THE FEDERATED STATES OF MICRONESIA

NATIONAL COMMUNICATION

PREPARED UNDER

THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

OCTOBER 1999

LIST OF SELECTED ACRONYMS

CDM	Clean Development Mechanism
DWFN	Distant Water Fishing Nation
EEZ	Exclusive Economic Zone
ENSO	El Niño-Southern Oscillation Cycle
FSM	The Federated States of Micronesia
GCM	General Circulation Model
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
OTEC	Ocean Thermal Energy Conversion
PICCAP	Pacific Islands Climate Change Assistance Programme
SPREP	South Pacific Regional Environment Programme
SOPAC	South Pacific Applied Geoscience Commission
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
USCSP	United States Country Studies Program

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FSM NATIONAL COMMUNICATION
UNDER THE
UN FRAMEWORK CONVENTION ON CLIMATE CHANGE
OCTOBER 1999
POLICY MAKERS SUMMARY

INTRODUCTION

The Federated States of Micronesia (FSM) is a grouping of 607 small islands in the Western Pacific about 2,500 miles southwest of the U.S. State of Hawaii and lying just above the Equator (between the Equator and 14 degrees North latitude and between 136 degrees and 166 degrees East longitude). FSM comprises what has been known generally as the Eastern and Western Caroline Islands. FSM is a young, independent nation created from part of the former United Nations Trust Territory of the Pacific Islands previously administered by the United States. The FSM concluded a Compact of Free Association with the United States in 1986 and became a member of the United Nations in 1991.

The diverse habitats and species which characterize these islands have always had a profound influence on the Micronesian peoples and their cultures. The FSM is comprised of four states – Yap, Chuuk, Pohnpei and Kosrae. The country's total land area amounts to only 262 square miles, but the territories of the FSM also include an estimated 1,506 square miles of lagoons (Gawel, 1993) and an Exclusive Economic Zone totaling 1,149,508 square miles (Asian Development Bank, 1996). The geographic range of the FSM covers 1,700 miles from east (the State of Kosrae) to west (the State of Yap). Each of the four States centers around one or more "high islands" and all but Kosrae include numerous atolls.

This geographic dispersion, high ecological variety and the rich, cultural diversity within FSM are important factors in considering how the nation embraces the challenges and opportunities of economic development and environmental stewardship – including the nation's response to climate change. There are marked differences among and even within the four States, reflecting a variety of natural conditions and social structures which have evolved over the thousands of years since the islands were first settled. Each State is concerned with the demands of its main island population center and rural areas as well as the unique requirements of its insular outer islands which can, themselves, differ markedly in terms of demographics, economics and culture. Each State has devised its own strategies for sustainable development, while an integrated perspective for the federation is provided by the national government.

Recognizing the beauty of the land and abundance of the sea, the inhabitants of the FSM have developed settlement patterns in keeping with their surroundings. Each inhabited island is divided into municipalities, villages (sections of municipalities), and farmsteads (smallest land holding unit within a village). The manner in which the people have arranged their landscape varies from dispersed settlement to neatly clustered villages. Special importance is attached to land in Micronesia both because of its short supply and its traditional importance.

NATIONAL CIRCUMSTANCES

Table 1.3 provides a summary of the National Circumstances of the FSM using the United Nations Framework Convention on Climate Change (UNFCCC) guidelines for National Communications.

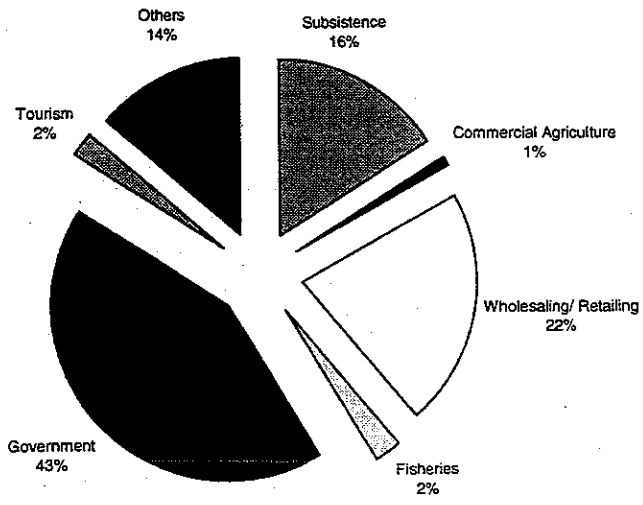
Table 1.3 National Circumstances

Criteria:	**1994**
Population	**105, 506**
Relevant Areas	**Land : 701** **Coral lagoon: 7,190** **EEZ: 2,600,00**
GDP(US$)	**$210,759,000**
GDP Per Capita(1994)	**$1,997.6**
Estimated share of the Informal Sec. in the Economy in GDP	**19.96%**
Share of industry(Fisheries) **in GDP**	**17%**
Share of services (Private Sector & Government) **in GDP**	**81%**
Share of Agriculture in GDP	**2%**
Land area used for agricultural purposes (square kilometers)	**250**
Urban population as Percentage 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: Department of Economic Affairs:
Federated States of Micronesia 1996 Economic Report (Office of Pacific Operations , Asian Development Bank, March 1997): and
1994 FSM Census of Population and Housing (FSM Office of Planning and statistics ,October 1996)

The Gross Domestic Product (GDP) of the FSM is estimated at roughly $211 million with a population of 105,506 whose per capita income is estimated at $1,997.60. According to presentations at the 2d FSM Economic Summit (September 1999), three main activities – subsistence farming, the distribution of goods (wholesaling and retailing) and provision of government services dominate the economy (see Figure 1.2). Commercial agriculture, fisheries and tourism are recognized as providing long-term growth potential but currently play a very small role in the FSM economy.

Figure 1.2 The Structure of the FSM Economy (1996)



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, few current commercial fruit and vegetable production units are no larger than 20 acres in size. Subsistence production is based mainly on a shifting cultivation system. This system takes the form of garden areas for root-crops (taro and 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 crops is a growth of plants and shrubs used for a number of other local purposes.

Coastal areas play a pivotal role in the culture and the economy of the FSM by supporting centers of population and attractive development sites as well as areas of active subsistence agriculture and fisheries activities. Historically, the inshore and near-shore marine environment is the source of a wide variety of traditional foods and this remains true today. The population of outer islands continues to rely predominantly on subsistence cropping and fishing (Asian Development Bank, 1996).

Mangrove forests play an important role in the coastal environment in many FSM states by: providing food and a protective environment for important species of fish, shellfish, crabs and other marine life; stabilizing coastal areas by protecting the coast from waves and storms and trapping sediment from upland erosion (thus protecting coral reefs); and providing a variety of subsistence products such as firewood, timber, thatch and medicines.

Coral reefs are a particularly important resource because of their roles in: protecting beaches and coastlines from erosion associated with storms and variations in sea level; providing local construction materials; serving as a habitat for marine fisheries; and an important draw for the emerging tourism industry.

The marine environment is of enormous importance to the people of the Federated States of Micronesia. The nation's marine resources are extensive and, in many ways, central to the future social, cultural, and economic prospects of the FSM. The exclusive economic zone of the FSM comprises 1,149,508 square miles. Tuna is the primary fisheries resource, including both surface schooling and deep-water, highly-migratory species. Pelagic fisheries resources, particularly tuna, appear to offer great potential for further exploitation, although the full extent of these resources has not been assessed accurately. The FSM National and State Governments expect that activities related to pelagic fishing will provide long-term economic benefits by providing jobs and substantial export revenue. Climate processes, such as the El Niño-Southern Oscillation (ENSO) cycle, are considered to be one of the key limiting factors to the development of the tuna industry in the FSM (Konno and Abraham, 1999).

Tourism is, as yet, an infant industry in the FSM but already contributes to the nation's economy in terms of employment, exports and income – particularly in service industries like hotels, restaurants, car rentals, etc. The visitor industry on Pohnpei is the single largest earner of foreign exchange in the State. All State economic development plans foresee considerable expansions of tourism activities for the coming decade. Current tourist activity emphasizes ecotourism, adventure tourism and cultural tourism. A precursor to the realization of the great potential for growth of the tourism sector is investment in tourism infrastructure, including additional accommodations, improved recreational opportunities and essential infrastructure in critical areas such as water resource management and transportation.

Maintaining adequate water resources is an important consideration for the FSM, particularly in low-lying atoll islands with a limited freshwater lens and a dependence on rainfall catchment as a principal source. Freshwater resources in the FSM are provided through a combination of: surface water resources associated with rivers and streams; rainwater catchment systems; and some groundwater resources through aquifers, particularly on high islands. Only Kosrae and Pohnpei have perennial streamflow and the large deltas of rivers with short stream length and steep channel gradients attest to the very high rainfall which occurs in the mountainous interiors of these islands. In atolls of the FSM, the freshwater lens "floats" on the underlying denser seawater and is tapped through shallow, hand-dug wells. This water supplements the rainwater catchment and storage tanks which are widely used and commonly the main source of drinking water in the outer islands.

Climate in the FSM

The islands of the FSM enjoy a tropical climate with relatively even, warm temperatures throughout the year – average temperature is approximately 80°F year-round. Summers (June through September) normally bring 50 to 80 percent more rainfall than winters. In part, this summer-winter difference in rainfall is related to the fact that FSM receives at least part of its rainfall from tropical cyclone events (with the season for tropical storms normally defined as June to November for areas north of the Equator).

Natural Variability

The people and governments of the FSM already face significant climate-related challenges associated with the cycle of El Niño and La Niña events in the tropical Pacific:

- changes in rainfall resulting in severe drought in many jurisdictions during El Niño events;
- changes in patterns of tropical storms;
- changes in the risks of storm surge, coastal erosion and saltwater intrusion associated with temporary variations in sea level which accompany the evolution of El Niño and La Niña across the tropical Pacific (La Niña events tend to bring higher than normal sea level conditions to the FSM); and
- changes in the migratory patterns of important fisheries like tuna.

Anticipating and responding to these changes – i.e., **adapting to natural climate variability – not only has significant near-term benefits but also provides valuable insights into the vulnerability of FSM communities, businesses and ecosystems to some of the potential consequences of climate change and important adaptation experience**. This is particularly important in light of a South Pacific Regional Environment Programme (SPREP)-sponsored 1999 analysis of regional climate change scenarios (derived from general circulation models) that suggests future temperature and rainfall patterns roughly consistent with an "El Niño-like state" (Jones et al, 1999).

