chemical characteristics. Although the waters are lacking in nutrients and relatively low in biological productivity, the quantity and value of harvestable fish in the FSM's Exclusive Economic Zone is very high. The most valuable are the tunas: bigeye (*Thunnus obesus*), yellowfin (*Thunnus albacares*), and skipjack (*Katsuwonus pelamis*). These roam widely and travel rapidly as they seek planktivorous baitfish, mainly herrings, sprats and anchovies, as their food.

The **reef flat** is the shallow zone on the reef which is exposed at the lowest tides but is usually covered with salt water. Mainly because of its occasional drying, it lacks a cover of living corals, however it supports very high biological productivity through its plant cover. The substrate is solid coral rock with scattered patches and bands of sand, rubble and silt. An important sub-zone of the reef flat is the seagrass habitat, important to many edible species of marine life such as turtles, fishes, shells and crabs because it provides food, shelter, and spawning and nursery grounds. At high tide, all parts of the reef flat are covered with water, allowing fish to move freely. In most islands, fish are heavily harvested on the reef flats by women and without boats. The outer reef flat generally has solid reef rock surfaces with certain algae attached, such as *Sargassum*, *Turbinaria*, *Amphiroa*, *Jania* and encrusting coralline algae. At outer points of the reef flat projecting far into the deep ocean are found exposed coral boulders, which have been plucked from the reef slope by large storm waves and deposited on top of the reef platform. The inner parts of the reef flat are better protected from waves and currents. They tend to be covered by a layer of rubble, sand or silt, which allows seagrasses and macroalgae with good anchoring ability to survive and provides habitat for bivalves and burrowing animals. The sand and silt is held in place by marine plants, so it does not readily wash away and damage coral growths. Reef flats protect shores from storm waves and tsunamis. Shore birds such as sandpipers, plovers, fattlers, whimbrels, turnstones and others seasonally feed at intertidal areas. The densely vegetated reef flat areas are probably the most productive areas of all land and water zones.

The **reef slope and lagoon** are always submerged. They have a base of solid coral rock which is covered by rocks, rubble, sand, silt or live corals, with sometimes seagrass and algae cover of unconsolidated sediments. Common seagrasses are *Enhalus*, *Thalassia*, *Halophila*, *Halodule* and *Syringodium*, while common algae are species of *Halimeda*, *Caulerpa*, *Avrainvillea*, *Tydemannia*, *Microcoleus*, *Asperagopsis*, *Dictyota*, *Galaxaura* and *Udotea*. The shallower parts of this zone have the richest coral growth, with often greater than 100 per cent coral cover (due to overlapping layers). Deeper lagoonal areas usually have less coral because of increased sand and sediment and decreased light and water circulation. Coral species in Micronesia number several hundred, with some of the highest diversities in the world. There are almost a thousand species of fish of the FSM coral reefs. Deeper waters are also feeding areas for green and hawksbill turtles, porpoises, and seabirds, including boobies, terns, tropic birds, frigate birds and shearwaters.

The **mangrove forest** is easily identified by the presence of unique mangrove trees growing intertidally in salty or brackish waters. The commonest indicator species in the FSM are the *Rhizophora* with long roots arching through the air, *Bruguiera* with knee-like root projections, buttressed *Xylocarpus* and *Sonneratia* with spike-like

root projections. They grow with an associated community of plants and animals along the shorelines of most high islands and a few atoll areas of the FSM. There is an unusual stand of mangroves far from shore on the leeward barrier reef of Pohnpei; at a few sites in Kosrae isolated clumps of mangrove remain on outer reef flats after shores have receded. Except in these two cases, mangroves grow in sand or silty soils with varying amounts of plant matter. Thick deposits of wet black mud and decaying vegetation occur in the inner areas of large mangrove stands, which can be more than a mile wide and, in the case of Pohnpei, practically surround the entire island. The healthiest, best formed mangrove stands in the Pacific Islands occur in Kosrae and Pohnpei, according to Dr Lawrence Hamilton (pers. comm.) and in this author's opinion. Numerous species of marine life depend upon the mangroves for sheltered habitat, especially during the young and larval stages of many edible crabs and fishes. Certain epiphytic plants (*Dendrobium* and other orchids and *Asplenium*, *Davallia*, *Nephrolepis*, *Ophioglossum* and other ferns) and birds, bats and lizards typically are found in the FSM mangrove community. *Emballonura* bats roost in cavities of large hollow *Sonneratia* trunks and fruit bats frequent mangroves. Birds associated with mangroves are the reef egret, white tern, swiftlets, honeyeaters, monarchs, bridled white-eye, pigeons, parrotfinches and starlings. Monitor lizards are there as well as the large mangrove crab, smaller crabs and mollusks. Some common mangrove fishes are mullets (*Chelon*, *Valamugih*), snappers (*Lutjanus*), rabbitfishes (*Siganus*), scats (*Scatophagus*), silver batfish (*Monodactylus*), mojarras and slipmouths (*Gerres*, *Leiognathus*), cardinalfishes of many genera and, in Yap, archerfishes (*Toxotes*). A single crocodile, *Crocodylus porosus*, was once collected about 20 years ago in Pohnpei mangroves, although this species now appears to be extinct throughout the FSM.

Detailed descriptions and maps of marine environments and lists of their species by habitats and stations are contained in the coastal resources atlases and inventories of Kosrae, Pohnpei and Yap Proper. Collections, literature and personal observations show that there are over 900 species of fishes in the FSM, over 400 species of hard and soft corals and over 300 species of marine macro-algae.

1.3 Early human interactions with the environment

1.3.1 Prehistoric settlements & archaeology

The original human settlers of the Federated States of Micronesia arrived over 3000 years ago from varied founding sources. Although trade, warfare and other interactions occurred among the islands of Micronesia and perhaps with Asian sailors, recorded history and accelerated foreign impacts began with the visits of European explorers in the 16th century.

Populations

Under the Sau Daleur empire, a few centuries before the present, the island of Pohnpei was estimated to have had a population of about 25,000 (Peoples 1990). At first contact with Europeans, in 1824, Kosrae was said to have had about 5,000 native inhabitants. Archaeologists estimate that peak prehistoric populations in Yap Proper were from 26,000 to 34,000 residents, at a density of 821 to 933 people per square mile (Hunter-Anderson 1983). These pre-contact populations were concentrated in low, level coastal areas of the high islands except in Yap, where settlements and farming also occurred inland, and in the case of fortified developments sometimes located among steep slopes for defensive advantages.

Resource-use rights

Traditionally, resource-use rights on every island and for all accessible marine resources had been distributed within the populations under customary practices that varied greatly among the islands. Chiefs had great power over resources in most cases. In some islands, turtles, large catches of fish and seasonal crops would be presented to the chief for his priority use and distribution and could not be harvested without chiefly permission. Rights could be given, earned, and inherited either matrilineally or patrilineally. Complex rights overlaid actual site ownerships. For example, owners of a tree and users of its fruit might not be the owners of the land on which it grew. 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 persists in Chuuk and Yap (Marine Resources Management Division 1987).

Subsistence impacts on resources

During the more than 3,000 years in which Micronesians occupied their islands, they evolved an ecological balance with the resources they used. Lagoon, reef and pelagic fishing provided most dietary proteins, supplemented by dogs and wild birds. Pigs, deer and other large mammals did not exist in the FSM until 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 (Ayres 1990). Heavier densities of settlement in Yap in prehistoric times required extensive and intensive farming practices with relatively greater impacts on natural ecology than in other islands. It is evident that traditional uses allowed for the management and sustained availability of some resources, while others were damaged or locally eliminated. Species believed once to have existed in the FSM but no longer because of prehistoric human impacts are the sea cow or dugong (*Dugong dugon*) and the marine crocodile (*Crocodylus porosus*) which both

still persist in neighboring Palau, and easily hunted bird species such as rails. A dugong was recorded in Guam, north of the FSM in 1974, while a crocodile was killed on Pohnpei Island less than 30 years ago. The largest giant clam species *Tridacna gigas* had apparently been abundant and widespread in most islands of the FSM before human settlement. It was still being harvested in Pohnpei a thousand years ago, according to archaeologists (Streck, pers. comm.), but is currently extinct in Yap, Chuuk, Pohnpei, and most other islands.

1.3.2 Historic developments

Developments related to rapid changes in populations, ways of life, infrastructure and impacts on resources that occurred during the last century and a half because of external and colonial influences are summarized in the next three sections.

Populations

Although estimated total Micronesian populations (based on pre-European contact figures) were overall less than total present populations, their local distributions and impacts on the environment were very different. In Yap Proper, pre-contact populations and population densities were much greater than present ones. During the 19th century, rapid extreme decreases in the numbers of Micronesians were caused by introduced diseases and warfare related to new weapons and foreign-influenced power struggles. For example, Kosrae's native population plummeted from an estimated 5,000 in 1824 to fewer than 300 survivors in the 1870s. On Sapwuafik (Ngatik Atoll) in Pohnpei, the entire male population was killed by a pirate group. Rapid natural increases in populations in many islands occurred after World War II, due to improved health services and facilities, including immunization programs and antibiotics.

