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1997 Climate Change National Communication

Federated States of Micronesia

***FSM**

Climate Change National Communication -- 1997

**Federated States of Micronesia*

Executive Summary

The Federated States of Micronesia includes the most geographically and culturally diverse part of the greater Micronesian region. The nation is comprised of four states – Yap, Chuuk, Pohnpei, and Kosrae – lying along the equator in geographic sequence from west to east. The nation has a total population of about 106,000. Each state has considerable autonomy within the federation and has devised its own strategy for development. An overall, integrated development vision for the federation is provided by the national government.

As a small islands developing nation, the Federated States of Micronesia is one of the countries most directly threatened by long-term global warming resulting from an increased level of greenhouse gases accumulating in the earth's atmosphere. Regarding the effects of global warming, as a coastal nation, the FSM is particularly vulnerable to accelerated sea-level rise. And, because of the country's geographic location, future global warming holds the possibility of creating more frequent, intense, or longer-lasting El Nino droughts.

Yet, the nation's human-sourced greenhouse gas emissions represent a negligible percentage of the world's total human-sourced release of carbon dioxide, methane, nitrous oxide, and other greenhouse gases into the atmosphere. It has even been speculated that because of the "sink" capacity of its extensive forest and coral reef systems, the nation may produce a net "uptake" of greenhouse gases. Still, the FSM acknowledges an international obligation, and values the opportunity, to act in "good faith" by joining with other responsible nations in a concerted effort to undertake reasonable source-oriented mitigation measures in order to control the level of greenhouse gases emitted into the atmosphere.

The FSM is also affected by climate change phenomena over the short-term. Moderate to strong El Nino episodes create drought conditions across the nation. And, La Nina events bring heavier than normal rainfall, flooding, and wave and storm surge to the FSM's islands.

Taking into account the FSM's unique climate change vulnerabilities, as well as other domestic and international considerations; the most effective national policy for the Federated States of Micronesia involves developing a response strategy that addresses both the effects and sources of those climate change phenomena that are most likely to have an adverse impact on the FSM in the short-term and long-term. This national response strategy will emphasize (1) undertaking both effect-oriented adaptation and source-oriented mitigation measures, and recognize (2) the 'value-added' benefit of those "combined" measures that provide for both adaptation and mitigation outcomes at the same time.

Since changes in climate are likely to first create physical and biological impacts on the FSM, which in turn will have social and economic repercussions, a national response strategy oriented toward undertaking adaptation and mitigation measures that help prevent or minimize biophysical impacts will also help to preclude or lessen socio-economic impacts. Therefore, the most prudent climate change response strategy will be for the FSM to focus its limited resources on implementing measures involving environmental management.

Importantly, as the FSM begins to undertake a comprehensive environmental management response strategy that includes implementation of both adaptation and mitigation measures, the nation will begin to maximize its potential contribution toward controlling global greenhouse gas emission levels by sustaining or increasing the "sink" (or "uptake") capacity of its coral reefs, and coastal and upland forests. The reason for this is straightforward. Many of the effect-oriented adaptation measures outlined in this communication are by definition also source-oriented mitigation measures. That is, they are "combined" measures that will provide for both climate change adaptation and mitigation outcomes at the same time.

In adopting a climate change response strategy that emphasizes environmental management, wherever possible, the FSM's policy approach will be to encourage a combination of incentives (or disincentives), and public awareness and "grass-roots" participatory community development programs and methods in the design and implementation of adaptation and mitigation measures.

The FSM national government's ability to respond effectively to global and regional climate change faces a major challenge in that, in the arena of environmental matters, the constitutional allocation of responsibilities between the national and state governments is not clear. To date, in most cases, management and enforcement of environmental resources has been delegated to or assumed by the states. Over the past few years, a tentative understanding has emerged between the national and state governments. It is now generally accepted that the states have the primary responsibility for control and management of the environment, and the national government has an important role to play in coordinating state activities and providing technical assistance.

The national government has identified four climate change phenomena which, over the short-term and long-term, represent a significant threat to the well-being of the environment and people of the Federated States of Micronesia. These priority vulnerabilities are: **Accelerated Sea-Level Rise**, **El Nino Events**, **La Nina Events**, and **Greenhouse Gas Emissions**.

Climate Change Priorities	Short-term	Long-term
Accelerated Sea-Level Rise		X
El Nino Events	X	X
La Nina Events	X	X
Greenhouse Gas Emissions		X

With regard to these four national climate change priorities, the FSM has concluded that:

- Over the long-term, if the FSM's coral reefs do not remain intact and healthy, **Accelerated Sea-Level Rise** represents a dire climate change

threat to the entire nation, both high islands and atolls, due to coastal inundation, erosion, and flooding due to wave and storm surge.

- Over both the short-term and long-term, **El Nino** episodes represent a significant climate change threat to the FSM because of the drought conditions they cause. And, due to global warming, **El Nino** events could become more frequent, intense, or longer-lasting in the future. Thus, over next century, **El Nino** episodes may come to pose an even greater threat to the FSM.

- Over both the short-term and long-term, **La Nina** episodes represent a climate change threat to the FSM because of the heavier than normal rainfall, flooding, and wave and storm surge conditions these events cause.

- Over the long-term, global warming caused by increased human release of **Greenhouse Gas Emissions** into the atmosphere represents a grave climate change threat to the FSM for two reasons: (1) The inevitable acceleration in the rise of sea-level that will be caused; and (2) the potential increase in the number, strength, or duration of **El Nino** events and the resulting drought conditions these episodes cause.

The national government remains concerned about the potential influence of climate change phenomena on typhoon activity. However, typhoons were not selected as a national climate change priority on the basis of the best available, but still inconclusive, scientific evidence on the affects of El Nino episodes and global warming on typhoon activity in the FSM and adjacent regions.

The FSM has identified six interconnected sectoral and four cross-sectoral areas of interest in which effect-oriented adaptation and source-oriented mitigation measures need to be adopted to address the known and potential impacts of the above four national climate change priorities. For each of the following areas of interest, a number of environmental management and other related measures have been outlined in this communication which could be cooperatively undertaken by the national and state governments to effectively contend with the FSM's major climate change vulnerabilities.

Sectoral Areas	Cross-Sectoral Areas
Coral Reef Ecosystems	Public Awareness Programs
Coastal Zone Ecosystems	Research Programs
Waste Management	Technology Development & Transfer
Upland Forest Ecosystems	Interagency Strengthening
Agriculture/Agroforestry	
Water Supply	

The environmental management focus of the sectoral and cross-sectoral climate change measures outlined in this FSM national communication has been selected based upon a simple truth: *The social, cultural, and economic prosperity of the Federated States of Micronesia has been and will continue to be directly dependent upon the health of its coral reefs and interconnected ecosystems.* In the arena of climate change, this truth remains paramount. If the FSM is to effectively cope with climate change impacts, the nation must

build an appropriate local strategy, capacity, and acceptance of responsibility for management of its coral reefs and other interrelated ecosystems. Successful local implementation of such an effort will depend upon the support, cooperation, and full participation of all important stakeholders, especially customary owners and users of these resources.

As this national communication outlines in some detail, to effectively contend with the FSM's major climate change vulnerabilities, both short-term and long-term, the nation must work cooperatively to achieve a common goal*: The conservation and sustainable use of its coral reefs and other associated ecosystems.* This goal can be reached with the active support and involvement (i.e., commitment of financial, technical, manpower, and other needed resources) of stakeholders at all levels: international, regional, national, state, municipal, and community. Attaining this goal can be facilitated by the active participation of private sector businesses, and governmental, non-governmental, and other agencies, organizations, and institutions.

Ultimately however, the key to achieving the conservation and sustainable use of the FSM's coral reefs and associated ecosystems resides within the local communities. The people who live, physically and spiritually, as a natural part of these fragile ecosystems will have to decide whether or not to make the commitment for themselves, and on behalf of their future generations, to adopt and implement a comprehensive, fully participatory, community-based management approach to their environment.

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"Working together, caring for each other and the environment; that is our Micronesian culture."

FSM Overview

The Federated States of Micronesia is a young, independent nation created from part of the former United States administered United Nations Trust Territory of the Pacific Islands following conclusion of a Compact of Free Association with its former administrator, the United States, in 1986. In 1991, the FSM became a member nation of the United Nations. The FSM includes the most geographically and culturally diverse part of the greater Micronesian region. The nation is comprised of four states – Yap, Chuuk (formerly Truk), Pohnpei (formerly Ponape), and Kosrae (formerly Kusraie) – lying along the equator and stretching about 1,700 miles (2,700 kilometers) in geographic sequence from west to east. Specifically, the FSM is located in the western Pacific Ocean between the equator and 14 degrees North latitude, and between 136 degrees and 166 degrees East longitude. The nation has a total population of about 106,000. Each state has considerable autonomy within the federation, but their unity provides greater resources with which to face the challenges of development. The states have devised their own strategies for development, while an integrated perspective for the federation is provided by the national government. This overall national development vision is described in the most recent FSM National Development Plan.

The marine area within the FSM's Exclusive Economic Zone (EEZ) totals over one million square miles (2.6 million square kilometers) and includes abundant and varied resources. The land area constituting the FSM's 607 islands, however, is only 271 square miles (701 square kilometers). Of these hundreds of islands, a number are relatively large and mountainous or hilly, while the rest are small, flat coral atolls or raised coralline islands. The diverse habitats and species of the natural environment have always had a profound influence on the Micronesian people and their cultures. There are marked differences among and even within the four states, reflecting both the conditions of nature and the social structures that have evolved over the thousands of years since the islands were first settled. In both the communal subsistence and cash economies, the land and marine resources that constitute the natural environment of the FSM are essential to the physical and cultural life of the people.

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National Circumstances

Table of National Circumstances	
Criteria:	**1994:**
Population	**105,506**
Relevant Areas (square kilometers)	***Land:*** **701** ***Coral Lagoon:*** **7,190** ***EEZ:*** **2,600,000**
GDP (US$)	**$205,500,000**
GDP Per Capita (1994 US$)	**$1,962**
Estimated Share of the Informal Sector in the Economy in GDP (percentage)	**21.8%**
Share of Industry (Fisheries) in GDP (percentage)	**10.4%**
Share of Services (Private Sector & Government) in GDP (percentage)	**49.0%**
Share of Agriculture in GDP (percentage)	**0.8%**
Land Area Used for Agricultural Purposes (square kilometers)	**250**
Urban Population as Percent of Total Population	**25.0%**
Livestock Population	***Pigs:*** **49,000**
Forest Area (square kilometers)	**549**
Population in Absolute Poverty (percentage)	**0%**
Life Expectancy at Birth (men/women years)	**64/67**
Literacy Rate (percentage)	**85%**

Sources: Federated States of Micronesia 1996 Economic Report (Office of Pacific Operations, Asian Development Bank, March 1997)
1994 FSM Census of Population and Housing (FSM Office of Planning and Statistics, October 1996)

Geography. The islands of the FSM can be divided into two types: high volcanic islands comprising Pohnpei Island, Chuuk Lagoon Islands, and Kosrae Island, Yap Island which is sedimentary, and low coral atolls. Pohnpei, Chuuk and Kosrae are characterised by steep, rugged uplands, whereas Yap Island has more gently sloping uplands surrounded by substantial, often swampy lowlands. The islands were originally under natural forest cover, but the natural upland forests are disappearing rapidly being converted to agroforestry or secondary vegetation, to the extent that significant areas only remain on the islands of Pohnpei and Kosrae.