Future Scenarios

Likely future scenarios associated with long-term climate change have been investigated using global climate models which attempt to capture the complex, coupled interactions among ocean, atmosphere and land that characterize the Earth's climate system. In February 1999, scientists from the Australia CSIRO Atmospheric Research group summarized their analysis of the results of six general circulation models (GCM's) for four Pacific regions (including Micronesia) in a study prepared for the South Pacific Regional Environment Programme (Jones et al, 1999). Based on this analysis, they recommended the use of IPCC (1996) projections of temperature and sea-level projections until projections based on new IPCC scenarios are available. Their model-based analysis of rainfall showed an increase over the central and eastern Pacific during both summer and winter seasons while changes over other regions were smaller, though tending towards an increase with moderate confidence for Polynesia N (a region straddling the equator at 5N to 10S and 145W to the dateline) but low confidence for the sign of rainfall changes elsewhere in the Pacific. This study notes, however, that the dominant influence in this region on rainfall (like winds, sea level, surface pressure and a number of other climate variables) is the ENSO cycle and that the model analysis shows a "more El Niño-like mean state over the Pacific under climate change" which would result in a distribution of rainfall patterns similar to that experienced currently under El Niño conditions. Although the CSIRO give low confidence to projections of rainfall from these models (except in the region of Polynesia N noted above), this could imply a tendency toward drier and warmer conditions in the western two-thirds of FSM, especially in the northern hemisphere winter months when ENSO impacts are strongest.

Currently, as part of the first National Assessment of the Consequences of Climate Variability and Change for the United States, scientists at the U.S. National Weather Service's National Centers for Environmental Prediction (Barnston, 1999) are investigating possible climate changes using the United Kingdom's Hadley Climate Model (HADCM2) and the first generation Canadian Coupled General Circulation Model (CGCM1). Both of these models run 100 years into the future with atmospheric gas concentrations (greenhouse gas plus sulfate aerosols) prescribed at a rate representing a continuation of what has already been observed over the past 30 years. These models agree on large-scale patterns but, importantly, differ somewhat on smaller scales – a fact that can be extremely important for small island jurisdictions surrounded by large expanses of ocean.

Even with these differences, **both models indicate a continuation of the slight changes that have already been observed over the last few decades. This implies that the western two-thirds of the FSM (Yap and Chuuk) would show a gradual drying tendency, primarily during winter months. In summer, while some further drying may occur, it could be followed by a tendency toward more rainfall, especially in the eastern portion of the FSM (Pohnpei and Kosrae)** as a result of **a gradual increase in the frequency of tropical cyclones for islands in the central and east-central Pacific**, both north and south of the equator.

These models also show that the region of very warm ocean water that has resided in the western tropical Pacific will tend to expand farther toward the east into areas slightly east of the date line that now experience very warm water only during an El Niño. **The expected result is a gradual increase in the frequency of tropical cyclones for islands in the central and east-central Pacific (both north and south of the equator). This would result in a tendency toward more cyclones for FSM (as well as Palau, Guam, the Marshall Islands and Hawaii).**
A recent analysis of regional climate change scenarios by CSIRO also **suggests that tropical cyclones may become 10-20% more intense during a period when atmospheric carbon dioxide has doubled (between 2030 and 2060).** This increased tendency toward more-intense cyclones for the FSM (with the possibility of an overall tendency toward more tropical cyclones as suggested by Barnston) has implications for coastal ecosystems, communities, infrastructure, economic development and public health and safety that involves far more than just changes in rainfall and the availability of water.

Complicating this potential threat from an increase in tropical cyclones, is the projected sea-level rise associated with most climate change scenarios. The Second Assessment Report of the IPCC concluded that global average sea-level rise would be on the order of 0.15 meters to 0.95 meters by 2100. Translating such global estimates into local or region-specific changes is difficult and complicated by many factors, including the fact that natural variability in the climate system such as ENSO bring year-to-year changes in sea level to many jurisdictions in the Pacific. Even with these uncertainties, a small island nation like the FSM -- whose population and economic centers are located in coastal areas -- must take the possibility of sea level rise seriously as a threat to our people and our environment. As a result, most of the initial work on the impacts of climate change for the FSM has focused on the consequences of accelerated sea level rise, including: inundation of low-lying coastal areas with implications for both coastal ecosystems and communities; increased erosion from wind and wave action with particular concerns about damages associated with tropical storms; and salt-water intrusion with implications for freshwater availability as well as the health/survivability of some coastal ecosystems. As many studies have described, the consequences of accelerated sea level rise will be superimposed on coastal ecosystems and human communities that are already subject to natural climate variability (e.g., ENSO and tropical storms) and the pressures of increasing population and development.

The Context for Climate Change

FSM communities, businesses and governments of the FSM are addressing climate change in the context of three broad challenges:

- **Promoting Economic Growth**
- **Balancing Resource Use and Management**
- **Ensuring Quality of Life**

The government agencies at all levels and the people of the FSM recognize that changes in climate (both natural and human-influenced) have significant consequences in all these areas. In light of this, the FSM Government believes that the most effective national climate policy entails a response strategy that **addresses the impacts and sources of climate change in both the near- and long-term**. This response strategy, therefore, recognizes and emphasizes:

- the **"value-added" benefit of flexible approaches which provide for both adaptation and mitigation at the same time**, combining an aggressive focus on impact-oriented adaptation measures with source-oriented mitigation measures. An example of this dual approach involves the pursuit of environmentally-sound technologies that address both adaptation and mitigation objectives such as the use of renewable energy technology for water desalination projects;

- the **importance of understanding and responding to the consequences of mean oceanic and atmospheric conditions and natural climate variability (such as ENSO)** to both build resilience for today's communities, businesses and ecosystems and develop insights into vulnerability and adaptation challenges associated with longer-term climate change;

- **the important role that emerging scientific insights and new technology** can play in both mitigation and adaptation in the FSM (e.g., climate forecasting and assessment tools as well as energy efficiency techniques);

- the **equally-important role of integrating traditional knowledge and practices** into national plans for responding to climate change (e.g., encouraging community-based traditional management practices for coastal resources); and

- the **importance of local capacity-building** through education, training and public outreach programs designed to strengthen the capabilities of local and regional institutions and develop endogenous skills.

Recognizing the inter-generational issues associated with climate change, **the FSM is committed to a climate policy which addresses today's problems today while taking early steps to minimize the negative consequences of long-term climate change**. Of particular note

in this context, is the FSM's **emphasis on public awareness and participatory community development programs in the design and implementation of adaptation and mitigation measures.** This open and inclusive approach is important because of the decentralized nature of most development and management decisions within the FSM as well as the importance of recognizing and protecting traditional rights (as reflected in the FSM Constitution).

GREENHOUSE GAS INVENTORY AND MITIGATION

The FSM was one of the first countries to sign and ratify the UNFCCC and the Nation remains concerned about the role that the impacts of climate change may have for the natural and socio-economic well-being of the country. Even though the FSM is not a significant contributor to the global emissions of greenhouse gases, pursuing a climate policy of "no action" would clearly be counter-productive in both the short- and long-term. While a policy that focuses solely on local impacts seems attractive and rational, the FSM is an active member of the international community and recognizes that it does not exist as a nation in isolation. The FSM acknowledges its international obligations 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

Using the methodologies outlined in the 1996 IPCC Guidelines for National Greenhouse Gas Inventory, the FSM has completed an emissions inventory for the baseline year of 1994. All four States of the FSM were covered in the 1994 Inventory of Greenhouse Gas Emissions for the Federated States of Micronesia which addresses the six sectors identified by the IPCC for use in national inventories (Foruw, 1999). Table 2.1 provides a national summary of FSM emissions following the guidelines for non-Annex 1 countries. The combined CO_2 emission total for the FSM is estimated at 235.972 Gigagrams with 235.950 Gigagrams coming from emissions associated with secondary fossil fuels. National emissions of methane are estimated at 0.339 Gigagrams and emissions of nitrous oxide are estimated at 0.0094 Gigagrams.

The energy sector has been identified as the principle source of greenhouse gas emissions in the FSM (as well as other small island states) and, therefore, was the principal focus of the FSM 1994 Inventory. In addition to carbon dioxide, the primary greenhouse gases covered in the FSM 1994 Inventory include methane and nitrous oxide. Other greenhouse gases, including carbon monoxide, oxides of nitrogen, and non-methane volatile organic compounds were also covered to the extent that data was available.

Table 2.1 FSM GHG Summary (COP2 Guidelines--Non-Annex 1 Countries) **Greenhouse Gas Source and Sink Categories**	CO2	CH4	N2O
Total (Net) National Emission (Gigagram per year)	**235.972**	**0.339**	**0.0094**
1. All Energy	**235.95**	**0.179**	**0.0041**
Fuel Combustion [1]	**235.95**	**0.179242**	**0.004104**
Energy and Transformation Industries	N/C	0.001584	0.000317
Industry	N/C	0.000951	0.000248
Transport	N/C	0.013592	0.001146
Commercial-Institutional	N/C	0.006015	0.00018
Residential	N/C	0.156471	0.002138
Agriculture/Forestry/Fishing[2]	N/C	0.000629	0.000075
Other (please specify)	N/C	N/C	N/C
Biomass Burned for Energy[3]		0	
Fugitive Fuel Emission		***0***	
Oil and Natural Gas Systems		0	
Coal Mining		0	
2. Industrial Processes	**0.022**		**0**
3. Agriculture		**0.04**	**0**
Enteric Fermentation		0.04	
Rice Cultivation		0	
Savanna Burning		N/A	
Others (please specify)		N/A	N/A
4. Land Use Change and Forestry	**N/A**		
Changes in Forest and other woody biomass stock	N/A		
Forest and Grassland Conversion	N/A		
Abandonment of Managed Lands	N/A		
5. Wastes[4]	**0**	**0.12**	**0.0053**
Solid Waste Disposal Sites		0.1	
Wastewater Handling		0.02	
Human Sewage			0.0053
5. Other Sources as appropriate and to the extent possible (please specify)	**X**	**X**	**X**

Note:

[1] Carbon dioxide emissions from fuel combustion is calculated using the "reference approach" in the IPCC Guideline. This methodology does not support CO_2 calculations at the sub-sectorial level (e.g., Energy Industry, Transport, etc.). Data on fuel consumption at the sub-sectorial level were not available for calculations. However, fuel consumptions at such detail levels were **estimated** to facilitate the calculations of the other greenhouse gases including CH_4 and N_2O. Methane and nitrous oxide emissions under fuel consumption, therefore, are based on estimates.