Colonial developments

Because they were not within early colonial trade routes across the Pacific, the islands of the FSM only had rare contact with Europeans and Americans before the 19th century, when whalers, missionaries and traders began visiting and settling on some of the islands. Spanish subjects came to enforce colonial claims, establish missions and convert Islanders to Christianity. Whalers of American and other nationalities came for food, water and services, especially in Kosrae and Pohnpei. American and British missionaries established Protestant missions; German, French, American, Belgian and other traders began trade and promotion of coconut oil, copra, bêche-de-mer, pearl shell and other items.

From 1886 to 1889, Pohnpei and Yap main islands were under Spanish resident administration, while other islands were nominally Spanish. Following its loss of the Spanish-American War in 1898, Spain sold all the islands making up the FSM (as well as the Marshalls, Northern Marianas and Palau) to Germany, which had interest in the copra trade as well as colonial expansion. Then, at the beginning of World War I in 1914, Japan invaded the islands and Germany withdrew. After that war, the League of Nations mandated these islands in 1921 to the occupying power, Japan. In World War II, mainly American military forces invaded or subdued the Japanese military and colonial powers in the islands and accomplished their surrender. The islands of the FSM were integrated with the Northern Marianas, the Marshalls and Palau by United Nations mandate to form the United Nations Trust Territory of the Pacific Islands, administered as a strategic trust by the United States after World War II.

Spanish authorities were mainly limited to the establishment of small administrative settlements in Kolonia, Pohnpei (as evidenced by the historic Spanish Wall) and Colonia, Yap with Catholic missions.

The German administration was more active in converting land to coconut plantations on all islands and registering land under a colonial system allowing ownership by the government and colonial settlers. It also introduced certain infrastructures such as canals to improve small boat transportation, subsea telegraph links from Yap to Hong Kong, improvements to harbors, docks, roads and limited health care and education services.

The FSM islands were developed by Japan for commercial gain and military defense as part of its expanding empire. Colonial settlers and Japanese military outnumbered Micronesians in the islands by the start of World War II. Agriculture and fisheries industries were developed by and for the Japanese. Infrastructure of roads, docks and harbors, power plants, water and sewage systems were constructed at areas of colonial settlement and schools, hospitals and other services were developed. Airstrips, seaplane ramps, gun emplacements, communication stations and military housing were extensively built and fortified,

with maximum military build-up at Chuuk Lagoon where the war fleet was supported by a base on Tonowas (Dublon) Island with over 30,000 military personnel.

During the American administration, starting in 1945, Japanese were repatriated, ending their commercial developments in agriculture and fisheries. Governors of the islands progressed from military officers for the first few years to appointed American civil servants under the Department of the Interior to appointed Micronesians and finally, popularly elected local leaders.

Funding from the US provided for programs in health, education, economic development and infrastructure development, which included construction of communication facilities (radio, television and satellite and cable telephone), water and sewage systems, power systems, roads, bridges, causeways, docks, harbors, airports and related facilities. Expatriate administrators, engineers, doctors, lawyers and other experts were provided while Micronesians were trained to assume their duties. Land and resources claimed by previous colonial governments were returned to local governments and individuals.

Colonial impacts on resources

The human resources of the FSM were most seriously impacted by colonial activities and the influences of early non-Micronesian visitors, as explained above. The natural resources, especially on land, were also changed by certain colonial activities. Beginning over a century ago, the colonially promoted mass development of coconut plantations for the copra trade rapidly spread to all islands, both high and low. This major trade in copra and minor trade in bêche-de-mer and pearl shell introduced the start of a monetary economy and non-traditional uses of renewable natural resources. The greatest impacts resulted from Japanese colonial developments, which included intensive agriculture such as sugar, sweet potato and rice production, fish processing using local hardwoods for fuel, salt production, paper manufacturing, and degradation of Fais Island by extensive phosphate mining. War materials including fuel and explosives were massively used and lost in Chuuk Lagoon during the sinking of the fleet. As supplies were cut off during the war, valuable trees were replaced in Chuuk by faster-producing crops which led to soil loss, and the practice of fishing with dynamite was introduced.

chapter 2 ♦

Sustained development through environmental management

2.1 Development trends

Development trends have been directed by the use of land and natural resources, capital and wealth distribution, development goals, past development activities and sources of development assistance. Most influential on the national and state governmental levels are the rapidly increasing populations and the decreasing financial support under the Compact of Free Association with the US, the treaty providing financial assistance at guaranteed annual rates for fifteen years. The major sources of employment and cash to fuel the FSM economy have been the national, state and municipal governments. This has been due to a combination of little productive employment in the private sector and relatively large amounts of funding to the government sector.

2.1.1 Population

Recent trends in population during the FSM's first decade as a new nation, starting in 1979, are the best basis of projections of future populations. The current estimated populations of each State and populations based on the census of 1979 are shown in Table 3.

Table 3 Estimated FSM populations by State

Year	Chuuk	Kosrae	Pohnpei	Yap	Total
1979	37,488	5,491	22,081	8,100	73,160
1990	49,163	7,369	33,263	10,782	100,577

Projections of populations based on current fertility and mortality rates are given in Table 4. This expresses an annual mean overall increase of 3.1 per cent. Changes in lifestyle and health services are expected to lower fertility rates and mortality rates, as shown by the table.

Migration has not been factored into these projections, and out-migration to the United States and its territories may be significant in the short term. Internal migration has not been well documented but is notable and prevails as students and working-age adults move from rural areas and outer islands to state centers. The main island of Pohnpei has over 90 per cent of the State's population, including many from the eight inhabited outer atolls. Yap Proper holds 65 per cent of the State's population, with many Outer Islanders staying there for employment and medical services. According to the Asian Development Bank report (1990), 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.

Table 4 Estimated FSM population projections by State

Year	Chuuk	Kosrae	Pohnpei	Yap	Total
1990	49,163	7,369	33,263	10,782	100,577
1991	50,549	7,513	34,228	11,019	103,309
1992	51,854	7,785	35,220	11,256	106,115
1993	53,254	8,003	36,242	11,510	109,009
1994	54,692	8,227	37,293	11,763	111,975
1995	56,169	8,425	38,386	12,034	115,014
2000	65,256	9,618	44,006	13,493	132,373

Sources Convard 1991; ADB 1990

2.1.2. Natural resources use

Land use

In the traditional subsistence economy, which remains widespread in the FSM, land is not a commodity to be sold or traded, but is deeply linked to personal and family identity and social status. This attitude towards land is gradually changing, with sales, trades and leases occurring, especially near development centers. Under the FSM Constitution, land can be owned only by its citizens, in spite of earlier ownership claims by colonial governments. Many land records from the Spanish, German and Japanese administrations have been lost or destroyed, but most people know the pre-colonial boundaries of their family lands. State land agencies are conducting cadastral surveys and registration of lands based on known ownership. Although the government has legal authority to take land by eminent domain and condemnation, it avoids using such practices (Bureau of Resources, Department of Development Services, TTPI, 1979).

The land areas of most islands are used heavily for agriculture production, mainly subsistence and copra. Copra for oil production has been the main cash crop in the FSM since colonial times. But its world price has been declining in recent years and so has its production in the FSM, despite subsidies through the Coconut Development Authority and state governments. Estimates of total production are shown in Table 5.

Table 5 Copra production, tons per year

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990
Tons	3407	3779	2384	5788	607	1774	2174	1140	2305

Practically every FSM household participates in agricultural activities, which result in production of over 60 per cent of all food consumed. About 40 per cent of the labor force is employed full-time or seasonally in farming.

The dominant agricultural use of the land is agro-forestry, which combines tree crops and shorter term crops, mostly grown near residences. Environmental impacts of agro-forestry are much lower than other developmental uses of land or more intensive kinds of farming. Spacing and mixing of species in agro-forestry without extensive monoculture or plowing reduces the impacts of pests, pesticides, erosion and changes of nutrient cycles in the soil. Freshwater wetland areas are very important for use in production of taro. In most inhabited atoll islands and low coral islands, the wetlands are exclusively planted to taro, which provides food

all year round. Extensive plantings of coconut trees as secondary vegetation and agro-forestry crops occupy much of the land which is not too steep and rocky. They persist even though the copra production for which they were planted has declined. Over 60 acres of pepper vines are under continued cultivation in Pohnpei for production of a high-priced export gourmet pepper. Pohnpei exports small amounts of bananas to Guam while Kosrae exports tangerines, oranges and limes to neighboring islands, and bananas and taro to Guam and the Marshalls. Yap betel nut is sold to neighboring islands. The quantities of exported produce are not large, probably under 1,000 tons per year, but data on amounts are lacking. Excluding the citrus trees and excess bananas and taro in Kosrae, the pepper and bananas in Pohnpei and coconuts everywhere, the majority of the remaining cash cropping is for vegetables, sakau (traditional kava drink), and betel nut for local sales. This small-scale commercial farming is carried out on high islands on small plots of land usually of less than one acre.