For any type of development planning activity in the FSM, including climate change, geographic dispersion is a critical feature to take into account. Each State must be concerned with the demands of its main island population center and rural areas as well as the unique requirements of its insular outer islands. These outer islands are different demographically, culturally and economically, and they are generally located at such distances that all aspects of central governance are expensive, demanding and generally plagued by inefficiencies. The circumstances of these outer islands cannot be ignored by planners.

Demography. Closely related to its geographic dispersion is the FSM's demography. Between 1989 and 1994, the population increased by 10 percent, with Pohnpei's and Kosrae's share of the population increasing by 13 and 4 percent respectively. For Pohnpei, this increase represents the migration of the general population to the Nation's capital for economic opportunities.

Although the medium age of the population has increased over the last 30 years from 16 to 18 years of age, the structure of the population remains the same. The FSM has one of the youngest populations among Pacific Island nations. Almost 64 percent of the Nation's population is under 24 years of age.

The average population density in 1994 was 389 persons per square mile. But this varies by State. It ranges from a high of 1,088 per square mile in Chuuk to 170 per square mile in Kosrae. The matter of population density is important since it raises the issue of economies of scale for a variety of development efforts, including climate change matters. Average population density on a statewide or nationwide basis may be misleading since the pattern of population density varies considerably.

Climate. The climate of the Federated States of Micronesia is typical of many tropical islands. Temperatures are relatively uniform, averaging in the mid 70 to mid 80 degrees Fahrenheit range; humidities average over 80 percent. Rainfall is high, varying from about 120 inches on drier islands to over 400 inches per year in the mountainous interior of Pohnpei.

On most islands, there is a pronounced wet season (June to October) and dry season (November to May). On Pohnpei, the “dry” season contracts to January to March. The western region of the FSM is subject to occasional (one in 20 years return period) typhoons which can cause severe damage. A recent typhoon on Pohnpei caused many landslides and damage to vegetation as well as infrastructure.

Resource Ownership. Land ownership is the most valued right in Micronesia; the landless person has much lower status than the landowner. Land ownership and tenure is complex within the FSM and varies from state to state. Traditionally, the use of terrestrial resources and all accessible marine resources was distributed among the people under the control of chiefs. Rights could be given, earned and inherited either matrilineally or patrilineally. Complex usage 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 involve communal ownership of a single plot, single ownership of several and separate plots, or usage right to land owned by traditional leaders. In the traditional economy, land is not a commodity to be sold or traded and, under the FSM Constitution, ownership of land is restricted to citizens. Land may be leased to non-citizens, the permissible lease periods varying from state to state. However, the attitude in some areas towards land is gradually changing, with sales and trades taking place as well as leases, especially near centers of development.

Some changes in land tenure resulted from the German, Japanese and American colonial occupations where land was "acquired" by the administrations for public purposes or for the "public good". All such land was transferred to the State and Municipal governments. In Pohnpei, the former colonial administrators interfered with traditional landownership by redistributing land titles to various people. Although many of the subsequent land disputes have since been settled, ownership of much land is still contested. Although the government has legal authority over land for "eminent domain and condemnation", this practice is strongly avoided.

Shallow reefs and the intertidal flats and their resources were traditionally usually owned by the nearby landowners, but this traditional ownership is no longer recognized in Kosrae and Pohnpei; in Yap and Chuuk it persists and is a central consideration in marine resources management.

Cultural & Historical Resources. Rich indeed is the Federated States of Micronesia in its varied cultural and historical resources -- prehistoric, pre-European historic, and European-Asian historic.

Kosrae Island has a stone city (Lelu) built of basalt boulders, columnar basalt crystal logs and coral rubble in-fill on the intertidal flat. Construction of the city is believed to have commenced about 1,500 years ago and it was still occupied in the 1820s. Kosrae also has historical shipwrecks from the whaling era.

Pohnpei Island has the much larger and better known stone city of Nan Madol which was the center of the Sau Daleur empire for some centuries (see picture below). This city was also built on the intertidal flat on 92 artificial islands connected by walled canals, with some also connected by subterranean tunnels. This city is also believed to be over 1,500 years old and may be much older. There are another two known stone cities and other megalithic stone edifices, petroglyphs and terraces in the rugged interior of Pohnpei Island. Pohnpei also has numerous historical sites from the Spanish, German and Japanese colonial eras.

One of Nan Madol's 92 artificial islands is shown below (photograph courtesy of Phoenix of Micronesia).

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In Chuuk State, there are also a number of megalithic remains, including a walled enclosure on the island of Tol. Chuuk is famous for its "Ghost Fleet" of sunken Japanese ships and airplanes from World War II in the lagoon which are now a major attraction for dive tourists.

Yap's traditional culture has been and remains very strong. This culture includes the famous "stone money" of Yap. There are also a number of historical wrecks and other material from the World War II period.

The identification and preservation of culturally and historically important sites are important when any development planning activity is undertaken, and climate change planning is no exception. While some sites have already suffered from developmental vandalism by humans, perhaps of greater concern at present is the destructive encroachment of nature on the stone cities. It is also quite evident that many more archaeological sites remain to be studied and identified.

Water. Only Kosrae and Pohnpei have perennial streamflow; the large deltas of rivers with short stream length and steep channel gradient attest to the very high rainfall which occurs in the mountainous interiors of these islands.

All communities in Kosrae State are served with piped systems mainly from stream intakes via gravity distribution. The central water supply system comprises about five miles of distribution mains drawing on a diverted river, a rapid sand filter, and a 40,000-gallon storage tank.

In Pohnpei State, the capital center of Kolonia has a water supply system that consists of a river source (the Nanpil Dam) supplemented by three drilled groundwater wells (bores) which feed 26 miles of distribution mains of the central water supply distribution system. Approximately 55 percent of connected households are on 24-hour water service. Rural areas have a few community system such as that in Kitti where a filtration and chlorination process precedes the distribution network.

Only in the capital center of Weno (Moen) and on parts of Tonoas (Dublon) in Chuuk State are there centralized water supply systems. Most of the State's population relies on individual roof catchments and storage tanks for their water. This water supply is supplemented by fresh to brackish groundwater from springs and shallow hand-dug wells.

In Yap State, the Gitam Dam supplies more that 30 million gallons to the capital center of Colonia but demand exceeds the capacity of the filtration and chlorination plant. The majority of the population relies on individual rainwater catchments. In addition, there are two deep well systems, one serving the northern part of Yap Island, while on the western side of Yap (Map and Rumung municipalities) spring water is collected and fed to the village by gravity feed.

In the FSM’s atolls, raised coralline islands, and in those coastal areas composed of coral sand deposits and lagoon sediments, the freshwater lens which "floats" on the underlying denser seawater is tapped through shallow, hand-dug wells to supplement the rainwater catchment and storage tanks which are widely used and commonly the main source of drinking water in the outer islands.

Land Resources: Flora & Forests. There are nine closely interconnected terrestrial ecological zones in the Federated States of Micronesia:

Coastal/Littoral Beach Strand. The Beach Strand is comprised of vegetation that is found commonly throughout the Pacific and that has adapted to sunny, salty, and windy conditions. Herbaceous strand such as Ipomoea littoralis and Vigna marina is found nearest the beach. Littoral shrubland is located directly behind the beach with the dominant plant being Scaevola taccada. Littoral woods are located further back and make up the dominant coastal vegetation. Common tree species include Calophyllum inophyllum, Hernandia sonora, Barringtonia asiatica and Pandanus tectorius, Hibiscus tiliaceus, Artocarpus (breadfruit), and Cocos nucifera (coconut), both planted and wild, and are found from the shoreline inland. Other important vegetation includes Casuarina littoralis, Cordia, Heritiera littoralis, , Messerschmidia, Morinda, Pisonia, Terminalia catappa and Derris, and Thespesia populnea.

Mangrove Forest. Mangrove Forest is generally in muddy saltwater reef flats along coastal areas. Kosrae is fairly unique within the Pacific in that most of the mangroves there are located behind the barrier islands of the Beach Strand. Major mangrove species found in the FSM include Rhizophora apiculata, R. mucronata, Sonneratia alba, and Bruguiera gymnorhiza, Luminitzera littorea, and Xylocarpus granatum.

Swamp Forest. Swamp Forest occurs extensively on Kosrae and Pohnpei and is defined largely by the presence of tropical swamp trees Barringtonia racemosa, Terminalia carolinensis, Hibiscus tiliaceus, Metroxylon amicarum, Erythrina fusca, and Campnosperma brevipetiolata.

Freshwater Marsh. Freshwater Marsh occurs on almost all the islands across the FSM. It is located mainly in poorly drained areas behind the Beach Strand. Marsh vegetation consists mainly of non-woody species like Phragmites karka, Scirpodendron ghaeri, Rhynchospora corymbosa, Cyperus javanicus, and Ludwigia hyssopifolia and octovalvis. These marshes are utilized for taro production in all the inhabited islands of Yap and Chuuk States as well as in all the outer islands of Pohnpei State.

Grassland. Human-induced Grassland is relatively extensive in the larger high islands of Yap, Chuuk and Pohnpei States, and is increasing in area due to frequent firing which destroys the forest edge and tree regeneration. Dominant grasses include Paspalum, Dimeria, Ischaemum, and Dicranopteris (staghorn ferns).

Secondary Forest. Secondary Forest is found wherever disturbance has occurred inland of the Mangrove and Swamp Forests and Beach Strands as a result of human activity through gardening or by nature through landslides, typhoons and strong storms. It is in these areas that much of the agroforestry has traditionally been undertaken. Consequently, a high proportion of the plant species found in Secondary Forest areas are comprised of trees or other overstory and shrubs which yield food, fruit or other useful products.

Primary Forest. The use of the term Primary Forest is restricted to that area of the FSM's high islands excluding Mangrove, Swamp, Secondary, Rain, and Crest Forests. Extremely little of this ecosystem remains in Chuuk and Yap, but extensive areas are still found in Pohnpei and Kosrae. Characteristic vegetation includes banyan figs, pandanus, climbing screwpine, the endemic palm (Clinostigma ponapensis) and a range of hardwood tree species. This zone provides for a wide range of human needs including timber, fruit, medicines, handicrafts, and dyes.

Rain Forest. Rain Forest is restricted to the interior mountain peaks of Kosrae and Pohnpei, generally being found in locations that exceed a 20 percent slope and have thin soils overlying rock. Apart from the typical hardwood rain forest species, other common

plants include banyans, tree ferns, bird's-nest ferns, mosses, some 36 endemic orchids, and pepper vines.

Crest (Dwarf or Cloud) Forest. The dense and dwarfed vegetation of the unusual Crest Forest is found only on the generally cloud-covered, extremely wet mountain ridge summits of Kosrae and Pohnpei. Trees are bent and stunted and support large growths of mosses, ferns, and other epiphytes. Many of the plants are dwarfed specimens of species found at lower elevations.

All States except Chuuk have large forested areas. Forests account for 63 percent of the total land area in Kosrae, 56 percent in Pohnpei (watershed forest reserve in the center of the island constituting about 30 percent of the total land area), and 33 percent in Yap, compared with about 10 percent in Chuuk. The forests of the central islands protect watersheds and prevent erosion. The coastal mangrove, swamp, and marsh areas filter run-off sediments and act as nurseries for many marine species.