[2] Newly added sub-sector

[3] Non-CO_2 gases emitted from burning biomass fuels are already accounted for under the sectors outlined above (e.g., residential) and therefore would be listed here as zero value.

[4] Newly added sector

Most of the emissions of greenhouse gases in the FSM comes from the use of petroleum-based fossil fuels for transportation and the production of energy. As a result, mitigation options related to reducing/controlling the emissions of fossil fuels will be considered in the context of national and state energy policies. Options for reducing energy-related greenhouse gas emissions in the FSM will address three general categories described recently in a Regional Mitigation Analysis Report by Ellis and Fifita (1999):

- **Demand-side management** – which refers to activities aimed at reducing energy consumption at the level of the user (e.g., conservation strategies, design and labeling of energy efficient appliances and technologies, and various measures targeted at ground transportation);

- **Supply-side management** – which refers to activities aimed at reducing the use of fossil fuels (e.g., increasing the efficiency of existing energy systems; increased use of renewable energy sources; and more efficient energy conversion technologies); and

- **Sink enhancement** – which refers to activities aimed at increasing local sinks for removing carbon dioxide from the atmosphere with a particular emphasis on the development of appropriate forest management programs.

With respect to sink enhancement efforts, it is important to note that mitigation forestry should not be developed under arrangements that would allow other countries to avoid their mitigation responsibilities (Ellis and Fifita, 1999).

The FSM 1994 Inventory identified the following policy measures and possible projects which could be undertaken to mitigate the emissions of greenhouse gases from the energy sector in the FSM:

- encourage the adoption of energy-efficient technologies (utilizing more efficient generators and providing appropriate financial incentives);

- monitor automobile emissions and take appropriate steps to reduce the emissions of carbon monoxide (the second highest GHG emission source in the FSM);

- encourage the use of renewable energy sources; and

- establish programs to enhance FSM's sink capacity (e.g., tree planting/forest conservation programs and coral reef preservation activities).

The **increased use of renewable energy sources offers an interesting opportunity for the FSM.** According to a study on sustainable development and energy use in the Pacific islands (Johnston, 1995), solar, biomass, hydro (for larger islands), and geothermal are identified as "good" potential renewable resources for at least parts of the FSM. Wind resource potential is

more limited and little, if any, information is available on the potential of OTEC and wave energy as resource options for the FSM. Only 20% of FSM's energy now comes from indigenous (non-petroleum) sources, so increasing this percentage could become an important part of FSM's mitigation strategies.

Consideration of forest management and land use practices that enhance the capacity of local vegetation to serve as sinks for carbon dioxide offers another opportunity for the FSM to reduce its net emissions of greenhouse gases. Policy making related to biomass alternatives to fossil fuels will have to balance these considerations. In addition, the FSM believes that exploration of sink enhancement opportunities in the marine environment (e.g., coral reefs) is a potentially important component of their national mitigation strategy (as is likely the case for many small island states with limited land area but significant ocean territories).

Providing incentives for the use of alternative energy sources and energy efficiency mechanisms in government and private-sector buildings and development projects offers another interesting mitigation option, particularly as it relates to facilities associated with the emergence of new economic sectors like tourism. Similarly, **increasing the efficiency of vehicles used in the transportation sector** also has potential in the FSM where transportation accounts for a large percentage of petroleum consumption.

Since the FSM accounts for only a very small percentage of the worldwide emissions of greenhouse gases, consideration of mechanisms to reduce those emissions represent only part of a national commitment to mitigation. In the FSM and many Pacific island countries, mitigation is set in a broader context of ensuring that the governments, communities/individuals and businesses of the FSM will do their part in climate mitigation efforts. This reality places even greater importance on national and international commitments toward capacity building and adaptation as high priorities in the context of climate change.

VULNERABILITY AND ADAPTATION

For the purposes of this National Communication, **vulnerability can be characterized as a reflection of the sensitivity of a given community, sector, or ecosystem to changes in climate combined with a measure of the ability of those systems to respond in such a way as to minimize the adverse effects of those changes or capitalize on any opportunities they might bring.** Thus, policy makers can seek to decrease or limit vulnerability by either reducing sensitivity to change – if possible – or by increasing resilience to change or both. The FSM is committed to pursuing principles of adaptation that seek to address both components of vulnerability. For purposes of these discussions, adaptation represents the combined policies and measures undertaken to reduce the vulnerability of the FSM to climate change. Wherever possible, the Government of the FSM is dedicated to exploring opportunities to increase the resilience of FSM communities and economic sectors to climate change through policies and actions that also have the added benefit of achieving mitigation goals. FSM climate policy will also include anticipatory actions designed to enhance the capability of governments,

communities/individuals and businesses in the FSM to avoid some of the potential consequences of climate change.

Vulnerability assessments were undertaken between 1993 and 1999 in three States of the FSM: Yap, Kosrae and Chuuk. Collectively, the three studies provide an initial assessment of the potential effects of climate change on the four types of islands found in the FSM with an emphasis on the consequences of accelerated sea level rise. As a result of climate change, the initial FSM vulnerability assessments projected that:

- temperature will increase;
- total rainfall will decrease;
- there will be a resultant increase in severe droughts;
- sea-level will rise according to IPCC projections; and
- the intensity and frequency of extreme events (e.g., tropical storms and storm surge) will increase.

In addition, the Chuuk vulnerability and adaptation assessment study suggests that there may be an increase in flooding – due to the projected increase in extreme events and shoreline erosion due to sea-level rise (Konno and Abraham, 1999).

Atolls and reef islands are expected to suffer severely as a consequence of accelerated sea-level rise and associated impacts. These islands have elevations up to about 7.0 meters with an average of 3.0 to 4.0 meters above present mean sea level. While most infrastructure on FSM atolls is above the mean sea levels predicted under climate change scenarios, historic experience suggests that high tides and storm events are expected to result in considerable damage to shoreline protection works and roads in low-lying (near-shore) areas and infrastructure such as causeways and airports.

The effects of climate change and accelerated sea-level rise will aggravate existing environmental problems on **high islands** as well. The initial FSM vulnerability and adaptation assessments indicate that the expected impacts of accelerated sea-level rise and other climate-related impacts on the low-lying areas of high islands will include:

- changes to the structure and biodiversity of reef systems with minimal effects on the morphology of coral reefs;
- loss of seagrass habitats from lagoons and sheltered reef flats;
- considerable increase in coastal erosion with resultant shoreline retreat;
- loss of coastal agricultural land;
- a slight increase in freshwater wetland systems;
- an increase in mangrove forest areas at the expense of sandy beach systems;
- increased risk from severe storms and other extreme events for human settlements in coastal margins; and
- increased risk to housing and infrastructure, especially coastal roads and filled areas.

In addition, changes in rainfall patterns may affect ecosystems at higher elevations. It should be noted that critical natural systems such as beaches, freshwater wetlands and mangroves in some areas are expected to continue to be degraded as a result of human activities, possibly at an accelerated rate, thereby reducing the resilience of natural systems already under stress.

The initial FSM vulnerability and adaptation assessments indicate that the **water resources of the FSM are threatened by projected climate change**. On atolls, the threat results from a combination of anticipated droughts and lower rates of recharge of the groundwater lens as a result of reduced rainfall as well as loss of the freshwater lens as a result of saltwater intrusion and shoreline erosion. Public health and nutrition problems may also arise as a result of saltwater intrusion and a general reduction in the quality of groundwater resources on the more highly-populated atolls.

Even with an anticipated reduction in rainfall, there should be minimal threat to the water resources of high islands. The topography, vegetation cover and soil conditions of the high islands aid in the capture of water and, therefore, make water resources on these islands less vulnerable than on atolls. The FSM's initial assessment studies suggest that **with proper management** there should be sufficient surface catchments and adequate and accessible aquifers to meet projected water supply demands.

As already noted, the **coastal resources of both atolls and the low-lying margins of high islands are already at severe risk** from a combination of shoreline erosion and human activities. Without implementation of integrated coastal management policies, the resource base of the most highly-populated islands will be at even greater risk in the future. **This situation would be further exacerbated by climate change through the anticipated losses of natural resources and important coastal systems such as sandy beaches** and possible threats to coral reefs.

Prolonged periods of drought over the past twenty years have been observed to have adverse effects on the agricultural productivity of atolls and reef islands. Both taro and breadfruit, for example, have been significantly affected by changes in the water table under adversely dry conditions. Projections of climate change used in the initial FSM assessment studies suggest that reduced rainfall and more frequent and intense droughts could increase the risk, particularly to people who are wholly or partially dependent on taro and breadfruit for subsistence needs.

Agricultural productivity on high islands seems to be better buffered against the adverse effects of reduced rainfall and enhanced drought conditions associated with climate change. On the other hand, the most productive agricultural areas of high islands are in low-lying coastal areas which are already at risk from the consequences of accelerated sea level rise which would accompany climate change. Enhanced crop diversity and selection (e.g., salt- and/or drought-tolerant species and pest-resistant species) could provide an effective adaptation tool. Appropriate, long-term land use strategies designed to protect and conserve land resources for agriculture are also expected to be important elements of efforts to respond to climate change.

The **potential impacts of climate on the tuna fishery of the FSM have yet to be fully** evaluated. The tuna fishery within the FSM Exclusive Economic Zone is already a high priority in the FSM and is expected to be an important element of the Nation's future economic development. The continuing viability of the tuna fishery depends upon factors related to the sustainable yield of the stocks, the world market for tuna and tuna products and the effects of environmental stresses, including the effects of climate variability and change. The potential impacts of climate on the tuna fishery of the FSM have yet to be fully evaluated. Such an evaluation would have to consider changes in ocean temperature, circulation and productivity might affect tuna and other important fish stocks and detailed information on how climate change might affect those important characteristics of the ocean environment around the FSM are not yet available. Recent scientific studies suggest that natural variability in the climate system, like the cycle of El Niños and La Niñas, has an effect on tuna (and other fish stocks) important to the FSM and many Pacific island countries (Lehody et al, 1997). If, as some climate projections suggest, climate change might affect (or manifest itself through) changes in patterns of natural variability like El Niño, we must improve our understanding of how those patterns affect tuna and other important fisheries in the FSM today and as well as our understanding of how those patterns might change in the future. In addition, we must develop a more complete understanding of the human dimensions of the fisheries of the FSM, including issues related to: how tuna and other fisheries fit in broad economic development plans for the Nation; recent and anticipated changes in fishing pressure; other environmental stresses which might be affecting important stocks; and the importance of tuna and other stocks (particularly reef fishes) as subsistence food for the people of the FSM.