The secondary forest areas on many islands are being converted for residential and urban land use, especially on Pohnpei, parts of Kosrae and Weno in Chuuk. These types of land use are also encroaching on mangrove and fringing reef habitats which are being filled for these developments and on forest areas opened to access by new roads.

Interior forest lands of the high islands serve as watersheds, acting as reservoirs to supply community water needs, but they are only legally protected as watersheds in Pohnpei. Their value as such is recognized by government authorities, but individuals encroach with farming and development of residences in these areas. Forest areas include the ecological zones of primary forests, secondary forests, swamp forests, rain forests, crest forests and mangrove forests. With inclusion of agro-forests, forest land dominates the land types of the FSM. Estimates of forest areas are shown in Table 6.

It is estimated that forest makes up 56 per cent of Pohnpei land, 63 per cent of Kosrae, and 33 per cent of Yap. However, these figures include marine areas of mangrove forest and do not include many of the high islands of Chuuk and outer islands of all states.

Table 6 Forest area by land class & forest type & by State (in acres)

	<i>Chuuk</i>	<i>Kosrae</i>	<i>Pohnpei</i>	<i>Yap</i>
Forest land	2,436	17,576	48,754	9,616
Timber land	656	9,157	41,408	9,034
Steep forest	-	8,248	6,720	-
Scrub forest	108	171	626	582
Secondary vegetation	624	3,005	4,565	1,370
Agro-forestry	7,567	6,474	29,389	6,287
Forest type				
Upland	1,673	12,545	31,006	6,316
Mangroves	756	3,860	13,652	2,894
Palm	5	-	3,417	-
Plantations	2	-	15	-
Swamp	-	959	529	383
Dwarf	-	170	2	-
Atoll	-	-	15	-

Source Convard 1991

Although river water and springs are major water sources on many islands, well water and rain catchments are also widely used. Ayers and Clayshulte (1983a, b) report that even in times of severe drought (e.g. the 1983 dry season), inhabited atoll islands of the FSM had potable well water (less than 250 mg/l chloride) available for minimal needs, although rainwater catchments were dry.

Marine resources use

The FSM's marine resources are classified in the following five categories, identified by legal and practical boundaries:

- ♦ the FSM-managed Extended Economic Zone from 12 to 200 miles beyond reef edges,
- ♦ the state-managed zone from outer reef slopes below 50 fathoms to 12 miles from islands and reefs,

- ♦ the shallower reefs and lagoon areas, less than 50 fathoms depth,
- ♦ the mangrove forest areas, and
- ♦ historic and preservation areas.

Exclusive Economic Zone (EEZ)

The major resource in the EEZ is tuna. Stocks appear to be quite stable with regard to the catch rate recorded for all fishing gear types for all licensed vessels of the distant-water fishing nations. The total number of foreign tuna vessels fishing in the FSM waters in recent years has been between 400 and 500. They have been licensed from Japan, Korea, Taiwan, USA, Philippines, Indonesia, Mexico, Australia, and Solomon Islands. They consist of pole-and-line, longline and purse seine boats. Catches are shown in Table 7. The predominant catch is of surface-swimming skipjack tuna, which comprises approximately 75 per cent of the total tonnage. Longline boats target large yellowfin and bigeye tuna for sashimi markets.

Table 7 Annual estimated foreign boat catch in the FSM 200-mile EEZ (metric tonnes)

<i>Year</i>	<i>Pole-and-line</i>	<i>Longline</i>	<i>Purse seine</i>	<i>Total</i>
1979	23,000	11,320	5,200	39,529
1980	21,000	12,756	5,800	39,556
1981	12,871	16,473	29,625	58,969
1982	3,066	7,977	33,030	44,073
1983	7,291	8,729	58,218	74,298
1984	17,683	13,350	79,173	110,206
1985	5,831	13,426	43,534	62,791
1986	32,616	7,621	73,301	113,538
1987	4,555	11,455	114,188	130,198
1988	14,065	14,893	162,000	190,958
1989	22,000	13,000	120,000	155,000

Source Micronesian Maritime Authority (1991)

The MMA, which has been monitoring the catch records, has not yet imposed a quota on the amount of catch. Based on current knowledge and available data, the MMA believes the purse seine and pole-and-line catches could be substantially increased without affecting the stocks of skipjack. Yellowfin and bigeye stocks do not appear endangered but require better stock assessment. A yellowfin tagging project by the South Pacific Commission is underway to determine stock data and fisheries interactions.

12-mile Zone

The tuna stocks of the EEZ migrate through this zone. They are not allowed to be exploited by foreign boats here but fishing beyond the 12-mile limit has an unmeasured impact in this zone. Local boats fish commercially for deep-bottom fishes below the 50-fathom zone in all states for local sales and export as fresh chilled whole fish. Traditional and subsistence fisheries have not exploited these stocks. However, the highest priced snappers and groupers from this fishery occur in very restricted zones forming narrow bands on the deep slopes outside the reefs. These very limited stocks have been rapidly fished out when commercialized in neighboring islands and may not recover when overfished. Based on catch and effort data, full-time commercial exploitation of these stocks should ideally be limited to only a few boats per state.

Shallower reefs & lagoons

Throughout the FSM over 250 inshore species of finfish are harvested as food, mainly for subsistence, using numerous fishing methods. Reefs and lagoons also provide lobsters, crabs, pearl shells, trochus, giant clams, sea cucumbers, aquarium fish, sponges, black coral and stony corals. Stock levels and sustainable yields are generally unknown for these diverse resources. However, quantitative surveys in recent years in Kosrae, Pohnpei, Pohnpei Outer Islands, Yap and Yap Outer Islands have shown that pearl oysters, giant clams, spiny lobsters and exportable sea cucumber species are not abundant enough for a regular commercial fishery. The same is true for commercial wild sponges surveyed in Pohnpei. Statistics show that efforts to fish reef and lagoon species are increasing, strictly by Micronesian fishermen. Trochus was introduced to the FSM reefs as an exotic species and has become the basis of a very important wholly Micronesian fishery. Its management receives much government attention because of both its great value and overharvesting. Existing stocks of lobsters, crabs, pearl shells, giant clams, sea cucumbers, aquarium fish, sponges and black coral are all low and can be easily depleted by overharvesting. Popular reef fish such as groupers, bump-head parrotfishes and various snappers and other large fish are becoming more difficult to catch because of fishing pressure. The smaller species of giant clams, like the largest species, are approaching extinction on practically all islands.

Mangrove forest areas

The coastal mangrove forests are directly used for timber, firewood, wood for handicrafts and areas for fish and crab harvest. Indirectly they protect shorelines from erosion due to tidal currents, normal waves and any storm waves not stopped by the fringing reefs. Low seaside areas are often washed away if not protected by mangroves. The mangrove zone also traps sediments and silt eroding from land areas, to protect coral reefs and marine life from their most destructive problem around high islands. Mangroves contribute to food chains and recycle human, animal and agricultural wastes.

Historic & preservation areas

Historic sunken ships and planes, including whaling ships in Kosrae and numerous World War II Japanese craft throughout the main and outer islands, are special marine resources attractive to tourists. The fleet of over 60 sunken ships in Chuuk Lagoon, now overgrown with beautiful corals hosting attractive fishes and other life-forms, is a world-famous attraction for visiting divers. Although generally considered land areas, the ancient ruins of Nan Madol in Pohnpei and Lelu in Kosrae are actually built in intertidal areas with shallow canals traversing the artificially created islands made of huge basaltic crystal "logs".

Preserves for marine resources are lacking in the FSM. However, States have designated sanctuary areas for protection of trochus (which was introduced to most FSM islands, except Yap Proper, where it occurs naturally). Local private support for marine parks in mangrove and lagoon areas exists at Enpein in Kitti Municipality of Pohnpei and between Utwe Village and Walung Settlement in Kosrae. Pohnpei State has considered declaring Minto Reef and Oroluk Atoll, or parts of it, as marine preserves. The National Government has encouraged such action, but no means to create a national marine preserve or sanctuary has been established.