Land Resources: Fauna. Terrestrial mammals are mainly restricted to introduced species such as pigs, dogs, cats, and, in the Rain Forest zone of Pohnpei, Philippines deer. There are a number of bats and rats. Although rats are not considered of valued, they are environmentally significant animals and can cause considerable damage to crops and plants.

Birds comprise by far the greatest proportion of the FSM's animals and include a number of endemic species. Shorebirds, egrets and terns are abundant in the Beach Strand. Of endemic bird species, the Kosrae mountain starling and the Kosrae rail have become extinct. Three endemic species in the FSM that have been listed as endangered are the nightingale reed-warbler, the Pohnpei greater white-eye, and the Pohnpei mountain starling. In addition, several species or populations are considered candidate endangered species. These are the short-eared owl, the Chuuk population of the Micronesian pigeon, the Chuuk monarch, and the Chuuk greater white-eye.

The coconut crab is strictly limited to coastal habitats and this species has been mostly wiped out along inhabited coastal areas. Animals that depend on the Mangrove and Swamp Forests, or Freshwater Marsh for habitat include the mangrove crab, currently threatened by overharvesting, and the introduced monitor lizard. The fruit bat, black noddy, brown noddy, white or fairy tern, cardinal honeyeater, and Micronesian pigeon all forage and nest mainly in these locations. A number of animals and birds also live in or otherwise make use of the Grasslands and Secondary Forest including the cardinal honeyeater, Micronesian starling, dusky white-eye, and blue-faced parrotfinch.

The Upand Forest (i.e., Primary and Rain Forests) ecosystems also provide a rich habitat for a number of animals and birds. The white-tailed tropic bird, audobon’s shearwater, cardinal honeyeater, gray swiftlet, Micronesian starling, dusky white-eye, purple-capped fruit dove, red jungle fowl, and the endangered Micronesian pigeon all nest and forage in the Upland Forest. The Crest Forest provides habitat for several species of tree snails, some found only in the FSM.

Marine Resources. The marine environment is of enormous importance to the people of the Federated States of Micronesia. For Chuuk, the marine environment is considered the basis for Chuukese culture, being the principle source of subsistence, recreation and commerce. The nation’s marine resources are extensive and in many ways central to the future social, cultural, and economic prospects of the FSM.

Historically, the inshore and near-shore marine environment is the source of a wide variety of traditional foods. This remains true today. Also, the water sports of swimming, canoeing

and sailing are traditionally popular and remain so for both residents of the FSM and tourists. In addition, large numbers of divers are attracted to the coral reefs and wartime relics, with Chuuk State being regarded as one of the top wreck diving locations in the world.

Economic Development. The economy of the Federated States of Micronesia is small, based on a small domestic market of about 106,000 people with modest levels of income and scattered over large distances. Infrastructure is not well developed and is generally inadequate for the increasing population; this is compounded by a low level of maintenance due to severe limitations on recurrent expenditure funds.

With the exception of offshore fisheries, there is a limited resource base, and a serious imbalance exists in external trade with as yet limited development of private sector activities outside of wholesale/retail and service industry sectors. The FSM is largely dependent on external aid and government sector activity. The current FSM National Development Plan recognizes that there is a marked dichotomy between the cash and traditional economies but that traditional values have been maintained.

The commercial and industrial sectors of the FMS consists primarily of small businesses, complemented by a few larger public companies, co-operatives and credit unions. Few family-based businesses have entered the industrial sector, most being engaged in commercial import/export, wholesale and retail business or service enterprises such as restaurants, taxis, car rentals, repair and maintenance etc.

While the FSM has preferential access to United States, Australian and New Zealand markets, the adjacent markets of Japan and the ASEAN countries also offer important marketing opportunities for FSM exports. However, there has been little growth in the FSM's exports during the 1990s. Interstate trade is minimal and generally involves agricultural produce.

Employment. For the FSM as a whole, subsistence and market jobs in agriculture and fisheries account for 28 percent of the work force. The major employer in the FSM is the public sector, accounting for one in every three jobs, slightly more than agriculture and fisheries sectors combined. Of the 14,381 persons estimated to be employed in the cash economy, nearly half are engaged by National or State Governments to operate public facilities, perform construction work and provide community services. Public sector wages and working conditions are said to be considerably superior to those of the private sector. This pattern has contributed to the low rate of development of those entrepreneurial and technical skills which are needed to increase efficiency in the production and export service sectors of the economy.

Expatriate labor is still required to supplement the limited numbers of local personnel trained in technical and professional services. Some Micronesians go abroad for advanced training and do not return; others including unskilled laborers migrate to Guam or Hawaii in search of employment and better pay. Meanwhile, hundreds of foreign workers are employed in construction and other semiskilled trades which would use local labor were adequate training programs available.

Private businesses provide employment mainly in the wholesale and retail trades, hotels, restaurants, light manufacturing, financial and business services, insurance and construction.

Forestry. The current main values of the forests are in their support of subsistence agroforestry activities, and for their ecological and environmental protection roles, not as a

source of commercial timber. The dominant forest areas of the central islands protect watersheds and prevent excessive erosion. The mangrove areas filter run-off sediments, and act as marine nurseries. The forest and mangroves also provide a protected natural habitat for exotic species of plants and wildlife.

Scattered use of forest resources occur throughout FSM, mostly for construction in subsistence homesteads and for firewood, but also for furniture. Mangrove timber is used for handicrafts and furniture.

The most serious environmental problem in the forestry sector is the extent of upland deforestation occurring on Pohnpei. The conservation and biodiversity values attached to Pohnpei's upland forests are as important as their hydrological buffering functions, in that the upland forests are habitat for 269 species of plants, 110 of which are endemic, as well as 24 species of birds of which 5 are endemic. However, over the last 20 years the upland forest has been threatened by increasing population pressure and exploitation, as a result of (1) conversion to agroforestry and agriculture (principally for sakau), (2) human settlement, (3) road construction, (4) hunting, and (5) tourism trails. Recent attempts to mitigate these adverse impacts have centered on the promotion of community-based management regimes which combine local community and traditional institutions with municipal and state governments, through local Watershed Area Management Committees. Initial results of this approach are encouraging, and while the process is long and complex, the outcome is anticipated to be more sustainable than regulatory solutions.

Similarly, the mangrove forests are important to the maintenance of the natural lagoon ecosystem, but overharvesting is occurring. There has been extensive use of mangrove wood for cooking, housepoles, sawn timber, woodcarvings, and other purposes resulting in over-exploitation occurring in some localities on Kosrae, Pohnpei and Yap.

Progress on these critical resource management issues will require legislation changes, public awareness education, and the investigation of alternative methods of resource development which are more sympathetic to environmental constraints. An initial investigation of some of these low-impact options within a framework of sustainability, compatibility and profitability (the SCP criteria) has been recently undertaken for Pohnpei, and further extension of this approach is expected.

Agriculture. Agriculture production in the FSM is primarily for subsistence, with some semi-commercial and commercial activity. Almost every household engages at least part-time in agricultural activity. With one exception, the few current commercial fruit and vegetable production units are no larger than 20 acres in size. Subsistence production is based mainly on shifting cultivation agroforestry systems. The agroforestry takes the form of garden areas for root-crops (e.g., taro, yam) and other vegetable production, interspersed with a high proportion of food trees, particularly varieties of coconut and breadfruit. Mango and a number of banana and papaya varieties are common with additions of varieties of citrus species in Yap and Kosrae (e.g., tangerines, limes, sweet and valencia oranges). Integrated with the mix of fruit and other food crops is an understory of plants and shrubs used for a number of other local purposes.

Bananas are one of the nation's agricultural exports (photograph courtesy of Phoenix of Micronesia).

This figure is not available electronically

Numerous attempts have been made in the past to develop commercial agriculture. Except for coconuts and bananas, none of these attempts succeeded in the long-term, although remnants exist, such as coffee on Pohnpei. The most notable recent success is the "open canopy gardens" producing vegetables such as head cabbage, green onions, bell peppers, and corn for small-holder commercial enterprises. Other local cash crops include cucumbers, watermelons, gourds, sweet potatoes, eggplants, tomatoes, cassava, and some betelnut, pineapple and sugarcane.

Copra remains the main cash and commercial export production crop throughout the FSM, but production has decreased dramatically. The decline is attributed to the low prices for copra coupled with increasing senility of the coconut palms. In addition to copra, black pepper is under cultivation in Pohnpei. Sakau (kava) has also become a cash crop on Pohnpei primarily for sale at local sakau bars. In Kosrae, citrus and root-crops are significant with banana, limes, tangerines, and taro exported to Guam, the Republic of the Marshall Islands, or Pohnpei. Periodically, Yap exports bananas, other vegetables, fruits and betelnut to Guam and Palau.

Farmstead livestock productions is increasingly important throughout the FSM, particularly pigs, poultry and eggs. Commercial egg production is reasonably well established now in all four States. Pigs remain the single most important animal raised by households for food, ceremonial purposes and sale. The FSM imports large quantities of frozen meats principally from the United States and Australia. However, these imports are small compared with those of frozen whole chicken, turkey and turkey tails.

Agricultural processing is limited to coconut products and gourmet pepper production. The agricultural marketing system is not well developed. Small local produce markets exist in State centers, supplying fresh fruit and vegetables to high-density residential areas where land scarcity or preference create a demand from salaried labor of the government or commercial sectors. Restaurants provide a small market for selected fruits and vegetables.

Fisheries. The fisheries resource of the FSM can be divided into: (1) the offshore, deep sea marine resources of the EEZ which are mainly exploited by the Distant Water Fishing Nations (DWFNs) under license agreements; and (2) the inshore and near-shore marine resources, comprised of fisheries which are exploited mainly for food production (subsistence fishing) and, to a growing extent, for commercial purposes (artisanal fishing). The inshore fishery is the area between the shoreline and a depth of 50 meters along the outer reef slope, and the near-shore fishery is from the 50 meters depth limit to the nation's 12 nautical mile jurisdiction.

Inshore & Near-shore Fisheries. Reef resources are critical to artisanal fishing activities. Data are obviously incomplete with the annual catch being variously estimated from 1,000 to 5,000 tons. This catch is largely consumed locally as an essential source of nutrition in the traditional Micronesian diet. Reef fish have tremendous importance to the healthy sustenance and cultural heritage of Micronesians. So far, efforts to avoid overfishing reef areas and to eliminate fishing with dynamite, bleach, cyanide, and other poisons have not been successful. Fish stocks in reef areas close to large urban populations have now been seriously depleted.

There is negligible resource stock information available on the inshore marine resources of the FSM, although some stock data trials have been initiated in two States. Until reliable information is available, resource management programs cannot be planned and implemented with confidence, so allocation of resources to data collection is a priority. In

the interim, it is generally accepted that the inshore fishery can only sustain a continuation of subsistence practices, with some small-scale commercial fishing in certain localities. The near-shore resource is also limited, and generally could only sustain fishing at the artisanal level for the domestic market.

Natural populations of the giant clam *(Tridacnidae)* as well as small clam species and other shellfish are declining. The giant clam has been almost completely eliminated in some parts of the FSM. A market for juvenile clams and seeds has also developed from foreign zoos and aquariums. For a variety of reasons, giant clams have been given the highest priority among aquaculture species in government development plans, and a national mariculture center has been established in Kosrae.

Trochus harvesting is also an important contributor to the economy in all the FSM's states. The trochus is harvested primarily for its shell, although some buyers also purchase the meat. The only marine reserve areas established to date are trochus sanctuaries.