Table 4.2 summarizes some of the possible adaptation options that the FSM is considering to address some of the climate change impacts described above.

Table 4.2 Possible climate change adaptation options for FSM	
Water Resources	Conduct a comprehensive inventory of existing water resources
	Assess the status of storage and distribution systems and secure resources for necessary improvements
	Encourage improvements to residential and commercial catchment systems and identify/support new technology
	Identify opportunities to adjust water conservation and management policies to incorporate information about climate variability and change
	Document the experience gained during the 1997-1998 El Niño and build on the concept of drought management task force(s) to assist governments, communities and businesses in responding to climate-related events
	Identify opportunities to improve watershed management
Coastal Resources	Identify buildings, infrastructure and ecosystems at risk and explore opportunities to protect critical facilities
	Develop and implement integrated coastal management objectives that enhance resilience of coastal systems to climate change and sea level rise
	Consider the need for beach nourishment and shoreline protection programs in high-risk areas
	Integrate considerations of climate change and sea level rise in planning for future construction and infrastructure
Agriculture	Document the experience gained during the 1997-1998 El Niño and build on the concept of drought management task force(s) to assist governments, communities and businesses in responding to climate-related events
	Develop policies which protect both subsistence and commercial crops during extreme events
	Explore opportunities to diversify crops and select drought and/or salt-tolerant species where appropriate
	Document low-lying agricultural areas at-risk from the effects of sea level rise and consider protection measures where appropriate and necessary
Fisheries	Enhance data collection and analyses required to improve understanding of the impacts of El Niño and La Niña events on tuna and other critical fisheries
	Identify and protect critical habitats for key inshore and near-shore species–particularly those important for subsistence fisheries
	Support monitoring and monitoring programs designed to improve understanding of the regional and local consequences of climate variability and change for tuna and other important fisheries.

Other policy implications developed in the context of initial FSM vulnerability and adaptation assessments include:

- Enhance capabilities to understand and respond to natural climate variability, particularly ENSO;
- Ensure an effective program of observations/monitoring, research, modeling and assessment to significantly improve understanding of the regional and local consequences of climate change and variability;
- Integrate considerations of climate change and variability in resource management, community planning and economic development decisions;
- Enhance public awareness and understanding of the consequences of climate change; and
- Integrate traditional knowledge and practices into both assessments of the consequences of climate change and the development of appropriate response options.

More broadly, **ensuring full implementation of the UNFCCC** by all countries is an essential component of an adaptation strategy for the FSM. Adequate support for the **Clean Development Mechanism** provisions of the Kyoto Protocol to the UNFCCC will be an important component of providing the financial support and expertise necessary to assist the FSM to explore new technologies and practices for adaptation.

POSSIBLE PROJECTS

Working with national and state government agencies, local communities and regional organizations, the FSM climate change program has begun developing ideas for specific projects which would help address issues related to greenhouse gas inventories, mitigation, vulnerability and adaptation, public education and awareness and capacity building. These projects are summarized below and discussed in more detail in Chapter Five of the FSM National Communication.

<u>Climate Change Data Collection and Analysis Projects</u>

- production of reliable, up-to-date maps of FSM jurisdictions showing detailed topography, natural features and built environment;
- establishment of baseline climate monitoring stations using selected reference sites to document current conditions, provide for continuous monitoring of critical parameters (e.g., temperature, rainfall, sea-level), and provide a reliable baseline from which to measure change;

- establish an ongoing program of vulnerability and adaptation assessment modeling;
- initiate a sustained program to provide and apply information on climate variability to support decision making in key sectors (e.g., water resource management, agriculture, fisheries, disaster preparedness); and
- produce a quantitative evaluation of the carbon sink potential of the FSM addressing both terrestrial and marine systems.

Public Awareness and Education

- climate change curriculum development for teachers and students at all levels;
- climate change awareness programs utilizing electronic media and print materials;
- climate change community workshops to increase awareness of the basic science of climate change and its local/regional consequences; and
- a climate change scholarship program aimed at developing in-country expertise in fields related to climate change and variability.

Energy-Sector Projects

- energy conservation capacity-building projects within FSM's four utilities companies;
- design and implementation of solar energy pilot projects;
- creation and maintenance of a solar energy information clearinghouse;
- consideration of a subsidy program for solar energy; and
- a feasibility study on other renewable energy resources.

Agriculture and Water Resource Projects

- evaluation of the vulnerability of FSM streams to ENSO-related droughts;
- a comprehensive assessment of FSM groundwater resources, including efforts to identify and protect drought-resistant groundwater sources;

- construction of solar desalination pilot plants; and

- expansion of community-based watershed management programs (like those initiated in Pohnpei and Kosrae).

Coastal Resources Projects

- a coastal resources baseline data project to provide quantitative data in vulnerable coastal communities and ecosystems; and

- design and implementation of a community-based, integrated coastal management planning project.

Fisheries

- evaluation of the impact of climate variability and change on the movement of tuna (and other pelagic fisheries).

Other projects which have received preliminary attention include an agriculture feasibility study on crop diversification and the selection of drought- and salt-tolerant species and investigation of the feasibility of breeding pelagic species (e.g., tuna).

INFORMATION AND RESEARCH NEEDS

Greenhouse Gas Emissions Inventories

The principal problems encountered during the conduct of the FSM 1994 GHG Emissions Inventory involved either the lack of data or data quality issues. With the exception of the aggregate fuel data from the energy sector, all other data used to complete the Inventory were derived from estimates. The FSM 1994 Emissions Inventory suggests targeting resources on a number of critical greenhouse gas data needs, including:

- Fuel consumption from "end-use activities" in key sectors such as agriculture;

- HFC, PFC and SF_6 consumption (due to the high global warming potential of these compounds event though they do not constitute a large percentage of FSM emissions); and
- Carbon dioxide removals – current and potential – associated with land use change and forestry practices as well as marine ecosystems. In this context, the FSM believes that carbon removal from marine (as well as land) ecosystems should be addressed in national inventories.

Mitigation

Some of the most significant constraints on the identification, exploration and implementation of more aggressive mitigation measures to reduce greenhouse gas emissions in the FSM include:

- lack of detailed, easily-accessible information on the renewable energy potential for individual states and the country as a whole;
- limited information the current role or future capacity of FSM ecosystems (managed and naturally-occurring) to serve as sinks for carbon dioxide;
- limited access to new technologies and limited expertise in the use of those technologies;
- financial and human resource costs associated with the acquisition and maintenance of new technologies;
- dependence of existing energy infrastructure and transportation systems on petroleum consumption; and
- need to balance economic development goals – particularly in emerging sectors like tourism – with concerns about the long-term sustainability of those ventures in the context of climate change (and other societal, economic and environmental stresses).

Vulnerability and Adaptation

The conduct and review of initial FSM vulnerability and adaptation assessment efforts highlighted a number of critical information and research needs, including:

- the need to expand assessment work to include climate change consequences not directly related to sea-level rise in a more integrated perspective of the broad suite of challenges and opportunities presented by climate change;
- the need to address differences in the nature (form, format and content), availability and quality of data and information required to support vulnerability and adaptation assessments;
- the need for adequate baseline information from which to measure changes and assess impacts;
- the need for adequate information on present conditions and current rates of change in critical systems, including enhanced understanding of the local and regional nature and consequences of natural variability;

- the need for detailed information on patterns of resource use, ecosystem change and changes in species diversity (both marine and terrestrial) at local, island, State, national and regional scales as well as research on critical climate-ecosystem interactions;

- the need for enhanced information on changing environmental, demographic and economic patterns and trends; and

- a need for enhanced information on available and potential response options, including increased attention to technology transfer associated with possible adaptation and mitigation strategies.

Other critical limitations encountered to date have included: the significant costs associated with field work in geographically-dispersed areas like the FSM; the limited number of scientific, technical and professional staff available; the need for a significantly enhanced program of community-based education and outreach; and the need for significant investments of time, money and human capital.

PUBLIC AWARENESS AND EDUCATION

In their regional synthesis of vulnerability and adaptation assessments conducted for ten Pacific island countries (including the FSM), Hay and Sem (1999) call for an "action-oriented, public awareness programme" as an "integral part of a well-conceived climate change response programme." FSM's climate change policy **emphasizes public awareness and participatory community development programs in the design and implementation of adaptation and mitigation measures**. With this in mind, the FSM is actively engaged in development of an effective program of education and public awareness in order to reach all sectors in the community. The FSM is currently developing a **community-based education and public awareness program** to ensure **grass roots access to information** about the science and implications of climate change for the FSM. The goal is to ensure the accessibility of information to all groups and sectors including women, youth, community groups, schools, individual households and businesses. As summarized below, this education and public awareness program will include: curriculum development for primary and secondary schools; college-level course development; radio, television and video programs as well as printed materials designed to reach a wide audience; and a series of community workshops on each of the four islands of the FSM.

CAPACITY BUILDING

The Federated States of Micronesia is dedicated to developing the capacity within the National and State governments to effectively address the climate change challenges facing the nation. The FSM is prepared to meet its obligations under Article 6, Education, Training And Public Awareness. As a small island developing state, the Federated States of Micronesia is one of the countries most threatened by the impacts of climate change, particularly accelerated sea- level rise. Education and skill levels within the country, however, are generally low, especially in scientific and technical fields.