2.1.3 Income & wealth distribution

Monetary income and wealth within the FSM is largely free enterprise, with only minor government intervention through national income taxes maximizing at 10 per cent per annum of recorded income and gross receipts taxes of 3 per cent. Land is not taxed and to most Micronesians is the most valued form of wealth, as discussed previously. The Compact of Free Association provides the major source of funding for all levels of government operations. Although the Government is not active in limiting the accumulation of wealth by individuals, it supplies a very significant amount of income and in some States provides more employment than the private sector. The National, State and local governments and para-governmental authorities, agencies and corporations are major employers in the

cash economy. Preliminary results of a manpower survey carried out in February, 1990, show that about 50 per cent of the population is of working age (15 to 65 years) (Asian Development Bank 1990). Many of these people are not considered to be in the labor force because they are in schools, ill, retired or caring for relatives. However, a large proportion of the labor force is unemployed, and most of those counted in agriculture and fisheries are normally in the subsistence sector. Table 8 presents estimated employment figures in public and private sectors, by State.

Within the government, 67 per cent of people were employed in education, health and general government. Throughout the States, many families have at least one member on a government payroll. Because of phase-out of some grants and the decrease in Compact funding, a reduction of employment in the government sector may be expected, concurrent with legally required step increases in government worker salaries.

Table 8 Distribution of employment by sector, as percentages, 1989

Sector	Chuuk	Kosrae	Pohnpei	Yap	FSM
Agriculture	20	13	25	13	20
Fisheries	10	5	6	3	7
Industry	8	10	9	10	9
Government	21	32	24	32	25
Other Services	11	18	11	13	12
Unemployed	29	22	25	28	27
Total	100	100	100	100	100

In 1988, government revenues per capita in each of the States were Chuuk \$963, Kosrae \$2,213, Pohnpei, \$1,013, and Yap \$1,944, and overall, including National Government revenues, \$1,650.

Estimated Gross Domestic Product (GDP) per capita in the FSM for 1988 varied from \$996 in Chuuk to \$2,272 in Kosrae, with an overall value of \$1,447. This is calculated as the sum of consumption expenditures, plus gross capital formation, plus exports, minus imports. The Gross National Product (GNP) consists of GDP plus net property income from abroad, which is difficult to determine, but estimated at \$3,900,000 for 1988. Thus, estimated GNP that year would be \$1,564 per capita (Asian Development Bank 1990).

Cash employment and the money economy are much less available to Outer Island residents than to those in or near state centers. Outer Islanders make up 12 per cent of households in Pohnpei, 33 per cent in Yap and 31 per cent in Chuuk, outside of Chuuk Lagoon. Residents of Kosrae, Pohnpei Proper, Chuuk Lagoon and Yap Proper are able to commute easily to state centers and participate in employment there, while also benefiting from centralized amenities. Median income in dollars per week per household for these residents was calculated by FSM OPS in 1988 to be \$82.73, while that of the Outer Islands was only \$6.49. 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. All Outer Island incomes were government-related. Outer Island expenditures were mostly on food (57 per cent) — 55 per cent of this was imported.

Table 9 Per capita weekly income by State, in \$US

	<i>Money income</i>	<i>Value of subsistence consumption</i>	<i>Total</i>
Chuuk	10.25*	7.46	17.71
Kosrae	20.73	11.37	32.10
Pohnpei	16.14	8.40	24.54
Yap	34.53	14.09	48.62
FSM Total	16.36	8.98	25.34

* US federal grants for typhoon damage contributed significantly to this Chuuk income figure, which would normally be lower.

Associated with the unequal distribution of income between main and outer islands is the unequal distribution of negative impacts caused by hazardous wastes, non-degradable and bulky solid wastes, fuel spills and all forms of air pollution, water pollution and noise pollution. Natural resources are less exploited in the outer islands, especially in the case of nearshore marine resources and natural tourist attractions. The harvest of trochus provides a valuable source of cash income to mainly subsistence fishermen. Trochus shells were the number two export (14 per cent of total export values) in 1988, after tourism (53 per cent). If managed properly, and seeded to additional outer islands, trochus can provide millions of dollars to hundreds of unemployed fishermen during short harvest seasons each year. Two private trochus button factories in Pohnpei are currently adding value to this product and employing local workers.

Another area of unequal income and wealth distribution is by sex. Although women in some islands traditionally are the owners and inheritors of land, men have more employment.

The percentage of households with zero income overall in the FSM is 16.1 per cent, with Kosrae households having 4.5 per cent, Chuuk 15.3 per cent, Pohnpei 16.4 per cent and Yap 23.3 per cent. These figures from the FSM Office of Planning and Statistics reflect subsistence economy in the outer islands.

2.1.4 Development goals

Expanded private sector employment is an overriding development goal of the Government. The Second National Development Plan (1992–1996) identifies eight interrelated themes which form the basis of national, state and sectoral objectives: economic development, national unity, human resource development, efficiency in government, cultural development, equity among States and between central and rural areas, quality of life and youth.

2.1.5 Economic development

Public institutions / agencies

The FSM National Government is a constitutional democracy with a single elected national legislative body, the FSM Congress, an executive branch of government headed by the elected President and Vice-President and their appointed cabinet members, and a judicial branch represented by the FSM Supreme Court. The fourteen Congress members include one senator elected for four years from each State and ten two-year term senators elected as follows: one from Yap, one from Kosrae, three from Pohnpei, and five from Chuuk. The Congress elects the President and Vice-President from among its four-year-term members. The National Government has responsibility for foreign relations, taxes, duties, tariffs and regulation of immigration, foreign investment, interstate commerce, banking, navigation, health, shipping, harmful substances control and natural resources in the EEZ. It distributes income and aid among the States.

The National Department of Resources and Development holds national governmental responsibility for economic development. It comprises the following sectors: agriculture (includes forestry); marine resources (includes aquaculture and coastal resources management); commerce and industry (includes tourism); labor; energy; and minerals. It also registers corporations and foreign investors and serves as staff for the Investment Development Fund Committee.

The National Fisheries Corporation was established to develop commercial large-scale fisheries and fish processing. It is governed by a board of directors

representing all States and is administered by a Chief Executive Officer and President. It targets joint-venture operations in tuna longlining and tuna purse seining and onshore support and processing of tuna.

The Coconut Development Authority assists nationwide in marketing copra and transporting it to markets from production areas throughout the islands. It applies subsidies approved by Congress and seeks development of alternative, value-added products from coconuts such as oil, soap and coconut milk.

State Governments also have the same three branches as the National Government with a popularly elected Governor and Lieutenant Governor heading the executive, and legislatures of senators (and a House of Representatives in Chuuk) elected for two-year terms. State courts have jurisdiction over non-national matters. Control of public funds and promotion of health, education and law enforcement have concurrent state and nationwide jurisdictions.

Within Kosrae State Government, economic development activities are supported by the Department of Conservation and Development, with responsibilities for agriculture, forestry, marine resources, energy, tourism, industry and commerce.

Pohnpei State has within its executive branch of government a Department of Conservation and Resources Surveillance which promotes development through its Divisions of Agriculture, Forestry, Marine Resources, Energy, and Economic Development. The Pohnpei State Tourism Commission deals with state tourism development. The Pohnpei State Economic Development Authority (EDA) concentrates on the implementation of fisheries development, but is also responsible for other economic development sectors. It answers to a board and has been active in manufacturing (zori factory), seaweed farming for export, aquarium supplies (fish and coral) and others. It has entered into joint ventures in tuna purse seining, provides shoreside services for tuna transshipping and is building a large fish processing facility. The Land Department of Pohnpei State administers State land and leases for commercial uses.

The Chuuk Department of Commerce and Industry was formed in 1990 along with the Department of Marine Resources and the Department of Agriculture. These departments had previously been united in the Department of Resources and Development. The Chuuk Maritime Authority, which has been active in aquaculture and fisheries development as well as resources management (it retains a team of Conservation officers), was incorporated into the new Department of Marine Resources. The Chuuk Visitors Bureau, separate from State Government agencies, promotes tourism for Chuuk State.

Yap State's Department of Resources and Development has responsibility for agriculture, forestry, tourism, industry and general economic development.

Table 10 FSM & State resource & environmental protection departments

Government/Department	Responsibilities		
	Development	Research	Management
FSM			
Dept Resources & Development	X	X	X
Marine Resources Division	X	X	X
Agriculture Division	X	X	X
Commerce & Industry Division	X	X	X
Department of Social Services	X	X	X
Attorney General			X
Micronesia Maritime Authority		X	X
Administrative Services-HPO	X	X	X
Pohnpei State			
Department of Conservation & Resources Surveillance	X	X	X
Marine Resources Division	X	X	X
Forestry Division	X	X	X
Agriculture Division	X	X	X
Department of Health	X	X	X
Historic Preservation Office		X	X

Table continued over-page

Government/Department	Responsibilities		
	Development	Research	Management
Chuuk State			
Department of Marine Resources	X	X	X
Department of Agriculture	X	X	
Department of Health Services	X	X	X
Historic Preservation Office	X	X	X
Kosrae State			
Department of Conservation & Development	X	X	X
Marine Resources Division	X	X	X
Agriculture & Forestry Division	X	X	
Historic Preservation Office	X	X	X
Department of Health Services	X	X	X
Yap State			
Environmental Protection Agency		X	X
Department of Resources & Development	X	X	X
Marine Resources Management	X	X	X
Agriculture & Forestry Division	X	X	
Historic Preservation Office		X	

Infrastructure

Infrastructure is considered here to include public facilities of power generation and distribution, water treatment and supply, wastewater collection and disposal, and also development-related structures such as roads, harbors and docks, airstrips and communication facilities.