The reefs, shallow passes, lagoons and other areas of the FSM provide many good sites for a number of other environmentally compatible mariculture development to serve both local and export markets. Cultivation of rabbit fish, sea sponge, blacklip pearl oyster, soft live corals for the aquarium trade, seaweed, and mangrove crabs are possibilities already exploited in mariculture projects or under consideration by the four States' Marine Resources Divisions.

Over-exploitation of inshore and near-shore reef fish resources is occurring in certain areas, as a combination of increasing catch effort (due largely to increasing population) and the breakdown of traditional resource management systems. Traditionally, a very complex system of responsibilities, rights and obligations set the framework for management of these fisheries resources with restrictions on access, based largely on social control rather than physical resource management. More recently, the trend toward "open access" coupled with modern technology has resulted in over-exploitation, and a breakdown in traditional management systems. However, there has been a recognition that different intervention strategies are needed for inshore and near-shore resources, with the resources being managed under a scheme of "co-operative management" using local fishery groups, and representative of the local community, as custodians of the resource.

Offshore Fisheries. Tuna is the primary fisheries resource, including both surface schooling and deep-water species. Pelagic resources appear to offer great potential for further exploitation, although the full extent of these resources has not been assessed accurately as yet. The annual fish catch within the EEZ was estimated at 230,000 tons in 1995. More particularly, tuna catches have been increasing, and marine resource officials believe that the catch of skipjack tuna can be increased without any significant risk of depleting that resource. Yellowfin and bigeye tuna are also targets of the foreign-licensed fishing effort. Lesser amounts of mahimahi, billfish, shark and other species are also caught as byproducts of tuna harvesting.

The National and State Governments expect that activities related to pelagic fishing will provide long-term economic benefits by creating hundreds of jobs and substantial export revenue. Offshore marine resources other than tuna are not considered likely to form the basis of a sustainable commercial fishery. The governments have invested in fisheries through joint ventures (e.g., transshipment and cold storage facilities as well as long-line and purse-seiner fishing operations) and by undertaking feasibility studies to assess future prospects. Tuna canneries have been proposed in all four States. However, there has as yet been no successful commercial processing of tuna, large-scale or small-scale, within the

FSM. Apart from intermittent landings of bycatch from transshipment operations, no fish from the commercial fisheries reaches the domestic market.

Tourism. Tourism is an infant industry but already a significant contributor to the FSM economy in terms of employment, exports, and income. The visitor industry on Pohnpei is the single largest earner of foreign exchange in the State. All State economic development plans foresee considerable expansion of tourism activities for the coming decade and each State is now represented in the PATA (Pacific Air Travel Association) Micronesian Chapter which is the only active regional tourist association offering support and technical assistance for the development of international markets.

Current tourist activity emphasizes ecotourism, adventure tourism, and cultural tourism, and has centered largely on the attraction of marine, coastal and reef resources, and wreck dives, and the special prehistoric cultural attractions of the Lelu Ruins in Kosrae and Nan Madol Ruins in Pohnpei. Increased activity would continue to focus on these attractions, but the need for careful planning and management to ensure the preservation of the cultural and historical treasures is recognized. A precursor to realization of the great potential for growth of the tourism sector is investment in tourist infrastructure, including additional accommodation, better transport connections, and improved recreational activities.

The nation's coral reefs offer visitors the best snorkeling and scuba diving found anywhere in the world (photograph courtesy of Phoenix of Micronesia).

This figure is not available electronically

Climate Change Response Strategy

Policy Orientation. As a small islands developing nation, the Federated States of Micronesia is one of the countries most directly threatened by long-term global warming resulting from an increased level of greenhouse gases accumulating in the earth's atmosphere. Regarding the effects of global warming, as a coastal nation, the FSM is particularly vulnerable to accelerated sea-level rise. And, because of the country's geographic location, future global warming holds the possibility of creating more frequent, intense, or longer-lasting El Nino droughts.

Yet, as is obvious from the FSM's GHG Emissions Inventory, the nation's human-sourced emissions represent a negligible percentage of the world's total human-sourced release of carbon dioxide, methane, nitrous oxide, and other greenhouse gases into the atmosphere. It has even been speculated that because of the "sink" capacity of its extensive forest and coral reef systems, the nation may produce a net "uptake" of greenhouse gases.

The FSM is also affected by climate change phenomena over the short-term. Moderate to strong El Nino episodes create drought conditions across the nation. And, La Nina events bring heavier than normal rainfall, flooding, and wave and storm surge to the FSM's islands.

In formulating a FSM national policy response to climate change that would take into account these circumstances, there were four main options to consider: (1) a source-oriented policy response of developing mitigation measures [i.e., control of greenhouse gas emissions]; (2) an effect-oriented policy response of developing adaptation measures [e.g., coral reef protection, coastal protection, human resettlement]; (3) an effect-oriented and source-oriented policy response of developing a mix of both adaptation and mitigation measures; and (4) "no action."

Pursuing a climate change policy of "no action" would clearly be counterproductive to the FSM's national interests over both the short-term and long-term. Given the circumstances, a more domestically attractive alternative would be to adopt a national policy response that focuses exclusively on effect-oriented adaptation measures. However, as an actively engaged member of the world community, the FSM recognizes that it does not exist as a nation in isolation. The country acknowledges an international obligation, and values the opportunity, to act in "good faith" by joining with other responsible nations in a concerted effort to undertake reasonable source-oriented mitigation measures in order to control the level of greenhouse gases emitted into the atmosphere.

Therefore, given the FSM's unique climate change vulnerabilities, as well as other domestic and international considerations, the most effective national policy for the FSM entails developing a response strategy that addresses both the effects and sources of those climate change phenomena that are most likely to have an adverse impact on the FSM in the short-term and long-term. This response strategy will emphasize (1) undertaking both effect-oriented adaptation and source-oriented mitigation measures, and recognize (2) the 'value-added' benefit of those "combined" measures that provide for both adaptation and mitigation outcomes at the same time.

As a final important point regarding the nation's policy orientation; changes in climate are likely to first create physical and biological impacts on the FSM, which in turn will have social and economic repercussions. Thus, a response strategy oriented toward undertaking climate change adaptation and mitigation measures that aid in preventing or minimizing biophysical impacts will also help to preclude or lessen socio-economic impacts. In this

regard, the most prudent climate change response strategy for the FSM will be to focus its limited resources on implementing measures involving environmental management.

Importantly, as the FSM begins to undertake a comprehensive environmental management response strategy that includes implementation of both adaptation and mitigation measures, the nation will begin to maximize its potential contribution toward controlling global greenhouse gas emission levels by sustaining or increasing the "sink" (or "uptake") capacity of its coral reefs, and coastal and upland forests. The reason for this is straightforward. Many of the effect-oriented adaptation measures outlined in this communication are by definition also source-oriented mitigation measures. That is, they are "combined" measures that will provide for both climate change adaptation and mitigation outcomes at the same time.

In adopting a climate change response strategy that emphasizes environmental management, wherever possible, the FSM's policy approach will be to encourage a combination of incentives (or disincentives), and public awareness and "grass-roots" participatory community development programs and methods in the design and implementation of adaptation and mitigation measures. The formulation of environmental management measures that require overly restrictive legislation or other types of government regulatory action will be discouraged as much as possible.

Constitutional Jurisdiction. In assessing the capability of the FSM national government to respond effectively to global and regional climate change, one major challenge immediately comes to light: the allocation of responsibilities between national and state governments, especially in the arena of environmental matters.

The FSM National Constitution gives those powers to the states that are not expressly delegated to the national government or prohibited to the states. National power is that which is expressly delegated to the national government, or that which is clearly national in character and beyond the power of the states to control. The FSM Constitution does not expressly delegate regulation of the "environment" to the national government, although it does express the power of the national government to exclusively regulate education and health. To date, in most cases, control and management of environmental resources have been delegated to or assumed by the states.

The lack of a clear constitutional allocation of power regarding environmental matters has in the past led to jurisdictional disputes. Given the absence in the FSM Constitution of explicit delegation of environmental control to the national government, proponents of state control argue that by default the power belongs to the states. In the early 1990s, in an attempt to clarify jurisdictional issues, the National and State Attorneys General met and formulated a tentative joint opinion regarding national and state jurisdiction over certain environmental concerns.

While this tentative joint opinion provides practical guidance on implementation of environmental controls, the ultimate determination of jurisdiction over environmental matters still rests with the judicial branch. The tentative joint opinion interprets the FSM Constitution as follows:

- The national government has the power to set minimum standards in all areas related to public health, including air quality, water quality, and waste management. The states can adopt these standards or formulate stricter standards. The national government will intervene if a state is unable to ensure that the minimum standards are being met.

- The national government is responsible for coordinating all state activities related to or initiated through foreign assistance.

- The national government can be involved in any environmental matters that involve (1) a threat to public health; (2) the traditions of the people of the FSM; (3) clear effects on foreign or interstate commerce; (4) all mining, mineral, and marine resource issues 12-miles beyond island baselines; and (5) foreign technical or financial assistance for biodiversity protection.

- The states generally have jurisdiction over (1) all mining, minerals, and marine resources within 12-miles of island baselines; (2) zoning and regulation of earthmoving; (3) agriculture; (4) forestry; (5) watershed protection; and (6) protection of ecosystems. The national government can intervene in most of the above areas when certain conditions are identified, such as threats to public health or clear effects on foreign and interstate commerce.

- Both the national and state governments have jurisdiction over the protection of endangered species and the establishment of wildlife preserves. States are recognized as usually having the lead role in these areas, however.

Additional guidance regarding jurisdiction over environmental matters can be found in former FSM President Bailey Olter's official endorsement of the 1993 Nationwide Environmental Management Strategies (NEMS) document prepared by SPREP. The endorsement stated:

- [t]he primary responsibility for environmental protection lies with the states. In implementing the recommendations of the NEMS, I direct all Departments and Offices of the Executive Branch to limit their involvement to coordinating state activities and providing technical assistance to the states, except for those few areas of environmental protection which are entrusted exclusively to the national government by the Constitution of the Federated States of Micronesia.

Therefore, while the states have the primary responsibility for control and management of the environment, the national government still has an important role to play in coordinating state activities and providing technical assistance.

The Sustainable Development Council. The FSM President's Environmental Management and Sustainable Development (SD) Council was created in the mid-1990s to address matters, including climate change, affecting the environmental management and sustainable development of the nation, and make recommendations to the FSM President. The Council is composed of the FSM Vice President as Council Chair, and representatives from all four states and eight executive branch departments: The Office of Planning and Statistics, Department of Health Services, Department of Education, Department of Resources and Development, Department of External Affairs, Office of the Attorney General, Micronesian Maritime Authority, and the Office of Disaster Control. The purpose of the SD Council is to ensure that the national government takes a consistent stand on development and the environment, and to ensure that all available resources and technical abilities are tapped when providing coordination services and technical assistance to the states.

International Networks. In developing an appropriate national strategy for addressing climate change matters at the national, regional, and global levels, the FSM works closely with the South Pacific Regional Environmental Programme's Pacific Islands Climate Change Assistance Programme (PICCAP), and the United States Environmental Protection Agency's Country Studies

Program (USCSP). These two programs continue to provide the FSM national government with strong financial support and technical assistance in the area of climate change planning.