Legally, the primary responsibility for environmental protection lies with the four State governments of the FSM. In addition, the geographic, economic, and social realities of capacity building in a developing nation comprised of 607 islands, eight indigenous languages, and 105,506 people spread over a large area of the Pacific Ocean, favor an approach focused on developing specific skills amongst a relatively large number of people in all four States. To address this unique situation, the **FSM has adopted a "country team" approach to developing a national climate change strategy and building national capacity**. Each State Governor was asked to designate a State agency that will serve as the focal agency for climate change. Through a coordinated Country Team approach, significant capacity building in focused climate change adaptation and mitigation skills is already underway. Through the team approach, participation in training opportunities, climate change workshops and meetings, and international negotiations has been distributed amongst the four FSM states and the national government to ensure expertise throughout the nation. Discussions at the September 1999 Second FSM Economic Summit included discussions of expanding the successful Country Team concept to address other environmental issues

It is important to note that **limited technical expertise needed to effectively deal with climate change is currently resident in existing government and private agencies**. For example, each State now has an independent public utilities authority, most of which have at least some resident expertise in various mitigation and adaptation strategies, e.g., promoting and implementing water and energy conservation measures, increasing and protecting groundwater and other fresh water supplies. Each State also has some level of planning capacity to ensure that positioning, design and protection of infrastructure and buildings is in line with future climate change projections. Health and environmental agencies are supported in all States, and staff are experienced in sanitation improvement, disease control and quarantine, disaster preparedness, and other areas of expertise that will be needed to deal with climate change. The FSM Climate Change Country Team and the respective governments need to focus efforts on involving these agencies in the development of the national climate change plan both to build their awareness of potential impacts and increase capacity and preparedness.

Efforts must be increased to engage an even greater cross-section of State and National government and non-government agencies with existing and potential climate change expertise through state and national workshops and other fora. Additional efforts in building public awareness of potential climate change impacts will also help to engage the nation's entire population in climate change planning and project implementation.

Because of the country's relatively small size, limited technical expertise, and budgetary constraints, it is anticipated that the FSM will depend considerably on regional and international technical and financial assistance to complement existing national human resources. The FSM was a participant in the United States Country Studies Program (USCSP), through which significant technical expertise was provided to FSM. In addition, the FSM is an active participant in the South Pacific Regional Environmental Programme's Pacific Islands Climate Change Assistance Programme (PICCAP) which provides scientific and technical assistance to the FSM in the implementation of the UNFCCC.

Concluding Remarks – A Commitment to the Future

In September 1999, national and state government officials and representatives of FSM communities and businesses convened for the Second FSM Economic Summit whose theme was "Charting the Course for Sustainable Growth and Self Reliance." In his opening remarks, President Leo A. Falcam noted that "Our economic strategy – the course we will chart – must be considerate of our proud citizens, our priceless culture and out pristine natural environment." Environmental considerations were a significant part of the discussions of policies and strategies developed during the Summit reflect the interdependence of environmental and economic considerations for the future of the FSM. The Summit identified a number of national policies with implications for the FSM climate change program including:

- expand and promote an environmental ethic – through curriculum development and community-based education efforts to address critical issues, including climate change;

- improve cooperation and coordination between different levels of government – with specific calls to: (1) expand the UNFCCC National Country Team concept; and (2) establish improved communication mechanisms to ensure broad dissemination of information on key issues such as climate change;

- develop technical support for existing and future environmental programs – including addressing technical training needs in environmental monitoring, resource management, emergency preparedness and waste management – all of which have implications for the Nation's climate change strategy;

- the environmentally-sound and efficient use of energy – including a call for national campaigns on energy efficiency and environmental issues related to energy; the institution of minimum efficiency standards; and compliance with EPA standards for the generation, storage and distribution of energy services;

- environmentally sustainable agricultural production – including strategies to encourage responsibility among community leaders for addressing environmental issues in agricultural planning and providing for the active involvement of communities in planning agricultural production through the use of environmentally-sensitive resource management approaches (e.g., watershed management); and

- ensure sustainable developments of inshore marine resources and preservation of the inshore marine environment – including the development of community-based, integrated coastal management plans which are considered to be essential to enhancing the capacity of the FSM to respond to the effects of climate change.

In closing his remarks to the Second Economic Summit, President Falcam called on the participants to "work together in an atmosphere of Micronesian consensus building." This philosophy of developing shared solutions to problems is central to the FSM approach to climate change and, we would submit, an essential ingredient of effective implementation of the UNFCCC.

EXECUTIVE SUMMARY

The Federated States of Micronesia (FSM) is a grouping of 607 small islands in the Western Pacific about 2,500 miles southwest of the U.S. State of Hawaii and lying above the Equator (between the equator and 14 degrees North latitude and between 136 degrees and 160 degrees East longitude). FSM is a young, independent nation created from part of the former United Nations Trust Territories of the Pacific Islands previously administered by the United States. The FSM concluded a Compact of Free Association with the United States in 1986 and became a member of the United Nations in 1991.

The FSM was one of the first countries to sign and ratify the United Nations Framework Convention on Climate Change (UNFCCC) and the FSM remains concerned about the role that climate change may play in the determining the future well-being of the country. Even though the FSM is not a significant contributor to the global emissions of greenhouse gases, pursuing a policy of "no action" would clearly be counter-productive in both the short- and long-term. While a policy that focuses solely on local impacts seems attractive and rational, the FSM is an active member of the international community and recognizes that it does not exist in isolation. The FSM acknowledges its international obligations 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 and develop effective strategies to respond to the challenges and opportunities presented by climate change.

The FSM is pursuing a climate policy that addresses the sources and impacts of climate change in both the near- and the long-term. This climate response strategy recognizes and emphasizes:

- the "value-added" benefits of flexible approaches which provide for both adaptation and mitigation at the same time (e.g., the use of renewable energy sources);
- the importance of understanding and responding to natural climate variability;
- the important role that science and technology can play in both mitigation and adaptation;
- the equally-important role of integrating traditional knowledge and practices in effective response strategies; and
- the importance of local capacity-building through education, training and public education.

Using the methodologies outlined in the 1996 IPCC Guidelines for National Greenhouse Gas Inventory, the FSM has completed an emissions inventory for the baseline year of 1994. This National Communication provides a summary of the results of that inventory. All four States of the FSM were included in the baseline inventory which addresses the six sectors identified by the IPCC. The combined CO_2 emissions total for the FSM is estimated at 235.972 Gigagrams with most of that total (235.950 Gigagrams) coming from emissions associated with secondary fossil fuels. National emissions of methane are estimated at 0.339 Gigagrams and emissions of nitrous oxides are estimated at 0.0094 Gigagrams.

Most of the emissions of greenhouse gases in the FSM comes from the burning of fossil fuels for transportation and the production of energy. As a result, mitigation options related to reducing/controlling emissions from fossil fuels will be considered in the context of national and State energy policies in the FSM. Mitigation measures being considered by the FSM (and described in this National Communication) include: encouraging the adoption of energy-efficient technologies; monitoring automobile emissions and taking appropriate steps to reduce emissions; exploring and encouraging the use of renewable sources of energy; and exploring opportunities to enhance FSM's sink capacity.

FSM's climate policy also addresses anticipatory actions designed to enhance the capability of governments, communities, individuals and businesses in the FSM to adapt to the consequences of climate change. Vulnerability and adaptation assessments were undertaken between 1993 and 1999 in three States of the FSM (Yap, Kosrae and Chuuk). As described in this National Communication, these assessments identified climate-change vulnerabilities for water resources, agriculture, coastal resources and fisheries. The FSM is already considering a number of adaptation options in all of these important areas. It is particularly important to note that climate change impacts in these areas have significant implications for the economic future of the FSM. This is particularly true for fisheries (primarily tuna) and tourism (which relies on both coastal resources and the availability of freshwater) -- two sectors that have been identified as crucial to the future economy of the FSM.

Since the people and governments of the FSM already face significant climate-related challenges associated with natural variability, particularly the El Niño-Southern Oscillation (ENSO) cycle in the tropical Pacific, FSM's climate policy considers adaptation to climate variability -- e.g.., anticipating and responding to ENSO-related changes in rainfall, tropical storms, sea level and fisheries (primarily the migratory pattern of tuna) – an important component of a national response to climate change. Effectively addressing the challenges and opportunities of climate variability will have significant near-term benefits for the FSM, provide valuable insights into FSM's vulnerability to climate change and provide valuable adaptation experience.

Recognizing the inter-generational issues associated with climate change, the FSM is committed to a climate change policy that addresses today's problems today and takes early steps to minimize the negative consequences of climate change in the long-term. Of particular note in this context, is FSM's emphasis on public awareness and participatory community development programs in the design and implementation of adaptation and mitigation measures. This open and inclusive approach is important because of the decentralized nature of most development and resource management decisions in the FSM. In closing the September 1999 Second FSM Economic Summit, FSM President Falcam called on participants to "work together in an atmosphere of Micronesian consensus building." This philosophy of developing shared solutions to problems is central to the FSM approach to climate change and, we would submit, an essential ingredient of effective implementation of the UNFCCC.

CHAPTER ONE – NATIONAL CIRCUMSTANCES

A SENSE OF PLACE

The Federated States of Micronesia (FSM) is a grouping of 607 small islands in the Western Pacific about 2,500 miles southwest of the U.S. State of Hawaii and lying just above the Equator (between the equator and 14 degrees North latitude and between 136 degrees and 166 degrees East longitude). FSM comprises what has been known generally as the Eastern and Western Caroline Islands. FSM is a young, independent nation created from part of the former United Nations Trust Territory of the Pacific Islands previously administered by the United States. The FSM concluded a Compact of Free Association with the United States in 1986 and became a member of the United Nations in 1991 (see Figure 1.1 for map of FSM).

The islands of the FSM are the result of volcanic activity millions of years ago that created islands and atolls of incredible variety. Some are the tips of mountain peaks thrust above the ocean's surface and now surrounded by coral reefs. Others are atolls -- islands that have sunk beneath the surface leaving a ring of coastal barrier reef and tiny island islets encircling a coral and sand lagoon. Still others are mixtures of atolls and high rugged islands within a lagoon. The diverse habitats and species which characterize these islands have always had a profound influence on the Micronesian peoples and their cultures.