Electricity consumers have only been recorded in two States: Kosrae 773 (1986) and 1,105 (1989); and Pohnpei 1,776 (1988). In spite of this lack of consumer records, the majority of households on Kosrae, Pohnpei, Yap Proper and Weno

Islands have electricity, which is supplied and subsidized by the government. Power is provided by diesel generators, except for a small hydropower station on Pohnpei. Rainwater catchment on houses and community structures, without distribution systems, is common in outer islands and rural settlements in all States and even in developed centers as a supplement to central water supplies. In Kosrae, government water systems individually supply surface water from streams and small reservoirs to Utwe, Malem, Tofol, Lelu, East and West Tafunsak and Walung communities. Chlorination treatment is applied only at the Tofol system. Pohnpei's water production is mainly through surface water, although some wells around Kolonia supplement the main river water source. The FSM Capitol at Palikir has its own well-water system. Weno's water system is supplied by wells supplemented with river water. Other high islands in Chuuk Lagoon have small springwater-supplied systems for individual settlements and utilize private wells. Yap Proper has widely distributed well systems and a central surface water reservoir. A United Nations-supported project for water supply planning and development is just beginning and should improve water supply.

Individual water-sealed toilets are promoted in most rural locations, while central sewage treatment plants with collection systems and ocean discharges are established in Colonia, Weno and Kolonia. Lelu, Kosrae, has a collection system from family septic tanks to a deep outfall, while Tofol, Kosrae, has oxidation ponds discharging to a river. The FSM Capitol has a large septic tank sewage system with temporary mound leaching field disposal.

Transportation infrastructure consists of roads, harbors, docks and airports. Coastal roads have encircled Pohnpei, Weno, Tonowas, and Fefan Islands in the last two decades. Kosrae's circumferential road is mostly completed. Major roads on Pohnpei, Weno, Yap Proper and Kosrae are partially paved with continuous expansion of paving occurring in Kosrae and Pohnpei.

There are harbors and commercial ports in Colonia, Yap; Weno and Tonowas, Chuuk; Kolonia, Pohnpei; and Lelu and Okat, Kosrae. These are able to handle container ships over 400 feet long as well as the largest tropical fishing vessels.

Major air fields in Kosrae, Pohnpei, Chuuk and Yap daily service Air Micronesia 727 jets. Additional small craft landing strips have been built on Pingelap and Mwoilloa in Pohnpei, Ta and Ulul in Chuuk Outer Islands and Fais, Ulithi and Woleai in Yap Outer Islands.

Communications are dominated by the FSM Telecommunications Corporation, which operates local phone lines and overseas satellite linkages. Fiber optic cables are being installed underground in Pohnpei, and outer islands have solar-powered radio systems. Commercial cable TV is used in Pohnpei while a government station broadcasts over the air in Yap.

Projects

Projects are being drawn up in the draft Second National Development Plan, but other significant projects are also being planned or implemented.

Chuuk Fresh Tuna Inc. is developing a longline fishing base at the main dock of Weno. This is to handle at least 1,000 port calls a year of local and distant-water fishing nation (foreign) tuna longliners transshipping fresh yellowfin and bigeye tuna by air to Japan. Capital costs are expected to be over \$8,000,000 for shoreside support facilities. A similar facility is planned for the fishing dock area in Colonia, Yap. Pohnpei constructed a fish processing plant to process over ten tons per day, associated with an improved longline transshipping operation similar to Chuuk's. Kosrae is constructing a 3,000 ton cold store for tuna to supply a future cannery there. The EIS for this has not yet been completed, but this will be one of the largest development projects in FSM in the near future and will have significant impacts. It can generate large quantities of pollutants which would not arise from the other tuna transshipping projects.

Sources of assistance

Finance for development is available in the FSM at special low interest rates and attractive conditions for repayment from the FSM Development Bank (FSM DB), the Asian Development Bank (ADB), and the Compact of Free Association's Investment Development Fund (IDF). The IDF has \$20 million available with a possible additional amount not exceeding \$40 million. It is provided by the US Government as a mitigation for unilateral changes in the Compact of Free Association imposed by the US Congress on the FSM. It is administered by the Federal Development Authority, consisting of the President and the four State Governors, with technical assistance from the FSM DB and the National Department of Resources and Development. Its funds are available for large (over \$250,000) loans for development projects that have a relation to the US economy, for example, joint ventures of US and FSM partners.

Additionally, commercial loans are available from the Bank of the FSM, the Bank of Guam and the Bank of Hawaii, through their local offices. These three commercial banks had deposits of about \$45 million in the FSM before 1990, while the ADB began making funds available to FSM in 1991. The FSM DB had assets of \$37.7 million in April, 1991. As of May 25, 1991, it had a total amount of \$17.9 million approved for direct and guaranty loans, \$.4 million in equity investment and \$.5 million in old EDLF accounts set up before independence.

Under the Compact, the FSM receives economic assistance amounting to over \$100 million per year for 15 years, until the year 2001. This makes up the major part of government revenue. Table 11 summarizes revenues and expenditures in 1988.

The annual US Compact of Free Association base grant will provide a total of \$51 million annually from 1992 until 1997 to the FSM for government operations (down from \$60 million per annum 1986-1991) and will decrease this to \$40 million annually between 1998 and 2002. The Compact basic block grant earmarks at least 40 per cent of the total grant each year for capital projects. This amounts to not less than \$20.4 million per year for the next five years. This will decrease, as the total grant decreases, to at least \$16 million annually from 1998 until 2002.

Table 11 Government budgets for 1988 (in \$'000)

	National	Chuuk	Kosrae	Pohnpei	Yap	Total
Revenue	48,053	48,800	15,442	32,372	20,399	165,066
Expenditure	26,490	37,690	12,522	24,257	14,502	115,461
Balance	21,563	11,110	2,920	8,115	5,897	49,605

Source ADB 1990

A "medium-term note program" is available to the FSM States. This provides development funds, under agreements with US banks, which are to be repaid by October, 2001. These are guaranteed by a pledge of a portion of the Compact funds if the projects supported by the notes do not generate sufficient income to repay capital and interest. This could eliminate some of the future Compact revenue if projects are not successful. The Pohnpei EDA fish processing facility is an example of a development project funded by such a note.

Private sector

Government-initiated and subsidized agencies and companies, operated somewhat independently of the governments and similar to private companies, are described under the above section on public institutions/agencies.

Purely non-governmental companies playing a significant role in economic development include:

- ◆ Continental Air Micronesia, providing the only international air service to and from the four States. It is the major carrier for tourists entering FSM and provides limited air cargo space for exports and imports.
- ◆ Mobil Oil, presently the sole supplier of fuel to FSM, with its own storage tanks in Yap, Pohnpei and Chuuk and providing regular tanker ship delivery of gasoline, kerosene diesel fuel and small amounts of other petroleum products;

- ♦ United Micronesia Development Authority, which has invested in the transportation, communication and commerce sectors;
- ♦ The Bank of the FSM, a domestic commercial bank with total assets of nearly \$18 million. In FY 1990 it had \$8.3 million in consumer loans at 15 per cent interest and \$1.8 million in commercial loans at an average of under 12.5 per cent interest (ADB 1990).

The small businesses that make up most of the FSM private sector are mostly service rather than production oriented. They lack skilled staff, especially in the managerial area. They include import, export, wholesale, retail, car rental, taxis, restaurants, hotels, construction firms etc. in all four States. Practically the only productive industries in the private sector are coconut oil and soap manufacturing, clothing manufacturing from imported textiles (employing several hundred Sri Lankans in Yap and planned for Pohnpei and Chuuk) and pepper processing and trochus button manufacturing in Pohnpei. Processing of privately raised poultry has increased with government support in Pohnpei and will be extended to other States.

Tourism is developing, with emphasis on diving. Two joint-venture live-aboard dive boats are based at Chuuk Lagoon, while hotels and smaller dive boats service thousands of scuba-diving visitors each year in all four States.

2.2 Major environmental impacts

Environmental impacts are caused by natural as well as human sources, as discussed below. They can be positive, as noted in 2.2.2., but are of most concern when they are major, negative and able to be controlled or prevented. Some impacts are cumulative, building up gradually and very slowly over many years. These pervasive impacts are often based on population density increases and are not easily measured by environmental parameters. But they can eventually trigger losses of resources and productivity or even disease epidemics and other dangers to human health. Within the FSM, the distribution of human-caused impacts of development, like economic development itself, shows a concentration in state centers, where populations, infrastructure, employment and construction are clustered.