Climate Change Priorities

Introduction. The national government has identified four climate change phenomena which, over the short-term and long-term, represent a significant threat to the well-being of the environment and people of the FSM. These priority vulnerabilities are: **Accelerated Sea-Level Rise**, **El Nino Events**, **La Nina Events**, and **Greenhouse Gas Emissions**. Some background on each is provided in this section along with a description of its significance for the FSM.

The national government remains concerned about the potential influence of climate change phenomena on typhoon activity. However, typhoons were not selected as a national climate change priority on the basis of the best available, but still inconclusive, scientific evidence on the affects of El Nino episodes and global warming on typhoon activity in the FSM and adjacent regions. It has been determined that during an El Nino episode, typhoons will tend to form more to the east or northeast of the FSM than usual, and then track to the north, northwest, or west. According to one leading Pacific typhoon expert, during an El Nino event, the FSM is most vulnerable to typhoon activity during November and December. It is during these two months that typhoons have the greatest likelihood of forming directly to the east, and then tracking west, gathering strength before traveling across the FSM.

Whether or not global warming would likely cause more frequent and stronger (both mean and maximum intensity) typhoons, or affect their area of occurrence was the subject of a 1993 international gathering of prominent typhoon scientists. These experts stated that a warmer climate could have some influence on typhoons, but that there is no reason to say that it would cause more or stronger storms, or affect their area of occurrence. The main reason for this is that climate change would affect other aspects of the weather as well. And, some of these other changes would likely work against more or stronger typhoons. The experts also stated that the number of typhoons varies so much from year to year that it would be hard to even tell whether global warming was having an effect. Thus, they concluded that global warming induced changes (or lack thereof) in typhoon activity around the globe may not be consistent, with some regions receiving more activity while others are getting less or remain at normal levels. Research in this area needs to be pursued until answers are found regarding the influence of global warming on typhoon activity in the FSM and adjacent regions.

Climate Change Priorities	Short-term	Long-term
Accelerated Sea-Level Rise		X
El Nino Events	X	X
La Nina Events	X	X
Greenhouse Gas Emissions		X

Accelerated Sea-Level Rise

Background. Global warming (i.e., increasingly warmer global surface temperatures) caused by greenhouse gases building up in the atmosphere will lead to an "accelerated rate of global sea-level rise" or ASLR. This sea-level rise will be mostly the result of thermal

expansion of the upper layers of the world's oceans due to warming, though increased melting of glaciers, small ice-caps, and the relatively large Greenland ice-cap would also contribute. Global sea-level has risen an average of .07 inch (1.8 millimeters) per year over the past 60 years. This is a rate of rise equal to about 7 inches (17.8 centimeters) per century. This rate is expected to accelerate due to global warming. However, the exact rate of acceleration is not known with any certainty. The Intergovernmental Panel on Climate Change (IPCC) estimates that, under a "Business-as Usual" scenario, sea-level will rise on a global range from 1.0 to 3.3 feet (0.3 to 1.0 meter) above present levels by the year 2100. Where and when this may occur remains unknown at this time.

Significance for the FSM. There could be many impacts of accelerated sea-level rise on the FSM. Some of the major physical effects might include the loss of land due to saltwater inundation, coastal erosion, salination of freshwater lenses, and increased occurrences of coastal flooding due to wave and storm surge. Any of these impacts would have major adverse environmental, social, cultural, and economic repercussions.

All the islands of the FSM are vulnerable to the threat posed by ASLR. Throughout the nation, the coastal areas are typically the most heavily developed, providing homes, infrastructure, and economic opportunities for the majority of the population. On high islands, options for abandoning coastal areas affected by inundation or flooding and moving landward are quite limited due to steep slopes and complex land tenure issues. On atolls, saltwater intrusion would destroy taro and other crops, and damage groundwater supplies even before large-scale inundation necessitated the migration of islet inhabitants. And, across the FSM, major historical and cultural sites located along shorelines could be lost forever.

Comprehensive environmental management that ensures intact and healthy coral reefs, wetlands, and other landward and upland ecosystems is the most effective defense against the impacts of ASLR. For example, intact mangrove areas serve: (1) to build up the size of coastal lands, (2) as natural barriers that protect coastlines against destructive physical forces such as erosive wave action, strong coastal winds, and torrential storms, and (3) to filter sediment and runoff from upland areas, thereby protecting the health of the coral reefs. In turn, if they remain healthy and undamaged, these reefs can permit the FSM's islands to grow up with the projected rise in sea-level over the next century *[coral has a .1 to .3 inch (3 to 7 millimeters) or more per year growth rate]*.

That is, intact and healthy growing coral reefs can act as a protective barrier to projected sea-level rise and accompanying increases in wave and storm surge, and thereby, minimize or prevent coastal inundation, erosion, and flooding. Thus, a comprehensive environmental management program can be used as a proactive tool for implementing measures which effectively address the FSM's potential vulnerability to ASLR. Likewise, awareness of the FSM's potential vulnerability to ASLR should also highlight the need to manage growth and development in coastal areas, particularly locations vulnerable to inundation and flooding.

In summary, over the long-term, if the FSM's coral reefs do not remain intact and healthy, ASLR represents a dire climate change threat to the entire nation, both high islands and atolls, due to coastal inundation, erosion, and flooding due to wave and storm surge.

The following four pages display inundation maps for the islands of Kosrae and Weno (Chuuk State). The first two maps show inundation zones for Kosrae if sea-level were to rise 1.0 foot (0.3 meter) and 3.3 feet (1.0 meter), respectively. Notice the large amount of roadway and other infrastructures lost under both inundation scenarios. The final two maps show inundation zones for Weno if sea-level were to rise 0.7 foot (0.2 meter) and 3.3 feet (1.0 meter), respectively. Notice the large areas of human settlement, roadway and other infrastructures lost. The 1.0 foot and 3.3 feet Kosrae maps show inundation areas for the year 2100 under the IPCC's 'low-estimate' and 'high-estimate', respectively, for global average sea-level increase under a

"Business-as-Usual" scenario. Similarly, the 0.7 foot and 3.3 feet Weno maps show the 'best-estimate' and 'high-estimate' for the years 2030 and 2100, respectively. It is important to note that these maps do not take into account wave and storm surge, or the growth rate of healthy, intact coral reefs which would increase or decrease, respectively, the size of the red inundation zones shown.

El Nino Events

Background. The term "El Nino" is really shorthand for what weather forecasters and scientists call the "El Nino-Southern Oscillation" or ENSO. During non-El Nino years, the Earth's warmest ocean water is in a huge pool in the western Pacific Ocean. East-to-West trade winds push water heated by the tropical sun westward, piling it up around Indonesia, Papua New Guinea, the Federated States of Micronesia, and other places west of the International Date Line.

From time to time -- for reasons that remain unknown -- the trade winds weaken and the warm water travels eastward across the Pacific Ocean to South America. The migration of this huge pool of warm water to the east causes both sea-level and sea surface temperature to rise in the eastern Pacific Ocean and fall in the western Pacific. So Pacific Ocean water levels and surface temperatures will be higher and warmer than normal in the eastern Pacific, and lower and cooler than normal in the western Pacific. When the warm water reaches the South American Coast it spreads north and south along the coast, creating the warmer than usual El Nino ocean surface temperatures that begin off the coast of Peru and extend far to the north and south.

What happens to the Pacific Ocean during an El Nino event also affects the atmosphere. As the Pacific Ocean's warmest water spreads eastward, the region of active rainfall and storm formation moves with it. This creates drought conditions in the western Pacific Ocean, and tends to cause typhoons to form much farther to the east than they normally do – usually in the central Pacific Ocean south of Hawaii.

Some scientists have speculated that global warming may cause an increase in the number, strength, or duration of El Nino episodes.

The chart below shows that major El Nino events have occurred during numerous years since the 1700s. There have been indications of El Nino dating as far back as the 1500s. Thus, it seems likely that El Nino episodes have been occurring throughout history. [**Source:** http://www.crseo.ucsb.edu/geos/gif/15.gif]

This figure is not available electronically

The maps below provide a detailed view of how El Nino rearranges the distribution of rainfall over the tropical Pacific. The colors indicate the distribution of sea-surface temperature for a normal month (top map) and a 'warm' El Nino month (bottom map). Red indicates warmer water and blue indicates colder water. The regions of heavy rainfall are indicated by the clouds. The surface trade winds are indicated by the pink arrows. Note how during a normal month (top map), the strong easterly surface winds (arrow) along the equator keep the surface waters of the central Pacific cool (blue). Heavy rainfall is confined to the warm (red) waters of the western Pacific Ocean, including the FSM. During an El Nino month (bottom map), the easterly surface trade winds have weakened and withdrawn to the eastern Pacific, allowing the central Pacific to warm, and the rain area to migrate eastward, outside the FSM. [**Source:** Reports to the Nation: El Nino and Climate Change Prediction, Spring 1994. Boulder, Colorado: University Corporation for Atmospheric Research]

Significance for the FSM. Due to the region of active rainfall and storm formation following the movement of warm water eastward, during a "typical" El Nino event, the FSM suffers drought conditions during the Winter and Spring months. With a severe El Nino episode, drought can begin as early as late Fall and extend into the following Summer. The stronger the El Nino, the longer-lasting the drought conditions will likely be. Whether an El Nino event is "typical" or stronger than usual, Yap and western Chuuk, being in the western part of the FSM, tend to be affected somewhat earlier and, in most cases, more harshly than eastern Chuuk and the eastern FSM states of Pohnpei and Kosrae.

It has not been clearly established whether typhoon activity in the FSM tends to increase with, decrease with, or not be affected by an El Nino event. However, it has been determined that typhoons will tend to form farther to the east and northeast than normal. The typical directions of the storm tracks taken by these typhoons are to the north, northwest, or west. According to one leading Pacific typhoon expert, during an El Nino event, the FSM is most vulnerable to typhoon activity during November and December. It is during these two months that typhoons have the greatest likelihood of forming directly east, and then tracking west, gathering strength before traveling across the FSM.

There has been some concern that strong El Nino events may lead to an increase in "coral bleaching" in some Pacific and Indian Ocean nations. However, at present, it is not at all clear [and seems unlikely] that the coral bleaching that was noticed represented a significant departure from what might occur during any normal year, nor that any such cases have occurred in the FSM during a severe El Nino episode. However, due to the aforementioned critical role played by healthy, undamaged coral reefs in protecting the FSM from vulnerability to accelerated sea-level rise, and wave and storm surge, the extent of any local "coral bleaching" effect due to a strong El Nino event needs to be carefully monitored and assessed.

In summary, over both the short-term and long-term, El Nino episodes represent a significant climate change threat to the FSM because of the drought conditions they cause. And, due to global warming, El Nino events could become more frequent, intense, or longer-lasting in the future. Thus, over the next century, El Nino episodes may come to pose an even greater threat to the FSM.