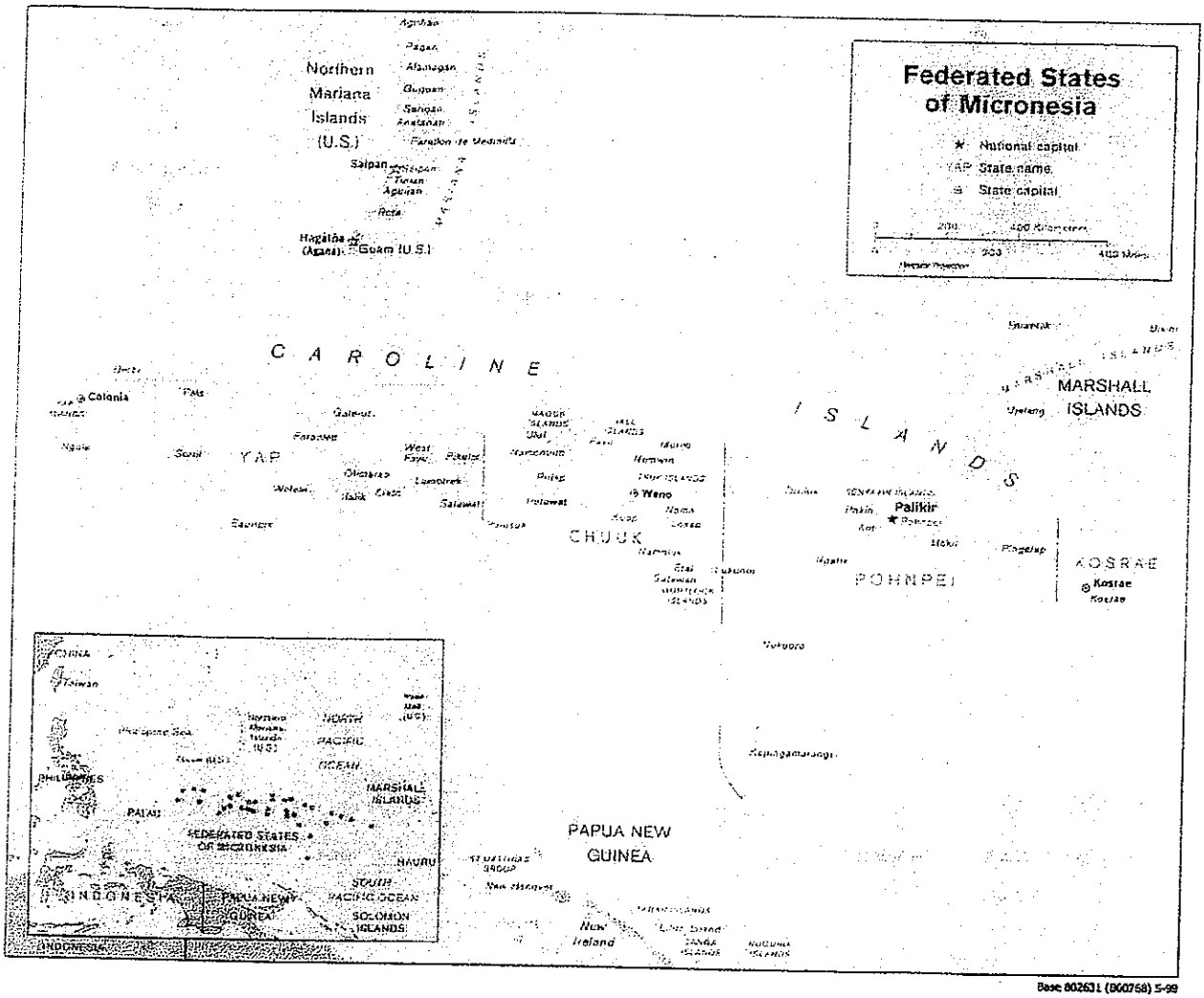
The FSM is comprised of four states -- Yap, Chuuk, Pohnpei and Kosrae. While the country's total land area amounts to only 262 square miles, the territory of the FSM also includes an estimated 1,506 square miles of lagoons (Gawel, 1993) and an Exclusive Economic Zone (EEZ) totaling 1,149,508 square miles (Asian Development Bank, 1996). The geographic range of the FSM covers 1,700 miles from east (the State of Kosrae) to west (the State of Yap). Each of the four States centers around one or more "high islands" and all but Kosrae include numerous atolls.

Table 1.1 Types and Numbers of Islands and Land and Lagoon Areas in the FSM

State	High volcanic	Atolls *	Atoll & Coral Reef	Coral Reef No-lagoon	Raised Coral	Land Area	Lagoon Area
Kosrae	2		3			42	
Pohnpei	9	9	154			133	279
Chuuk	15	12	273	2		39	822
Yap	4	12	141	3	1	48	405
TOTAL	30	33	571	5	1	262	1,506

Source: Gawel, (1993)
Note: Each atoll has one to scores of individual small islands that can change in area and number due to storm wave impacts.

Figure 1.1. The Federated States of Micronesia and the Boundaries of the States of Yap, Chuuk, Pohnpei and Kosrae



This geographic dispersion, high ecological variety and the rich, cultural diversity within FSM are important factors in considering how the nation embraces the challenges and opportunities of economic development and environmental stewardship – including the nation's response to climate change and variability. There are marked differences among and even within the four states, reflecting a variety of natural conditions and social structures which have evolved over the thousands of years since the islands were first settled. Each state is concerned with the demands of its main island population center and rural areas as well as the unique requirements of its insular outer islands which can, themselves, differ markedly in terms of demographics, economics and culture. Each state has devised their own strategies for sustainable development, while an integrated perspective for the federation is provided by the national government.

AN INTRODUCTION TO OUR PEOPLE

Closely related to its geographic dispersion is FSM's demography. **The people of the FSM are classified as Micronesians, although some inhabitants of Pohnpei state are of Polynesian origin** (particularly on Nukuoro and Kapingamarangi atolls). The influence of European and Japanese contacts is also seen. Although united as a country, the people are a heterogenous mixture with different customs and traditions bound together by recent history and common aspiration. As noted earlier, the four states of the FSM are separated by large expanses of water. Prior to Western contact, this isolation led to the development of unique traditions, customs and language on each of the islands. While each of the four states exhibits its own distinct culture and tradition, there are also common cultural and economic bonds that are centuries old. The cultural diversity of the FSM is typified by the existence of eight major indigenous languages, although English remains the official language of commerce. The cultural similarities are indicated by the importance of traditional extended family and clan systems found on each island.

As depicted in Table 1.2, the FSM 1994 Census estimates total population at 105,506 (FSM Office of Planning and Statistics, 1996). Over the last 40 years, the growth rate of population in the FSM has exceeded 3% per annum and the current rate of national growth remains high. However, since the Compact of Free Association was signed, out-migration of about 2% of the population occurs each year, effectively lowering the annual growth rate to about 1%. **The FSM has one of the youngest populations among Pacific Island nations** and it is expected that the 15-24 year age group will account for 50% of the population increase in the coming decade. Population density varies by state but the average population density in 1994 was 389 persons per square mile. Population density ranges from a high of 1,088 individuals per square mile in Chuuk to 170 individuals per square mile in Kosrae.

Table 1.2 Population Distribution by State, FSM-1994

State	Number			Percent		
	Total	Males	Females	Total	Males	Females
Total	105,506	53,923	51,583	100.0	100.0	100.0
Yap	11,178	5,565	5,613	10.6	10.3	10.9
Chuuk	53,319	27,299	26,020	50.5	50.6	50.5
Pohnpei	33,692	17,253	16,439	31.0	32.0	31.9
Kosrae	7,317	3,806	3,511	6.9	7.1	6.8

Source: 1994 FSM Census, Office of Planning and Statistics (June 1996)

The **basic subsistence economy is based on cultivation of tree crops (primarily breadfruit, banana, coconut, and citrus) and root crops (primarily taro and yam) supplemented by fishing**. Small-scale agriculture and various traditional fishing practices continue today and the populations of outer islands continue to rely predominantly on subsistence cropping and fishing (Asian Development Bank, 1996). Sharing, communal work and the offering of tributes to the traditional leaders are fundamental to the subsistence economy system and the culture of the island societies of the FSM. The basic economic unit is the household, which consists primarily of extended families. Larger solitary social groups found on most of the FSM islands are matrilineal clans. Traditional political systems, such as the Nahmwarki Political System on Pohnpei and the Council of Pilung on Yap, continue to play an important role in the lives of the people of the FSM today.

Recognizing the beauty of the land and natural productivity of the sea, the inhabitants of the FSM have developed settlement patterns in keeping with their surroundings. Each inhabited island is divided into municipalities, villages (sections of municipalities), and farmsteads (smallest land holding unit within a village). The manner in which the people have arranged their landscape varies from dispersed settlement to neatly clustered villages. Special importance is attached to land in Micronesia both because of its short supply and its traditional importance.

Although details vary from state to state, **land ownership remains the most valued right in Micronesia**. 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 according to customary land use systems. 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. Under the FSM Constitution, ownership of land is restricted to FSM 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 administration 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 land ownership by redistributing land titles to various people. Although many of the subsequent land disputes have since been settled, ownership of much land in that state is still contested. State governments have legal authority over land for "eminent domain and condemnation" although use of this power is strongly avoided.

Traditionally, shallow reefs and the intertidal flats and their resources were usually owned by the nearby landowners but this traditional ownership is no longer recognized in Kosrae and Pohnpei. In Yap and Chuuk, the reef flats remain privately owned and this is a central consideration in marine resource management.

NATIONAL CIRCUMSTANCES

Table 1.3 provides a summary of the National Circumstances of the FSM using the UNFCCC guidelines for National Communications. The following sections expand on the statistics contained in that Table.