On a global scale, human impacts are believed to be contributing to climate change. This can greatly impact on the FSM through sea level rise and increased and more violent storms.

2.2.1 Negative impacts of development

In localized situations, developments can completely and directly eliminate resources and habitats; for example, when mangrove areas are filled to create dry land or when native forests are replaced by coconut plantations. In all FSM States, much of the natural forest land has been replaced by secondary vegetation and agriculture, while some, especially mangroves, has been cut and other forests lost due to human-caused fires, erosion and soil depletion. Yap and Pohnpei both have extensive areas, formerly forested, where the soil has been degraded so that only savannahs, grass and species of little value persist.

Interference with ecological processes such as interruption of nutrient cycles in land vegetation and soils, or migration of spawning aquatic species, or preventing sunlight from reaching coral because of increased turbidity, etc., are more difficult to identify, but are occurring widely. Likewise, chronic poisoning (leaks from fuel storage, pipelines, pesticides, fertilizer, sewage lines, sunken ships, etc.) is not readily detected until damage has occurred. Another indirect impact may occur when reef habitat change leads to ciguatera fish poisoning.

In the long term, loss of unique genetic resources and endangered species is a very serious problem. Species declining or even threatened with extinction are only partly known for the FSM. The current legally recognized endangered species (under the TTPI laws inherited by the FSM) are shown in Table 12.

Table 12 Endangered species of the FSM

Common name	Scientific name	Range in the FSM
Dugong (sea cow)	<i>Dugong dugon</i>	Straggler
Blue whale	<i>Balaenoptera musculus</i>	All seas
Sperm whale	<i>Physeter catodon</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 kraemeri</i>	Tol, Chuuk

Among those with limited habitats and numbers in decline due to overharvest or loss of critical habitat are some traditionally very important food species such as sea turtles, coconut crabs, mangrove crabs, giant clams, bump-headed parrotfish and native pigeons. Less important foods that are also locally threatened include fruit bats and many forest birds and reef fishes. The nipa palms for roof thatching and certain hardwood trees used for construction are being lost to harvesting without reforestation and to changes in land use.

2.2.2 Positive impacts of development

In attaining economic goals through development, certain positive impacts on the FSM environment will be realized. In general, the desired sustainable development with minimum negative environmental changes can allow for improved health, well-being and improved living conditions. Providing more citizens with cash income through employment means that they have the freedom to improve their personal living conditions and better care for their children's health, education and development. Certain types of economic development directly and indirectly enhance the environment. Expanded local production of foods and goods can decrease the importation of such items, with related decreases in solid waste generation (from packaging) and oil pollution from transportation of imports. The expansion of tourism as a clean industry that promotes environmental quality and supports preservation of natural and cultural resources can bring many positive impacts. It not only makes residents aware of the beauty, uniqueness and value of their present resources, but also ties protection and sustainability to a means of cash income.

2.3 Specific causes of threats & negative impacts

Scientists and technicians generally accept that global climate changes are being accelerated by worldwide human-influenced emissions of carbon dioxide, methane, chlorofluorocarbons and other chemicals into the environment. Resulting climate changes in the FSM are uncertain but according to some predictions, global temperatures can be expected to increase 1 to 2 degrees Centigrade during the next human generation. Depending upon what regional cloud effects and weather changes occur, expanding seawater volumes and perhaps melting of polar ice are expected to cause a sea level rise of 15 to 30 centimeters (six to twelve inches) before the year 2030. Some scientists predict an even larger and more rapid increase in temperatures and sea levels.

If the sea level rises as predicted, the atoll islands of the FSM will become practically uninhabitable by the middle of the next century. Their freshwater lenses will be destroyed, with subsequent killing of vegetation critical to subsistence, such

as taro and breadfruit. Also, they will be more susceptible to storm damage, with waves sweeping over the islands and destroying parts of them or even wiping out entire islands. Even on high islands, coastal flooding would be disastrous, since most settlements, infrastructure and development and most farming and food production is concentrated in low coastal areas. Coastal erosion would increase, even if flooding were not occurring, mangroves may decrease and salt intrusion into groundwater would impact on high island vegetation and water supplies. If farming and settlements responded by moving inland, development of sloped raised lands would cause erosion with siltation of rivers and coastal waters. A temperature increase would increase human discomfort from heat and humidity so that developed areas would need to increase air conditioning and energy consumption. Shallow reef-building corals are living in water temperatures near to their maximum tolerance levels. Increased temperatures would stress corals and could prevent reef growth and maintenance. Changes in weather could increase precipitation and even storm occurrence and could change ocean currents and marine productivity.

Typhoons can produce extreme damage to terrestrial and marine environments, as well as endangering humans and their developments. High winds in a super typhoon reach over 150 knots, blowing away much vegetation and even coconut trees. Salt spray damages vegetation even in the interior of islands. Storm waves flood coastal areas of high islands and can completely inundate low ones. Extensive wave damage to coral reefs can occur down to a depth of 20 meters. Blocks of coral reef weighing many tons are hydraulically plucked from submerged areas and tossed on top of shallow reef platforms or shorelines, just as ships may be stranded by storm-generated waves.

Tsunamis are not expected to be a threat to the islands of the FSM because sea bottom slopes around all the islands are shaped by the coral reefs in such a way that they do not allow tsunamis to build up to threatening and damaging proportions at the shorelines. The earthquakes which trigger tsunamis are more likely to occur in the far west of the FSM near Yap Proper, but are extremely rare in the rest of the country.

Oil spills could occur in the FSM from accidents involving any of the thousands of trips made each year by the fishing boats and cargo ships plying its waters. Those international ships using FSM ports comply with insurance and legal responsibilities to cover spills they cause; although the FSM has not joined international conventions regarding pollution controls on shipping, the countries which flag these ships see to compliance with such conventions. The MMA requires all foreign fishing boats it licenses to have oil spill liability insurance, whether or not they use local ports. The Department of Transportation has responsibility for safety and inspection of the state-operated field trip ships.

Oil spills and releases of other hazardous or toxic wastes could occur at sea without the knowledge of local officials and drift to areas where they would create serious impacts. No large-scale transfer of hazardous materials besides that by oil tankers and perhaps military ships on the high seas are known of or planned for FSM waters. However, international shipping routes and fisheries patterns bring considerable sea traffic through its waters.

War materials with extreme toxicity are being incinerated at Johnston Atoll by the US military, who have also contaminated the northern Marshall Islands with radioactivity from nuclear weapon testing. Proposals have been made for imported solid waste and even nuclear waste storage and disposal in the Marshalls. Unfortunately, the FSM is downwind and downstream of these sites and has no authority to control them. The South Pacific Forum has called for a closing down of the Johnston Atoll Chemical Agent Disposal System once its current operations are completed. The US Congress and Federal Government have no intention of operating this facility after finishing the current program in 1994 and US law requires that it be dismantled. However, US legislators and officials are known to change policies and laws, especially in defense matters.

Within the boundaries of the FSM, environmental damage is generated from many sources. Local intensive land use and urbanization contaminates land and coastal waters with gasoline, lubricating oils, asphaltic oil, PCBs, chlorine and sewage sludge. Crop production releases pesticides and fertilizers imported by State agriculture departments and many small wholesalers. Livestock production generates manure disposal problems. Processing of crops, meat and fish creates high BOD, organic wastes, and contamination by fuel, freon, ammonia and cleaning chemicals. Timber production destroys natural ecosystems, lowers diversity and contributes to soil erosion and water turbidity, as do fires. Proposed pond aquaculture would add nutrients and turbidity to water from wastes and unused feed. Industrial fishing wastes much by-catch, while smaller-scale fishing overfishes some stocks and creates oil spills. Destructive fishing with explosives and poisons is done on a small scale, with long-term habitat damage. Dredging and sand mining on shores and in lagoons have significantly damaged local marine environments. The unique situation of a fleet of World War II warships on the bottom of Chuuk Lagoon threatens the world-reknowned beauty of the lagoon with hundreds of tons of deteriorating explosives and chemicals. Controlling dust on roads with waste oil and dumping of hazardous wastes (old medicines, chlorine containers, POL containers and POL tank bottom sediments with lead sludge) in local landfills should be stopped. Disposal of hazardous wastes should be done at suitable facilities outside the country. In rural areas, bacterial and soap contamination from toilets, washing clothes and dishes and bathing is threatening wells and contaminating groundwater.