The brown "boomerang" shaped area of "DRY" (drought) on the map below shows that during the Winter months of a "typical" El Nino year, all the FSM's main islands and almost all of its outer islands receive much less rainfall than during a normal year. During a strong El Nino event, the brown "boomerang" shaped area of drought extends farther to the east, covering the entire FSM, and can remain in place into the late Spring months. [**Source:** http://nic.fb4.noaa.gov/products/analysis_monitoring/impacts/warm.gif]

This figure is not available electronically

La Nina Events

Background. Sometimes, but not always, several months after a warm El Nino event, the trade winds strength, sea-level heights, and sea surface temperatures in the Pacific Ocean can reverse dramatically in the other direction. The trade winds strengthen and warm water travels back westward across the Pacific Ocean and piles up in the western Pacific around Indonesia, Papua New Guinea, and the Federated States of Micronesia. The migration of this huge pool of warm water to the west causes both sea-level and sea surface temperature to rise in the western Pacific Ocean and fall in the eastern Pacific. So ocean water levels and surface temperatures will be higher and warmer than normal in the western Pacific, and lower and cooler than normal in the eastern Pacific – just the opposite of an El Nino episode. Such an event is called a cold "La Nina" episode. As mentioned above, for reasons that remain unclear, a La Nina event does not always follow a warm El Nino event.

As with an El Nino, what happens to the ocean during a La Nina event also affects the atmosphere. As the Pacific Ocean's warmest water spreads westward, the region of active rainfall and storm formation moves with it. This creates heavier than normal rainfall, flooding, and wave and storm surge conditions in many parts of the western Pacific Ocean. The affect of a La Nina episode on typhoon formation and tracking is unclear at this time. It is also not clear at this time whether global warming could result in an increase in the frequency or strength of La Nina episodes.

The green "boomerang" shaped area of "WET" (rain) on the map below shows that during the Winter months of a "typical" La Nina year, all the FSM's main islands and almost all of its outer islands receive much more rainfall than during a normal year. During a strong La Nina event, the green "boomerang" shaped area of rain extends farther to the east, covering the entire FSM, and can remain in place into the Spring months. [**Source:** http://nic.fb4.noaa.gov/products/analysis_monitoring/impacts/cold.gif]

This figure is not available electronically

Significance for the FSM. Due to the region of active rainfall and storm formation following the movement of warm water westward, during a "typical" La Nina event, the FSM suffers heavier than normal rainfall, flooding, and wave and storm surge conditions during the Winter and Spring months. It has not been clearly established whether typhoon activity in the FSM tends to increase with, decrease with, or not be affected by a La Nina event. There has been no evidence presented to date that would suggest strong La Nina events lead to an increase in coral bleaching in the FSM.

In summary, over both the short-term and long-term, La Nina episodes represent a climate change threat to the FSM because of the heavier than normal rainfall, flooding, and wave and storm surge conditions these events cause.

Greenhouse Gas Emissions

Background. A natural greenhouse effect keeps the Earth at a temperature suitable for life. Some of the gases responsible for the greenhouse effect are increasing at an unprecedented rate because of human activity. This increased level of greenhouse gases in the atmosphere will strengthen the natural greenhouse effect, leading to an overall warming of the Earth's surface. This "global warming" resulting from the enhanced greenhouse effect is likely to be obscured for another five to ten or more years.

The extent of human-caused global warming will depend largely on future concentrations of greenhouse gases that humans release into the atmosphere, particularly the levels of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) that are put out. Such releases are hard to predict, because they require an understanding of future human activity. Furthermore, in addition to the amount of greenhouse gases released by natural and human sources, the concentration of these gases in the atmosphere also depends on natural processes (termed "sinks") such as photosynthesis which remove greenhouse gases from it. And, assessing the relative contribution of each greenhouse gas to overall global warming is another challenge to be faced. Thus, accurate prediction of the rate of future global warming faces numerous obstacles and this effort still remains at an early stage of development.

However, it can be stated that the rate at which global warming will occur is tied closely to future releases of greenhouse gases. According to the "Business-as-Usual" scenario developed by the Intergovernmental Panel on Climate Change (IPCC) in 1990, the rate of global warming is projected to be somewhere from 0.3 to 0.9 degrees Fahrenheit (0.2 to 0.5 degrees Centigrade) per decade. This estimate is uncertain because it depends on economic and social development factors.

Significance for the FSM. As noted previously, under IPCC's "Business-as-Usual" scenario, global warming will cause sea-level to rise on a global range from 1.0 to 3.3 feet (0.3 to 1.0 meter) above present levels by the year 2100. Translating global estimates to predictions of climate change on a regional level such as the western Pacific Ocean is a daunting task because the timing and magnitude of regional climate change remains uncertain. However, it is clear that there will be marked regional variations from the global averages. Whatever this variability eventually comes to mean for one or another region; as a small islands developing nation whose population and economic growth are almost exclusively centered in the coastal areas, projected sea-level rise poses a grave threat to the environment and people of the FSM.

There has been some speculation that global warming may lead to an increase in "coral bleaching" in the world's tropical oceans. However, at present, it is not at all clear [and seems unlikely] that this would be the case in the FSM. Still, due to the aforementioned critical role played by healthy, undamaged coral reefs in protecting the FSM from vulnerability to accelerated sea-level rise, and wave and storm surge, the extent of any local "coral bleaching" effects due to global warming would want to be carefully monitored and assessed over time.

As noted previously, some scientists have speculated that global warming may result in an increase in the frequency, strength, or duration of El Nino episodes. Recall that, due to the region of active rainfall and storm formation following the movement of warm water eastward, during a "typical" El Nino event the FSM suffers drought conditions during the Winter and Spring months. And, with a severe El Nino episode, drought can begin as early as the late Fall and extend into the following Summer.

In summary, over the long-term, global warming caused by increased human release of greenhouse gas emissions into the atmosphere represents a grave climate change threat to the FSM for two reasons: (1) The inevitable acceleration in the rise of sea-level that will be caused; and (2) the potential increase in the number, strength, or duration of El Nino events and the resulting drought conditions these episodes cause.

The photograph below shows a portion of Nukuoro Atoll in Pohnpei State. The land area (islets) of the FSM's many atolls rarely exceeds 10 to 13 feet (3 to 4 meters) above present mean sea level.

This figure is not available electronically

Vulnerability and Sectoral Adaptation

Introduction. The FSM has identified six interconnected sectoral areas of interest in which effect-oriented adaptation measures need to be adopted to address the known and potential impacts of the four priority climate change phenomena identified in the previous section. For each of these areas of interest, a number of environmental management and other related measures have been outlined in this communication which could be cooperatively undertaken by the national and state governments to effectively contend with the FSM's major climate change vulnerabilities.

Sectoral Areas
Coral Reef Ecosystems
Coastal Zone Ecosystems
Waste Management
Upland Forest Ecosystems
Agriculture/Agroforestry
Water Supply

Coral Reef Ecosystems

Background. At present, the overall state of the FSM's reef ecosystems can be described as excellent to good. Inspection of numerous locations has shown communities of reef corals to be generally healthy and composed of diverse coral species. What adverse impacts have occurred tend to be localized and for the most part reversible. For example, reef fisheries have come under pressure from destructive fishing and gathering practices. This has resulted in the overharvesting of some stocks of fish and other reef food sources.

However, human threats to the health of the nation's fragile coral reef ecosystems are increasing at an alarming rate. A rapidly growing population, increasing urban and rural coastal congestion, and stresses associated with modernization hold out the very real short-term danger of irreversible reef damage occurring in the near future. The direct sources of these pressures on the FSM's coral reef ecosystems have been well documented: mechanical coral and sand dredging; blasting channels; siltation; pollution from garbage disposal, human sewage, animal waste from commercial operations; freshwater discharge; destructive fishing methods including the use of dynamite, bleach, cyanide and other poisons; overexploitation of reef fishery stocks resulting from the use of imported nets and overcollection of various other marine species such as sea cucumber, crab, shellfish and live coral; damage to live coral from anchor dragging; construction of infrastructure on reefs such as ports, airports and roads; and, a lack of marine protected areas.

Significance for Priority Climate Change Vulnerabilities. The nation's coral reef ecosystems are the first, best, and most effective line of defense against inundation from projected ***Sea-Level Rise*** over the next century. If the FSM protects its coral reefs, these reefs will protect the country's islands. The reason for this is straightforward. Healthy, undamaged corals grow at a rate that will let the FSM's islands grow up with the ***Sea-Level Rise*** that has been estimated to occur here during the next 100 years due to climate change *[.1 to .3 inch (3 to 7 millimeters) or more per year]*. Thus, if climate change phenomena

such as ***Sea-Level Rise*** due to global warming, ***El Nino,*** and ***La Nina*** are the only major climate change factors affecting the future health of the nation's coral reefs (that is, no major human-caused stresses are placed on top of these climate change stresses); then, the FSM can anticipate suffering minimal adverse impacts from ***Sea-Level Rise*** through the year 2100.

Furthermore, in addition to providing both a continuing, sustainable source of subsistence and livelihood, the plentiful stocks of fish and other food sources that characterize a healthy, productive coral reef ecosystem can serve as a natural food bank that can be accessed during times of special need. For example, crop and livestock shortages that could result from extended periods of drought associated with severe ***El Nino*** conditions could be compensated for through exploitation of a healthy, undamaged coral reef ecosystem's variety of food resources.

Succinctly stated, the FSM's coral reef ecosystems must be actively protected. Natural stresses on the nation's reefs due to climate change phenomena are of less immediate concern than direct human-caused stresses. In this regard, any major problems that could be anticipated over the long-term would result from the cumulative effect of these interacting human and natural stresses on the reefs. Therefore, adaptation measures need to be undertaken with a timely sense of urgency, but in a careful manner, to ensure the long-term protection of the FSM's coral reefs from threats resulting primarily from human activities.

Adaptation Measures.

> *Develop a sustainable community-based coral reef protection program modeled upon Pohnpei's Watershed Protection Program. Ensure this program integrates protection components for coastal zones, forests, and other relevant areas.*
>
> *Create marine protected areas that provide for the customary harvesting of reef resources by Micronesians using traditional collection methods.*
>
> *Assess which reef fishery stocks have been overexploited (e.g., rabbit fish and sea cucumber). During certain seasons prohibit harvesting of, place catch limits on, or close specific fishing areas populated by those reef fishery stocks that have been depleted due to this overexploitation.*
>
> *Ban or permit only seasonal use of imported fishing nets.*
>
> *Create a FSM "National Coral Reef Protection 'Green Seal' of Approval" to award to private sector visitor industry and related businesses that undertake specified measures to meet predetermined, strict coral reef ecosystem protection criteria. Publicize through nationally controlled media sources (e.g., tourism literature, Internet websites) which businesses have earned this award. Give these businesses award decals to display at their sites and allow them to publicize that they have earned this award in their own business advertisements and literature.*

For existing and new residential and commercial building construction, provide a yearly rebate (i.e., a scaled percentage up to some maximum) of the owner's total electric bill if the structure meets certain predetermined, strict criteria for coral reef ecosystem protection. For example, one criterion might be the replanting of bulldozed or cleared hillsides or beach areas with trees, shrubs, and plants that have been identified as effective in preventing erosion and stablizing the particular land in question. Another criterion might be whether or not a beach structure is built on stilts.

Enforce a strict ban on the use of dynamite, bleach, cyanide, and other poisons for fishing.

Develop market-driven (dis)incentives that discourage or minimize the large-scale commercial dredging of coral and sand.

At popular diving and fishing sites, work with private sector stakeholders to construct permanent mooring buoys to minimize the destruction of coral due to the dragging of boat anchors. Two examples of this are the mooring buoy projects undertaken in Kosrae and Yap States.