NATIONAL CIRCUMSTANCES

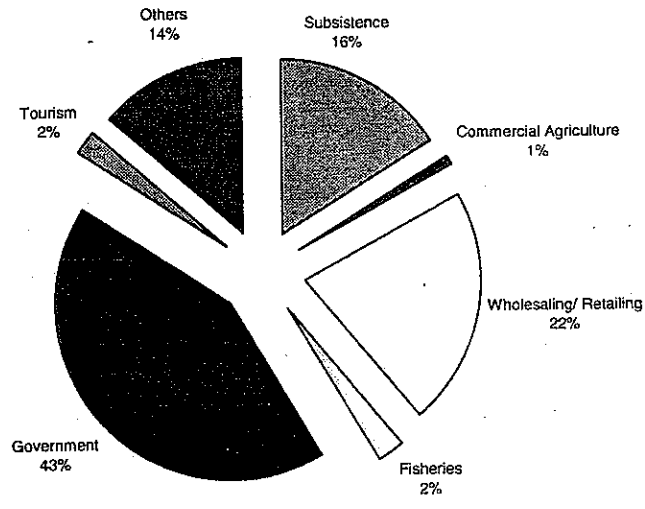
Table 1.3 National Circumstances	
Criteria:	**1994**
Population	**105, 506**
Relevant Areas	**Land : 701** **Coral lagoon: 7,190** **EEZ: 2,600,00**
GDP(US$)	**$210,759,000**
GDP Per Capita(1994)	**$1,997.6**
Estimated share of the Informal Sec. in the Economy in GDP	**19.96%**
Share of industry(Fisheries) **in GDP**	**17%**
Share of services (Private Sector & Government) **in GDP**	**81%**
Share of Agriculture in GDP	**2%**
Land area used for agricultural purposes (square kilometers)	**250**
Urban population as Percentage 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: Department of Economic Affairs:
Federated States of Micronesia 1996 Economic Report (Office of Pacific Operations , Asian Development Bank, March 1997): and
1994 FSM Census of Population and Housing (FSM Office of Planning and statistics ,October 1996)

The FSM Economy

The Gross Domestic Product (GDP) of the FSM is estimated at $211 million and a population of 105,506 whose annual per-capita income is estimated at $1.997.60. The market economy of the Federated States of Micronesia is based, largely, on a small domestic market with modest levels of income and scattered across large distances. Interstate trade is minimal and generally involves agricultural products. 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. Based on statistics presented during the September 1999 Second FSM Economic Summit, three main activities – subsistence farming, distribution of goods (wholesaling and retailing) and government services – dominate the economy. Commercial agriculture, fisheries and tourism are recognized as providing long-term growth potential but, currently, play very small roles in the FSM economy.

Figure 1.2 The Structure of the FSM Economy (1996)



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 the wholesale/retail and service industry sectors. The commercial and industrial sectors of the FSM consist primarily of small businesses, complemented by a few larger public companies, co-operatives and credit unions. Private businesses provide employment mainly in the wholesale and retail trades, hotels, restaurants, light manufacturing, financial and business services, insurance and construction. Few family-based businesses have entered the industrial sector, most being engaged in commercial import/export, wholesale and retail businesses or service enterprises such as restaurants, taxis, car rentals, repair and maintenance and others. This means that the FSM is largely dependent on external aid and government sector activity.

Of the 14,835 persons estimated to be employed in the FSM in 1997, nearly half were 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. In addition, infrastructure in many parts of the FSM is not well-developed and generally inadequate for the growing population. Severe limitations on recurrent expenditure funds compounds this problem by providing only a low level of maintenance for key facilities.

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 semi-skilled trades which would use local labor were adequate training programs available.

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. Few current commercial fruit and vegetable production units are larger than 20 acres in size. Subsistence production is based mainly on a shifting cultivation system. This system takes the form of garden areas for root-crops (taro and 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 crops is a growth of plants and shrubs used for a number of other local purposes.

Numerous attempts have been made in the past to develop commercial agriculture. Except for coconuts and bananas, none of these attempts have succeeded in the long-term, although remnants exist, such as coffee production 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, casava, and some betelnut, pineapple and sugarcane.

Copra production remains an important cash and commercial export production crop throughout the FSM but production has decreased dramatically in recent years. The decline is attributed to the low prices for copra coupled with the 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 are increasingly important throughout the FSM, particularly pigs, poultry and eggs. Commercial egg production is reasonably well-established now in some 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. These imports are small, however, 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, as-yet, 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 employees of the government or commercial sectors. Restaurants provide a small market for selected fruits and vegetables.

Coastal and Marine Resources

Coastal areas play a pivotal role in the culture and the economy of the FSM by supporting centers of population and attractive development sites as well as areas of active subsistence agriculture and fisheries activities. The marine environment is considered the basis for Chuukese culture, for example, being the principle source of subsistence, recreation and commerce. Historically, the coastal environment is the source of a wide variety of traditional foods and this remains true today. The population of outer islands continues to rely predominantly on subsistence cropping and fishing (Asian Development Bank, 1996). In addition, the water sports of fishing, swimming, canoeing and sailing are traditionally popular and remain so for both the residents of the FSM and for tourists. 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. The surrounding oceans are home to several large species of game fish such as marlin, mahi-mahi, tuna, barracuda, sailfish and assorted bottom fish.

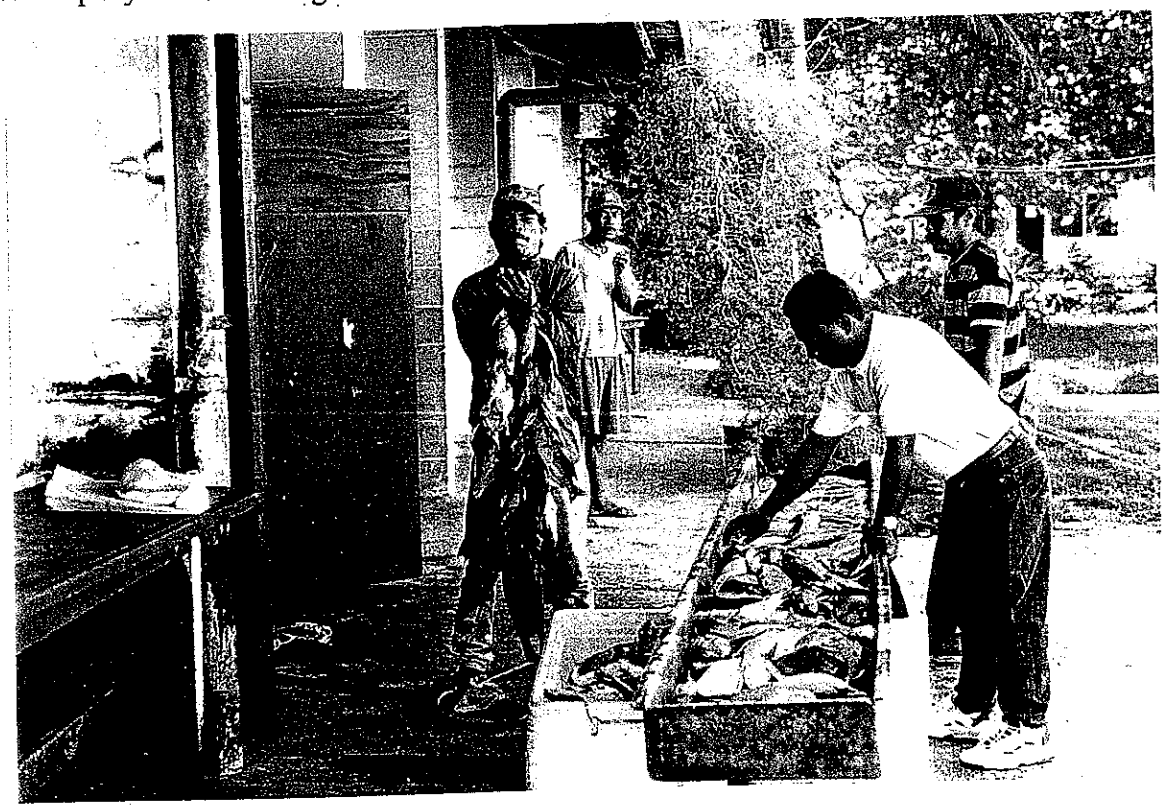
Although limited in extent in some FSM states, **sand beaches** represent a critical coastal resource in the FSM.. In Yap state, for example, the sand-rich coastal plains are the sites of most coastal villages and are a very important component of traditional and modern settlements and culture (Richmond and Reiss, 1994). The sandy beaches of Kosrae are one of the island's principal attractions and represent a resource that is fundamental to the expansion of the tourism sector (Goodwin et al, 1998).

Coral reefs are a particularly important resource because of their roles in: protecting beaches and coastlines from erosion associated with storms and variations in sea level; providing local construction materials; and serving as a habitat for tropical fish of every description and color, as well as marine turtles and manta rays. This latter characteristic makes the coral reefs of the FSM an important factor in supporting the nation's emerging tourism industry. Reef areas in the FSM are critical to artisanal and subsistence fishing activities. Goodwin et al (1998) noted that although there is no data on the amount of annual catch, reef fish constitute an important part of the Kosrean diet and a source of high quality protein. In addition, they highlight other reef resources including clams, sea cucumbers, lobsters and sea turtles (Goodwin et al, 1998).

Mangrove forests play an important role in the coastal environment of many FSM states by: providing food and a protective environment for important species of fish, shellfish, crabs and other marine life; stabilizing coastal areas by protecting the coast from waves and storms and trapping sediment from upland erosion, thus protecting coral reefs; and providing a source of a variety of subsistence products such as firewood, timber, thatch and medicine. In their vulnerability assessment for Yap, Richmond and Reiss (1994) note that the mangrove forests represent a fairly stable features that have slowly expanded their territory during the past 6,000 years–the late Holocene period when present-day sea level has been near its present position. Since the landward extent of mangrove forests is approximately the spring high tide level, any change potential change in sea level would, likely, affect the landward extent of those ecosystems (Richmond and Reiss, 1994). In many areas of the FSM, however, mangrove forests

are currently stressed due to the removal of trees and a decline in ecosystem health associated with large-scale diversions of freshwater for human consumption (Goodwin et al, 1998).

A Background Report produced as a part of the FSM National Fisheries Policy Study notes that, while not economically-significant from a national standpoint, **coastal fisheries in the FSM** "provide a valuable source of protein, enjoyment and some income for subsistence fishers" and, in the outer islands, "is critical for the nutritional well-being of the community (Asian Development Bank, 1996). The inshore resources (within the 12-mile territorial sea) may have some modest commercial value but the dangers of overfishing, particularly for reef fish, are considered significant. This management challenge exists even in the absence of possible changes in ecosystem conditions (like temperature, productivity and extreme events) that might accompany climate change.



Local fishermen assess their catch from FSM coastal waters (Source: Joseph Konno)

Fisheries

The marine environment is of enormous importance to the people of the FSM. The nation's marine resources are extensive and, in many ways, central to the future social, cultural, and economic prospects of the FSM. The exclusive economic zone of the FSM comprises 1,149,508 square miles. The fisheries resource of the FSM can be divided into: (1) the offshore, deep sea marine resources of the Exclusive Economic Zone (EEZ) which are mainly exploited by Distant Water Fishing Nations (DWFNs) under license agreements; and (2) the inshore 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 embraces the area between the shoreline out to the nation's 12 nautical mile territorial sea jurisdiction.