2.4 Constraints to sustainable development

Environmental concerns must be closely integrated with economic development to ensure sustainability, but constraints to this integration are prevalent in the FSM and include:

- ◆ Lack of infrastructure to match development and population growth
- ◆ Lack of resource assessment
- ◆ Lack of a specific or even general understanding of the environment
- ◆ Lack of news coverage and information dissemination
- ◆ Lack of a management plan for sustainable development
- ◆ Lack of trained and skilled officials
- ◆ Lack of coordination and cooperation in resource management and environmental protection
- ◆ Lack of controls on land and resource use
- ◆ Lack of controls on adjacent international waters
- ◆ Priority on urgent employment and short-term development objectives
- ◆ Priority on political spending rather than support of sustainable development projects (including construction costs over maintenance)
- ◆ Transfer of authority to the States for environmental protection
- ◆ Lack of definition of State and National roles in environmental matters.

The basic education which can support sustainable economic development is inadequate in the FSM. Teaching is often of poor quality, curricula are inappropriate with respect to job opportunities and public schools are not able to accommodate all students and lack maintenance. Meanwhile, the US grants which have been significant in education budgets are expected to decrease while student populations will increase by 25 per cent in the next decade (ADB 1990).

The general public has day-to-day survival needs dominating its activities. Idealists and planners may call for self-reliance, but in reality, only exceptional citizens would be satisfied with increased self-reliance in their lifestyle. According to Petersen (1979), villagers in Pohnpei are not interested in adequate subsistence, nor even "the right to subsistence", instead they want "continued and increased access to the goods and prestige provided by employment". Most of the FSM public supports development in the belief that it will lead to more wealth or material benefits for individuals. But few will question whether immediate benefits interfere with long-term ones to be protected through environmental management for sustainable development. Especially in the increase in aquatic pollution and

pressures on publicly owned marine resources, management for long-term benefit is much less emphasized than the immediate benefits of economic development.

chapter 3 ♦

Responses to environmental issues

Responses to environmental issues have arisen in the FSM through the National Government and Congress, the State Governments and legislatures, municipal governments, non-governmental organizations and individuals, as noted below.

3.1 Environmental legislation & regulations

The National Constitution of the Federated States of Micronesia, adopted in 1979 and amended in 1991, is the basis for legal authority and decision making in the nation. Laws and regulations to control and protect natural resources and the environment have been established at both national and state levels in the FSM. Recent amendments to the Constitution in 1991 transferred more environmental protection authority to the States. At the national level, the FSM has acceded to the UN Law of the Sea Treaty and regional South Pacific conventions on the environment. Under the Constitution, the National Government is responsible for control of radioactive and hazardous waste. Former Trust Territory laws regarding the environment remain in effect until they are replaced or repealed by FSM laws.

(Regulations are a widely accepted and useful form of environmental control and resource management. They can be more easily changed than laws, to allow for urgent action. They can be flexible enough to be modified or expanded as needed to obtain best results. Besides the following nationwide regulations, others exist at state and municipal levels to protect quality of life.)

FSM Environmental Laws & Regulations

Constitution

- Article IX. Section 2 (g): Congress has the power to control foreign and interstate commerce;
 Section 2 (h): power to regulate navigation and shipping except within lagoons, lakes and rivers;
 Section 2 (m). power to regulate natural resources beyond the 12-mile limit;
 Section 3 (c): power to promote health, concurrently with the States.
- Article XII. Section XIII: Congress has the power to regulate radioactive, toxic chemical or other harmful substances.

Statutes within the FSM code of laws

- Title 23. Chapter 1 (as amended by PL 4-71): Marine Species Preservation
 Chapter 3: Endangered Species Act
- Title 25. (as amended by PL 3-83 and PL 5-21): Environmental Protection
- Title 28. International Trade (not currently applied, but could be used for future regulation)
- Title 41. Section 601: regulates disposal of human excreta;
 Section 602: regulates rubbish.

Regulations

- Disposition of Human Remains (Sept. 1, 1971)
 Ship Sanitation (Sept. 15, 1974)
 Endangered Species (Dec. 4, 1976)
 Toilet Facilities and Sewage Disposal (Jan. 31, 1977)
 Solid Waste (April 12, 1979)
 Air Pollution (June 25, 1980)
 Pesticides (Aug. 1, 1980)
 Public Water Supply Systems (Feb. 1, 1983)
 Marine and Fresh Water Quality Standards (March 31, 1986)
 Earthmoving Regulations (Nov. 7, 1988) (Replaced: Control of Earthmoving and Sedimentation (Oct. 29, 1976)
 Environmental Impact Assessment (Feb. 1, 1989)

3.2 Government policies

On January 29, 1991, President John R. Hagelgam established the FSM Presidential Task Force on Environmental Management and Sustainable Development (EMSD) to oversee the preparation of a Nationwide Environmental Management Strategy (NEMS) for the nation. Members of the Task Force include the Secretary of the Department of Human Resources as Chairman, the National Planner, elected Vice-Chairman, the Attorney General, the Secretary of the Department of Resources and Development, the Secretary of the Department of Finance, the Secretary of External Affairs and the following four representatives appointed by the Governor of each State: the Chuuk Director of the Department of Commerce and Industry, the Kosrae Director of the Department of Health, the Pohnpei Chief of Environmental Health and Sanitation and an official who is a member of the Yap Environmental Protection Authority. They are to develop nationwide policy on matters of the environment and sustainable development.

The States have numerous diverse policies related to the environment and sustainable development.

3.3 Institutions

3.3.1 National institutions

The national Department of Human Resources coordinates health services involving more than one State and external assistance related to health and the environment. It has the single position of an Environmental Health Coordinator with responsibilities for all environmental protection at the national level. The Administrators of Marine Resources and of Agriculture in the Department of Resources and Development carry out some resource management and conservation responsibilities including coastal resources management and quarantine operations, respectively. The living resources of the 200-mile EEZ are managed by the Micronesian Maritime Authority under its national level board.

3.3.2 State Government institutions

Yap State's environmental protection program is administered by its Environmental Protection Authority. The other States keep environmental regulatory responsibilities within the Environmental Health and Sanitation Division of the Department of Health Services. Although the new Chuuk State Constitution calls for the establishment of a cabinet-level environmental department, this has been delayed for lack of funding. These state offices regulate water quality, earthmoving, pesticides, solid waste disposal, air pollution and drinking water. State agencies

responsible for natural resources management and conservation are the Kosrae Department of Conservation and Development, Pohnpei Department of Conservation and Resources Surveillance, Chuuk Departments of Marine Resources and Agriculture and Yap Department of Resources and Development.

3.3.3 Municipal & sub-state governmental institutions

Governments of municipalities (of which Kosrae has 4, Pohnpei 10, Chuuk 40 and Yap 15), development authorities and councils of chiefs have the ability to deal with natural resources and environmental conditions on a limited basis, but provide forums that can be more appropriate and closer to local public concerns than higher governmental levels.

3.3.4 Private sector institutions

Two key Micronesia-based internal non-governmental organizations (NGOs) that work with environmental concerns are the Yap Institute of Natural Science in Colonia, Yap, and Micronesia Islands Conservation, centered at the Community College of Micronesia in Pohnpei. Local church, community, youth, women's, farmers', fishermen's, tourism and commerce groups and service organizations can play a future role in environmental protection and sustainable development.

3.3.5 Regional institutions

The FSM is a member of the South Pacific Regional Environmental Programme, the South Pacific Commission, the South Pacific Applied Geoscience Commission, the South Pacific Forum, the Forum Fisheries Agency, the Alliance of Small Island States, the World Health Organization, the Economic and Social Commission for Asia and the Pacific, the Asian Development Bank, UNESCO, and other organizations concerned with the environment and natural resources.

3.4 Specific programs & projects

3.4.1 Planning

National and State Governments produce and implement five-year development plans and also plans of narrower scope which include environmental management and sustainable development activities. Annual appropriations are to conform to approved plans.

3.4.2 Infrastructure

In capital improvement programs, the FSM Governments set high priorities on creating infrastructure which controls sources of environmental damage, such as sewer and water systems, stormwater drainage and sanitary landfills.

3.4.3 Resource management

Resource management activities are undertaken on the national level in the marine 200-mile zone through licensing of fishing by the Micronesian Maritime Authority and enforcement of fishery laws by the Attorney General. On the state level, terrestrial and inshore resources are managed for the public good by the Departments listed in Table 10.

3.4.4 Resource enhancement

Certain projects are being undertaken or planned in the FSM to enhance valuable natural resources including marine resources, forests and soils.

Trochus or top shell has been introduced to the reefs of most islands and atolls of the FSM and has become a valuable source of food and cash income. A current project in Pohnpei is spawning trochus at the Lenger Island Aquaculture Hatchery to produce hundreds of thousands of young for seeding reefs whose trochus has been overharvested. Chuuk and Kosrae plan to establish similar trochus enhancement projects when it is shown that the Pohnpei efforts are capable of success. A very valuable species with similar biology and ecology to trochus, the green snail, *Turbo marmorata*, can be spawned at the trochus hatcheries and is planned for reef seeding in the future when its spawning technology is transferred from Okinawa.