Coastal Zone (and Coral Reef) Ecosystems

Background. Coral reefs create sheltered lagoons and protect sand beaches, mangroves and other shoreline areas against wave damage. In turn, stabilized coastlines, including intact beaches, mangroves, and other areas lying directly inland from the shoreline such as freshwater wetlands, protect reefs from excessive sedimentation due to erosion and from a detrimentally high level of nutrients forming in reef saltwater. For example, mangroves located in muddy reef flats trap sediments and filter out harmful nutrients, thus protecting coral reefs. Mangroves also help preserve coastal lands by acting as natural barriers that protect against erosive wave action, strong coastal winds, and torrential storms. In addition, they promote growth in the size of coastal areas.

Freshwater wetlands such as swamp forests and marshes preserve coastal areas by absorbing excess rainwater runoff from storms. This helps to contain flooding, trap sediments and filter out nutrients, again protecting coral reef ecosystems. The vegetation growing along the back edge of and directly behind beaches -- mostly plants and shrubs adapted to sunny, windy and salty conditions -- helps prevent coastline erosion, once again protecting coral reefs from damaging siltation. In addition to playing an important role in coastal land stabilization, mangroves, freshwater wetlands, vegetation and seagrasses also provide a food source, and spawning, breeding, nursery, and nesting habitats for reef and ocean fish, crabs, shellfish, migratory birds, bats, lizards and a multitude of other marine and non-marine life. Mangroves and freshwater wetlands also provide an important food source for humans.

Significance for Priority Climate Change Vulnerabilities. The well-being of coral reef and adjacent coastal area ecosystems are intimately connected. Threats to the coastline's natural habitats represent direct threats to the health and productivity of the coral reefs, and vice versa. As emphasized previously, the nation's coral reefs, if they remain healthy and intact, are the best, most effective line of defense against inundation from projected ***Sea-Level Rise*** due to global warming and other factors over the next century. Further, because healthy coastline habitats such as mangroves and freshwater wetlands contain a naturally occurring food source for the human population, like with healthy coral

reef habitats, these habitats' food supply can be exploited during extended periods of drought associated with severe ***El Nino*** conditions.

Adaptation Measures.

> *Ensure that a community-based coral reef protection program encompasses sustainable management of coastal areas adjacent to the shoreline.*
>
> *Undertake widespread, large-scale mangrove reforestation.*

The photograph below shows a mangrove area that has been clear-cut in front of Maslu Village on the north coast of Kosrae. [**Source:** SOPAC Technical Report 228, July 1996]

This figure is not available electronically

> *Discourage the harvesting of mangroves for firewood and building material, and the clear-cutting of mangrove areas for home sites or to "open up a view" of the lagoon or ocean.*
>
> *Place a nationwide moratorium on commercial mangrove logging until sustainable yields can be determined and suitable regulations established to ensure overharvesting does not take place.*
>
> *Encourage maintenance or restoration of the natural vegetation that grows along the back edge of and directly behind beaches -- mostly plants and shrubs adapted to sunny, windy and salty conditions.*
>
> *Utilize Micronesian technologies and practices to promote shoreline stabilization and coastal area ecosystem preservation. Discourage the use of contemporary seawall, groyne, and revetment construction. Three examples of these types of local measures are (1) the nearshore "Sea Fences" in Yap, (2) the nearshore "Staggered-stone Sea Fences" in Yap, and (3) the use of stilts in construction of shoreline structures as in Kosrae.*

The photograph below shows a traditional Yapese "Sea Fence". For centuries they have been built to limit coastal erosion and block excessive amounts of sediment from flowing out onto the coral reefs.

This figure is not available electronically

> *Create and strictly enforce a ban on the purchase for commercial resale of any size female mangrove crab, and any male mangrove crab with a shell less than a prescribed number of inches across from "horn to horn."*
>
> *Complete climate change vulnerability assessments for each state in the FSM. Based on these studies, develop a comprehensive and detailed set of GIS coastal inundation zone maps for the FSM. Make this set of maps readily available to citizens, the private sector, government agencies, and any other stakeholders as a means of informing their decisions with respect to long-term coastal planning and development efforts (e.g., infrastructure, human settlement, cultural and historical site preservation, resort construction).*

The photograph below shows two parallel rows (foreground and background) of traditional Yapese "Staggered-Stone Sea Fences" which for centuries have been built by placing large coral rock just offshore in a randomly spaced arrangement that limits coastal erosion and blocks excessive amounts of sediment from flowing out onto the coral reefs.

This figure is not available electronically

Waste Management (and Coral Reef & Coastal Zone Ecosystems)

Background. At present, solid and liquid waste pollution in the FSM comes primarily from domestic sources. However, with the strong government emphasis on economic development, it is anticipated that the generation of both solid and liquid waste will increase in quantity and type in the near future.

Currently, there is no public solid waste collection system in the FSM. Consequently the disposal of household garbage is a major concern. This situation is not restricted to urban centers, but extends to main island rural areas and to the outer islands. Household garbage is often dumped in coastal area mangroves and freshwater wetlands to create land for family and community use. In addition to being a health hazard and aesthetic eyesore, this method of waste disposal reduces the size of important mangrove and freshwater wetland habitats in the FSM. Leaching from this waste also causes marine pollution that represents a direct threat to the health and productivity of extensive portions of coastal area, and therefore, coral reef ecosystems.

The repair, maintenance, improvement and expansion of existing treatment plants for human sewage is a major concern for rapidly expanding coastal urban areas. Due to less than adequate sewage treatment and disposal, and the fact that no treatment systems are available to handle industrial waste; marine pollution is an increasing issue in all major FSM population centers. Human sewage and animal waste along rural shoreline areas is also becoming a major concern due to the increasing density of human settlement and the recent development of commercial livestock operations such as piggeries and chicken farms. If not adequately addressed, marine pollution from these sources will contribute significantly to degradation of coastal area and coral reef habitats.

Significance for Priority Climate Change Vulnerabilities. The problems of solid waste, human sewage, and to a growing extent animal waste disposal represent a major danger to the health and productivity of coastal area ecosystems. In turn, degraded coastal habitats directly threaten the health and productivity of coral reef ecosystems. And, dead or unhealthy coral reefs would leave the FSM's islands vulnerable to coastal inundation from ***Sea-Level Rise*** due to global warming. As well, unhealthy coral reef and coastal area habitats would mean less productive food sources for exploitation during times of special need such as extended periods of drought caused by severe ***El Nino*** events.

Adaptation Measures.

> *Identify suitable inland landfill sites for major dumps or local garbage pits for urban, rural and outer island communities throughout the nation. Shift solid waste disposal to these more appropriate locations and ensure the sites are properly managed. Facilitate the establishment of private sector refuse collection businesses to deliver garbage to these new dumps or garbage pits .*
>
> *Undertake a comprehensive nationwide recycling program for packaging and other types of products made of plastic, aluminum, and glass. Subsidize funding for this effort through a refundable deposit on major packaging products (e.g., aluminum cans, plastic and glass bottles, plastic bags).*
>
> *Ban or create (dis)incentives that discourage the use or random discarding of all plastic packaging products (e.g., plastic bags, plastic "six-pack" rings) that have been shown to be detrimental to the reef ecosystem including corals, turtles, and sharks.*
>
> *Develop and implement a long-range plan for the adequate treatment and disposal of urban and rural area human sewage, and waste from rural area commercial livestock operations.*

Upland Forest (and Coral Reef & Coastal Zone) Ecosystems

Background. The upland forest areas found on the FSM's highest islands serve several important ecological functions. Perhaps most importantly, the extensive root systems of the forest trees and underlying plants and shrubs (aided by a ground layer of decomposing vegetation) serve to capture rainfall by slowing down surface runoff. This provides time for the water to sink into the ground where it is filtered and slowly released into the streams and rivers that eventually make their way to the coastal zone mangroves, freshwater wetlands, and coral reef lagoon. Through this process of slowing down rainwater surface runoff, the upland forests act to significantly reduce soil erosion, and thus help protect freshwater wetlands, mangrove areas and coral reefs from the degrading effects of sedimentation.

Furthermore, by slowing down surface runoff and allowing rainwater to gradually seep into the ground, the upland forests facilitate the slow release of ground water which helps ensure stream flow during relatively dry periods. It also acts to reduce flood the severity of flooding when it occurs.

Significance for Priority Climate Change Vulnerabilities. As has been stressed throughout this communication, protecting the health and productivity of the nation's coral reef and coastal area ecosystems is essential to maintaining an effective line of defense against projected ***Sea-Level Rise*** and coping with periods of drought caused by severe ***El Nino*** conditions. Further degradation of the upland forests on the FSM's highest islands would mean increased soil erosion, and consequently increased sedimentation of coral reefs, mangroves, and freshwater wetlands. This would obviously have an adverse impact on the health and productivity of these two crucial habitats.

Maintaining healthy upland forest ecosystems are also critically important during extended and heavy periods of rain such as those associated with ***La Nina*** conditions. As noted above, by slowing down surface runoff and allowing rainwater to gradually seep into the ground,

the upland forests act to reduce the severity of flooding. As also mentioned, the forest trees, shrubs, and plants have extensive root systems which act to stabilize saturated hillsides and so lessen the risk of destructive landslides occurring – with sometimes deadly consequences.

The two Pohnpei Watershed maps below were taken from a very effective 'in-venacular' public awareness campaign poster that was displayed prominently outside most small, rural 'family' stores throughout Pohnpei in 1997. It was part of the Pohnpei Watershed Protection Program's continuing "grass-roots" community outreach activities. The Pohnpeian word "nanwel" means virgin forest land, and "nansapw" means land that is farmed, lived on, or developed for other purposes. At the top of the maps, the sentences say: "In the year 1975, 42 percent of our home, Pohnpei, was virgin forest land. In the year 1995, only 15 percent remained." The words at the bottom say: "These maps are pictures of our home, Pohnpei, that were taken from an airplane flying overhead." [**Source:** The Pohnpei Nature Conservancy]

This figure is not available electronically

Adaptation Measures.

> *Where appropriate, ensure that an upland forest (watershed) protection program component (modeled after Pohnpei's Watershed Protection Program) is integrated into any nationwide community-based coral reef protection program (which would also have a component encompassing the sustainable management of coastal areas adjacent to the shoreline).*
>
> *Facilitate the further development of Pohnpei's Watershed Protection Program, and extend this program model to the other states.*

Agriculture/Agroforestry

Background. Agricultural production in the FSM is primarily for subsistence, with growing commercial activity. Almost every household engages at least part-time in agricultural cultivation. One major aspect of this subsistence production takes the form of garden areas for root-crop cultivation, especially taro and yam. Taro, both dryland and wetland types, is cultivated throughout the FSM and is an important dietary staple. In the inhabited atolls, community taro patches are maintained by pit-culture in the central island trough, and represent a substantial local food resource.

Subsistence and commercial agricultural production also includes the cultivation of vegetables such as bell pepper and green onion, interspersed with a high proportion of food trees, particularly coconut, breadfruit, banana, mango, and papaya. Other subsistence and commercial cultivation includes fruit trees such as lime, tangerine, and orange, as well as crops such as sugarcane, betel nut, pepper, sakau, and coffee. Integrated with the mix of food crops are a variety of plants and shrubs used for medicine, condiments, fiber, handicrafts, and ornaments.

Significance for Priority Climate Change Vulnerabilities. Protection of the nation's irreplaceable food-production base is essential. Any climate change that adversely affects the cultivation of such local dietary staples as taro, banana, breadfruit, yam, and coconut is a major threat to the health and well-being of the citizens of the FSM. When intense, an ***El Nino*** event produces drought conditions across the FSM that have severe negative impacts on local agriculture. For example, increased saltwater intrusion resulting from drought-induced lowering of the freshwater lens on coral atolls can kill much of the taro crop. And, on all the FSM's islands, reduction in crop yields can be staggering: losses of coconut from

50-55%, losses of breadfruit from 50-80%, losses of taro and yam from 60-70%, and losses of banana from 25-75%.

Paradoxically, a strong ***La Nina*** event can also have damaging repercussions for the taro crops of coral atolls and other low-lying coastal areas in the FSM. The temporary rise in sea-level, and the increased frequency and magnitude of wave and storm surge that accompanies a strong ***La Nina*** episode in the FSM can result in saltwater intrusion killing a substantial portion the taro crop. Likewise, if the health of the coral reefs are not protected so the nation's islands can grow up with the projected long-term ***Sea-Level Rise*** caused by global warming; then, this sea rise in combination with wave and storm surge activity will result in saltwater intrusion having a destructive impact on the taro crops of coral atolls and other low-lying coastal areas.

Adaptation Measures.

> *In a forecasted strong El Nino year, have state agricultural extension agents encourage farmers to plant appropriate local, normally 'dryland' crops in freshwater wetland areas such as taro patches, marshes, and swamps .*
>
> *Discourage widespread use of inorganic fertilizers and chemical pesticides.*
>
> *Create taro patches better able to tolerate saltwater intrusion by encouraging farmers to employ traditional taro patch composting practices on an extensive and continuing basis in order to build up soil level and fertility.*

The picture below was taken on Nukuoro Atoll in Pohnpei State. It shows a Nukuoro community taro patch in various stages of restoration. The dark area of soil in the middle is an unrestored portion of the patch which was made infertile by saltwater intrusion. In the past, nearly the entire patch was in this condition. The portion of the taro patch in the picture's foreground is in the process of being rehabilitated. Notice that this area has been sectioned-off using stacked-up coconut husks, and then coconut, banana, and other types of leaves as well as a variety of other biomass are piled up inside and composted. This simultaneously builds up the soil height and fertility. In the background of the picture are fully rehabilitated sections of the patch with densely growing, healthy taro.

This figure is not available electronically

Water Supply

Background. In the FSM, the majority of the public's water supply comes from surface water sources such as rivers, streams, and individual roof rainwater catchments, or fresh to brackish groundwater sources such as springs and shallow hand-dug wells. In several places, groundwater from deep drilled wells (bores) is also available.

In the coral atolls and in those coastal areas composed of sand deposits and lagoon sediments, the fragile freshwater lens which "floats" on the underlying denser seawater is tapped and used along with rainwater catchments as the main source of water for drinking, cooking, washing, and bathing.

Significance for Priority Climate Change Vulnerabilities. An adequate supply of water readily accessible for public consumption on a continuous basis is a goal that has not

yet been achieved in the FSM. Any climate change phenomenon that threatens the present supply of this critical, and at times, scarce resource represents a major threat to the health and well-being of the citizens of the FSM. A strong ***El Nino*** episode produces drought conditions in the FSM severe enough to: (1) completely dry up many of the springs, and not allow for adequate recharge of the shallow wells and roof rainwater catchments that individual village homes depend on for their water supply; (2) reduce river and stream flows to levels insufficient to meet the community water demands of many other villages and large population centers; and, (3) lower a coral atoll's freshwater lens to the point where saltwater penetrates the lens making it too brackish or salty for human use.

Ironically, a strong ***La Nina*** event can also have a damaging effect on the fragile freshwater lens of coral atolls and those coastal areas composed of sand deposits and lagoon sediments. The temporary rise in sea-level, and the increased frequency and magnitude of wave and storm surge that accompanies a strong ***La Nina*** episode in the FSM can result in saltwater intrusion of the lens making the water unfit for human consumption. Likewise, if the health of the FSM's coral reefs is not protected so that the nation's islands can grow up with the estimated long-term ***Sea-Level Rise*** caused by global warming; then, this projected sea rise in combination with wave and storm surge activity will result in the same destructive saltwater penetration of the freshwater lens.

Adaptation Measures.

> *Increase the available public water supply on high volcanic islands by identifying appropriate locations, drilling deep wells (bores), and constructing suitable water system infrastructure.*
>
> *Identify and construct appropriate (i.e., small-scale, low technology, low maintenance, inexpensive) solar desalination systems to increase the fresh potable water supply in atoll communities and other insular coastal areas. And, improve present community water systems on atolls and in other insular coastal and rural areas by constructing additional roof rainwater catchments.*

Vulnerability and Sectoral Mitigation

Greenhouse Gas Inventory

Background. The FSM Greenhouse Gas Inventory addressed national emission estimates for applicable sectors: Energy, Industrial Processes, Solvent Use, Agriculture, Land Use Change and Forestry, and Wastes. Succintly stated, the nation's human-sourced greenhouse gas emissions represent a negligible percentage of the world's total human-sourced release of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and other greenhouse gases. For example, the country has estimated yearly emissions from the energy sector, its largest source of greenhouse gas emissions, of about 146.0 Gigagrams of carbon dioxide. And, there are no greenhouse gases emitted from industrial sources. In fact, it has been speculated that because of the "sink" capacity of its extensive forest and coral reef systems, the nation may produce a net "uptake" of greenhouse gases.

Significance for Priority Climate Change Vulnerabilities. As a deeply concerned member of the international community, and one of the nations most directly threatened by the adverse effects of global warming; the FSM recognizes the need to set an example by making every reasonable effort to control the level, no matter how negligible, of the human-sourced ***greenhouse gases*** it does emit into the atmosphere. In this regard, the FSM is committed to undertaking the mitigation measures necessary to develop as a model for others to emulate.

As it begins to implement the sectoral effect-oriented adaptation measures previously suggested in this national communication; in most cases, the FSM will simultaneously be undertaking source-oriented [that is, ***greenhouse gases***] mitigation measures. For example, extensive coral reefs actively protected will be photosynthesizing and converting carbon dioxide into coral. Likewise, protected mangroves and other forest areas will be photosynthesizing and converting carbon dioxide into biomass. Consequently, as the nation begins to undertake climate change adaptation measures that focus on comprehensive environmental management, it also begins to maximize it's potential contribution toward controlling global ***greenhouse gas*** emission levels by sustaining or increasing the "sink" (or "uptake") capacity of its coral reefs, and coastal and upland forests.

Mitigation Measures.

> *Implement programs for the reforestation of mangrove, upland forest, and other forest areas that have been clear-cut or overharvested.*
>
> *Develop a sustainable community-based coral reef protection program modeled upon Pohnpei's Watershed Protection Program. Ensure the program integrates protection components for coastal zones, forests, and other relevant areas.*
>
> *Undertake the other Mitigation-related sectoral Adaptation Measures listed under Coral Reefs, Coastal Zones, Waste Management, Upland Forests, Agriculture/Agroforestry, and Water Supply.*
>
> *Continue to promote renewable energy alternatives, especially solar, in the outer islands and other insular areas of the nation.*

Cross-Sectoral Measures

Introduction. Cross-sectoral measures refer to types of support measures that could be applied across the six sectors discussed earlier. Such measures can help to reinforce the implementation of the adaptation and mitigation measures that were listed under these different sectors. The FSM has identified four cross-sectoral areas of interest in which measures need to be developed and adopted to address the known and potential impacts of the four priority climate change vulnerabilities identified earlier: (1) public awareness programs, (2) research programs, (3) technology development and transfer, and (4) interagency strengthening. For each of these four areas of interest, cross-sectoral measures have been outlined below which could be cooperatively undertaken by the national and state governments to effectively contend with the FSM's major climate change vulnerabilities.

Cross-Sectoral Areas
Public Awareness Programs
Research Programs
Technology Development & Transfer
Interagency Strengthening

Public Awareness Programs.

Promote water conservation and fire danger awareness and coping methods on both high islands and atolls, especially during anticipated El Nino events.

Develop appropriate curricula in climate change and related environmental education for primary and secondary schools, and the College of Micronesia.

Develop a "grass-roots" community education program that informs citizens about climate change and related environmental areas.

Train government extension officers in climate change and related environmental areas to raise their awareness.

Continue to raise the awareness of top-level government leaders and politicians about climate change and related environmental concerns.

Develop supplemental outreach materials for national climate change personnel and their state agency counterparts. Provide these personnel with basic training in effective public meeting ' facilitation' skills.

Research Programs.

Document traditional Micronesian knowledge of environmental management systems for future application (e.g., incorporating stilt construction in shoreline structures as in Kosrae, and building various Yapese styles of "sea fences").

Complete any vulnerability or other needs assessment studies required prior to implementation of any adaptation and mitigation program measures.

Design an evaluation component into each adaptation and mitigation program measure implemented.

Technology Development & Transfer.

Develop and implement where appropriate the traditional Micronesian knowledge of environmental management systems documented through the first Research Program measure listed above.

Network with such organizations as the South Pacific Regional Environmental Programme (SPREP), and the SEAGRANT Program to identify, transfer, and modify as required by local circumstances, appropriate technologies for use in implementation of sectoral climate change adaptation and mitigation measures.

Interagency Strengthening.

Implement the NEMS recommendation for the structuring of the Sustainable Development Council into four basic working groups:

** Management and protection of natural resources.*
**Improvement of waste management and pollution control.*
**Improvement of environmental awareness and education .*
**Integration of environmental considerations in economic development.*

Address climate change adaptation and mitigation measures in the context of these four working groups.

Concluding Remarks

The environmental management focus of the sectoral and cross-sectoral climate change measures outlined in this national communication has been selected based upon a simple truth: *The social, cultural, and economic prosperity of the Federated States of Micronesia has been and will continue to be directly dependent upon the health of its coral reefs and interconnected ecosystems.* In the arena of climate change, this truth remains paramount. If the FSM is to effectively cope with climate change impacts, the nation must build an appropriate local strategy, capacity, and acceptance of responsibility for management of its coral reefs and other interrelated ecosystems. Successful local implementation of such an effort will depend upon the support, cooperation, and full participation of all important stakeholders, especially customary owners and users of these resources.

As this national communication outlines in some detail, to effectively contend with the FSM's major climate change vulnerabilities, both short-term and long-term, the nation must work cooperatively to achieve a common goal*: The conservation and sustainable use of its coral reefs and other associated ecosystems.* This goal can be reached with the active support and involvement (i.e., commitment of financial, technical, manpower, and other needed resources) of stakeholders at all levels: international, regional, national, state, municipal, and community. Attaining this goal can be facilitated by the active participation of private sector businesses, and governmental, non-governmental, and other agencies, organizations, and institutions.

Ultimately however, the key to achieving the conservation and sustainable use of the FSM's coral reefs and associated ecosystems resides within the local communities. The people who live, physically and spiritually, as a natural part of these fragile ecosystems will have to decide whether or not to make the commitment for themselves, and on behalf of their future generations, to adopt and implement a comprehensive, fully participatory, community-based management approach to their environment.

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Acronyms

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
ASLR	Accelerated Sea-Level Rise
DWFN	Deep Water Fishing Nation
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ENSO	El Nino - Southern Oscillation
FSM	Federated States of Micronesia
GDP	Gross Domestic Product
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
NEMS	National Environmental Management Strategies
PICCAP	Pacific Islands Climate Change Assistance Programme
SD	Sustainable Development
SPREP	South Pacific Regional Environmental Programme
USCSP	United States Country Studies Program