The technology to artificially spawn giant clams of seven species of the family Tridacnidae has been developed at the Micronesian Mariculture Demonstration Center in Palau and transferred to the hatcheries in Pohnpei and Kosrae. These facilities plan to produce hundreds of thousands of clam seeds to allow stocking of reefs throughout the FSM.

Another marine species with great importance as subsistence food, the green sea turtle, *Chelonia mydas*, is periodically assisted by local programs to try to increase the survival of its young in outer island nesting sites in Pohnpei and Yap. Most turtles are killed by natural predators such as fish, crabs and birds during their first days after hatching. By penning and feeding hatchlings and protecting them from predators until they are a few months old and too big to be killed by most predators, Marine Resources staff and local fishermen hope to increase turtle stocks.

Culture of native pearl oyster (*Pinctada margaritifera*) to seed and grow black pearls artificially is being undertaken as a pilot project by Pohnpei State Marine Resources through collecting of spat or young oysters settling out of the plankton in lagoons. Good substrate needed by the young oysters is provided by hanging plastic spat collectors; those that settle and survive on the collectors are available for seeding. By this method, wild stock of oysters can be left unharvested and wild as well as cultured shells can contribute increases to the stocks.

Similarly, commercial sponges (*Spongia officinalis*) are being cultured in Pohnpei Lagoon. The plan is to establish farms with seed produced from original wild stock, so that all commercially harvested sponges will be from renewable colonies. Wild stock will no longer be harvested for commercial sale. This same approach is planned for development in the other States including outer islands.

In Pohnpei, staff of the Community College of Micronesia are undertaking to plant branches of fast-growing corals in barren lagoon areas, to increase valuable habitats for reef fishes and mitigate damage from dredging or other developments.

Enhancement of forest resources, including mangroves, is accomplished by planting of seedlings.

Enhancement and protection of soils is accomplished by planting protective ground covers and recycling organic wastes by composting, mulching and using locally generated fertilizers. Construction projects have planted grasses and trees to protect exposed soils at many specific sites, such as the new Capitol area. Individual farmers are improving their garden soils by adding green manure (unused crops) and livestock manure.

chapter 4 ♦

Future priorities

Production of this report and implementation of its recommendations, and the recommendations of the United Nations Conference on Environment and Development (UNCED) in 1992, should assist the FSM to set its priorities for improving institutions, making policies, developing and implementing programs, providing training and producing laws, regulations and controls for better environmental management and sustained development. Some suggestions for these priority actions follow.

4.1 Institutional priorities

- ♦ Increase environmental planning capabilities in the State and National Offices of Planning and Statistics.
- ♦ Establish coastal resources management or environmental management for sustainable development programs.
- ♦ Address sea level rise in disaster control planning.
- ♦ Coordinate activities in planning, development, environmental and historic protection and resources management across regional, national, state and local levels.

4.2 Policy priorities

- ♦ Create new laws for endangered species and critical habitats.
- ♦ Require all developments, government and private, to have EIA and environmental cost/benefit evaluation early in the planning process; connect compliance with provision of utilities and with issuance of Foreign Investment Permits.
- ♦ Participate in SPREP programs, including the Marine Pollution Emergency Contingency Plan, the Regional Marine Turtle Conservation Programme, and others.

- ◆ Make a declaration to the United Nations that FSM will join the Organization of Small Island States.
- ◆ Address impacts of climate change, including the following:
 - Plan for relocation of residents of low coastal areas and atolls/low islands and plan for any other emergencies due to sea level rise when designing drainage, coastal structures and supporting infrastructure.
 - Maintain ability to migrate to US and to access US Federal Emergency Management Act assistance.
 - Obtain international recognition for the EEZ not changing in spite of any sea level rises
 - Through FSM participation in UNCFD in 1992, press on all nations their responsibilities to decrease causes of climate change and sea level rise.

4.3 Program priorities

New internal programs may be initiated in addition to the continuation and strengthening of many of those addressed above. The following should be considered either as programs or projects.

- ◆ Establish a comprehensive program of coastal resources management at state and national levels. It could address most of the problems related to environmental management and sustained development. Under recently re-enacted US coastal management laws, the FSM could qualify for assistance to develop a nationwide coastal resources management plan which would lead to funding at least over the next decade to implement a flexible program to include environmental planning, EIA, education, technical training, resource assessment, monitoring, regulation and enforcement support, based on public input and understanding and state-level operations.
- ◆ Identify endangered species, biodiversity characteristics and critical habitats.
- ◆ Establish a program to implement the response options recommended by the SPREP in-depth study of potential impact of expected climatic changes on the natural environment and the socio-economic structures and activities of the FSM.
- ◆ Establish a program of biological monitoring of select habitats for endangered species, biological diversity and other criteria of resource quality.
- ◆ Develop and implement standardized inshore marine resources management laws and regulations to be implemented by the States with assistance and advice

from national officials. The proposed Asian Development Bank FSM Fisheries Program, if implemented, may provide support for initiating this.

- ◆ Extend the USGS water resources activities to the FSM to provide applied research in water resources through the University of Guam Water and Energy Research Institute. National R&D Department and Human Resources Department staff must plan and coordinate with the States for priorities in these activities.
- ◆ Plan with international and national assistance to solve power, water, solid waste disposal and sewage disposal needs, with long-term objectives of reducing dependence on imported fuel and expertise.

New appropriate facilities should be constructed with local funds, loans and bonds, while existing public infrastructures should be hardened against threats of natural disasters. The Omnibus Insular Areas Act of 1991 of the US Congress authorises appropriations to meet some of these needs in the FSM.

- ◆ Investigate water-borne diseases and undertake prevention and treatment activities with World Health Organization support.

Some of the existing programs to be built on include:

- ◆ The computerized standardized database of the state and national Historic Preservation Program should be expanded to include all natural resources and environmental management data, similar to a computerized geographic information system.
- ◆ The agriculture extension services in place in all States can be better utilized for educating the public and obtaining public input to government plans and activities in resources management. They can begin to include more conservation and aquaculture activities. The Soil Conservation Program can contribute much support to erosion control aspects and planning for best agricultural practices.
- ◆ State conservation programs can be expanded with more staff and better training provided through the RETA Project.
- ◆ The existing state trochus sanctuaries can be reorganized and expanded in scope in certain areas to establish exclusion of commercial fisheries, designation of preserves. In Kosrae and Pohnpei, the State Governments can designate public submerged land areas for particular uses such as dredging, deep ship channels, preserves, aquaculture areas and can allow overlapping uses in some sites such as recreational fishing and diving, low-intensity mariculture and preservation, etc. This could be approached as a zoning system for public submerged lands with its development incorporated with Coastal Resources Management Programs in each State.
- ◆ Physical and economic development planning should continue and be provided with improved expertise and more staff, while incorporating increased

sustainable development and environmental management principles. Implementation of the already planned public projects including construction of roads, airstrips, ports, water and wastewater systems and power and telecommunication systems should follow these principles.

4.4 Training priorities

The environment overall belongs to the public and it is up to the people to care for it. To succeed in achieving sustainable development, it is critical to have the public understand its concepts and know specifically what part they can play in its promotion. Public education through extension work of resource management offices in State Governments must be promoted.

More urgent and more critical than public education is the provision of environmental management knowledge to decision makers and leaders in the public and private sectors. They generally need training in awareness of the complementary roles played by environmental management and economic development. International agencies could assist in developing appropriate programs to educate leaders on the sustainable development needs within each State. Short internal seminars and external regional workshops should be developed for this purpose. Chambers of commerce as well as government development and planning agencies should be co-sponsors. In particular it is necessary to educate State Government officials responsible for land management on the best use of land and on how to prevent land-use problems while providing resource management information to landowners.

Youth service combined with training could be developed at the national level. It could employ and train youth in conservation work and aquaculture, farming, fisheries and tourism. Central core training could be held at the Community College of Micronesia in Pohnpei, followed by aquaculture training at the National Aquaculture Center in Kosrae, fisheries training at the Micronesian Maritime and Fisheries Academy in Yap, farming through the Land Grant Program in Pohnpei, and tourism and industry training in Chuuk and Pohnpei tied to practical training in Guam, the Northern Marianas and elsewhere. In a related program, the Government should develop training to prepare youth for out-migration forced by environmental changes. At the same time the FSM should increase educational orientation at all levels towards marine resources and mariculture as well as development opportunities expected to result from sea level changes. Revised school curricula should build in teaching about sustainable development and environmental management principles based on existing resource conditions and traditional knowledge. A program with SPREP support should work with teachers

and education officials of public and private schools to introduce strategies, activities and curricula for teaching and learning about the environment.

The general public must be provided with increased amounts of better information concerning environmental management and sustainable development. This may be accomplished through radio programs, newspaper coverage (including club and organization newsletters), posters, pamphlets and videos (available on government and cable stations and at video rental shops). These should be produced in vernacular translations as well as in English.

chapter 5 ♦

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