Offshore Fisheries – Tuna (most importantly yellowfin and skipjack tuna) is the primary fisheries resource, including both surface schooling and deep-water, highly-migratory species. Pelagic fisheries resources appear to offer great potential for further exploitation, although the full extent of these resources has not been assessed accurately to date. As shown in Table 1.3, the fisheries industry constitutes a 17% share of the nation's GDP. The annual fish catch within the FSM Exclusive Economic Zone was estimated at 46,256 metric tons for 1998. That represents a decrease of about 18.4% below the record high year of 1995 when the catch was estimated at nearly 250,000 metric tons. Most of this decrease is associated with a decline in tuna catch by the foreign purse seine operations which are dominated by Japanese and Taiwanese interests. The longline catch of yellowfin and bigeye tuna in FSM waters has also declined in recent years and is associated with a decreased effort by both Japanese and Chinese interests (Park, 1999). Discussions at the September 1999 Second FSM Economic Summit suggest that these declines may, in part, be due to a decrease in demand (particularly for sashimi) associated with the Asian economic crisis.

In addition to tuna, lesser amounts of mahi mahi, billfish, shark and other species are also caught. Offshore marine resources other than tuna are not considered likely to form the basis of a sustainable commercial fishery.

Tuna in FSM waters has long been recognized as a valuable natural resource and a significant source of revenue (Konno and Abraham, 1999). A 1991 study to support the formulation of an FSM national fisheries policy, for example, notes that "It is not an exaggeration to say that the economic future of the FSM lies with fisheries" (Miles, 1991). Similarly, a 1996 background report on fisheries supported by the Asian Development Bank noted that "the tuna-based offshore fishery is potentially FSM's foundation for future economic self-sufficiency for the country" (Asian Development Bank, 1996). The FSM National and State Governments expect that activities related to pelagic fishing will provide long-term economic benefits by providing jobs and substantial export revenue. The governments have invested in fisheries through joint ventures and all four states have fish handling and processing facilities (e.g., transshipment and cold storage facilities) as well as some long-line and purse-seiner fishing operations. The Pohnpei Fisheries Corporation has developed a small but world-class fish processing facility (Asian Development Bank, 1996). The domestic longline fleet increased during the past year with the acquisition of additional vessels by the Micronesian Longline Fishing Company and a joint venture between Taiwan and Kosrae (Park,1999). Apart from intermittent landings of by-catch from transshipment operations, no fish from the commercial fisheries reaches the domestic FSM market

Climate processes, such as the ENSO cycle, are considered to be one of the key limiting factors to the development of the tuna industry in the FSM (Konno and Abraham, 1999). In a 1997 NATURE article, Lehody et al note that catches of skipjack tuna are highest in the western equatorial Pacific warm pool and identify a close relationship between the geographic displacement of that warm pool (and the important area of surface water convergence at the eastern edge of the warm pool) associated with the ENSO cycle and the distribution of skipjack stocks. Their work suggests a strong correlation between the eastward extension of the warm pool during an El Niño event and a similar eastward shift in tuna stocks. Conversely, they note a more westward distribution of tuna stocks during a La Niña event[1]. Clearly, the geographic location of tuna stocks relative to the FSM will influence the catches of both domestic fleets distant water fleets within FSM's Exclusive Economic Zone and will influence the extent to which the distant water fleets make use of transshipment and processing facilities in the FSM. Konno and Abraham (1999) noted that El Niño conditions were associated with a decrease in catch within the FSM EEZ and an increase in catch in the EEZ's of the Marshall Islands and Kirabati. Changes in patterns of the ENSO cycle that might accompany climate change would clearly have implications for the viability of tuna fisheries in the FSM as would more general changes in ocean temperature, productivity or circulation that might be associated with climate change. In their regional synthesis of vulnerability and adaptation assessments in ten Pacific island countries, including the FSM, Hay and Sem noted that an improved understanding how environmental and social systems respond to present-day climate variability is critical to determining how those same systems will respond to variations in oceanic and atmospheric conditions associated with climate change (Hay and Sem, 1999).

Inshore Shore Fisheries – Reef resources are critical to artisanal fishing activities. The catch of fisheries resources in coastal waters 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. Unfortunately, efforts to avoid over fishing reef areas and to eliminate fishing with dynamite, bleach, cyanide and other poisons have not been unsuccessful to date. Fish stocks in reef areas close to large urban populations, especially, have 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.

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[1]Lehody et al noted that during the La Niña periods examined, the purse seine fleet (and hence the concentration of tuna) were concentrated west of 160°E and, during El Niño years, the fleet extended its activities as far east as 160°W.

Natural populations of the giant clam (*Tridacnidae*) as well as 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 FSM Government development plans and a national mariculture center has been established in Kosrae.

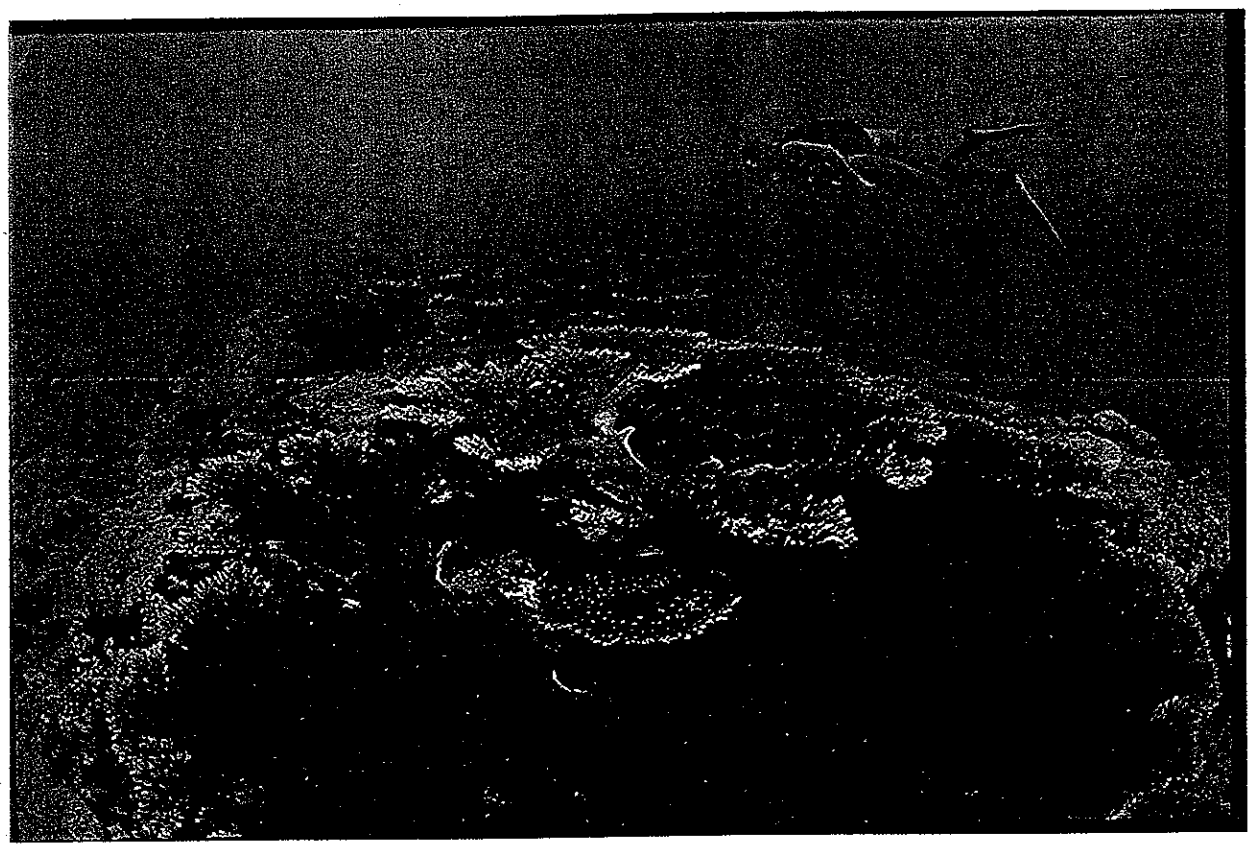
Trochus harvesting is also an important contributor to the economy in all FSM states. The trochus is harvested primarily for its shell, although some buyers also purchase the meat. Early marine reserve areas were established as trochus sanctuaries.

The reefs, shallow passes, lagoons and other areas of the FSM provide many good sites for a number of other environmentally-compatible mariculture development activities 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 either already being cultivated or under consideration by the Marine Resources Divisions of the FSM states.

Over-exploitation of inshore resources, particularly reef fish, is occurring in certain areas, as a result of increasing catch effort (due largely to increasing population) and the breakdown of traditional resource management systems. There is, however, a growing recognition that intervention strategies are needed for inshore resources, with resources under a scheme of "cooperative management" using local fishery groups and representatives of local communities as custodians of the resource.

Tourism

Tourism is, as yet, an infant industry in the FSM but is already a significant contributor to the nation's economy in terms of employment, exports and income – particularly in service industries like hotels, restaurants, car rentals, etc. The visitor industry on Pohnpei is the single largest earner of foreign exchange in the State. All State economic development plans foresee considerable expansions of tourism activities for the coming decade. Below, a diver enjoys one of FSM's beautiful coral reef areas.



Current tourist activity emphasizes ecotourism, adventure tourism and cultural tourism. This activity has centered, largely, on the attraction of marine, coastal and reef resources, 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 natural, cultural and historic treasures is recognized. A precursor to the realization of the great potential for growth of the tourism sector is investment in tourism infrastructure, including additional accommodations, improved recreational opportunities and essential infrastructure in critical areas such as water resource management and transportation.

OTHER IMPORTANT RESOURCE CONSIDERATIONS

Water

Freshwater resources in the FSM are provided through a combination of: surface water resources associated with rivers and streams; rainwater catchment systems; and some groundwater resources through aquifers, particularly on high islands. Only Kosrae and Pohnpei have perennial streamflow; the large deltas of rivers with short stream length and steep channel gradients attest to the very high rainfall which occurs in the mountainous interiors of these islands. In the atolls of the FSM, the freshwater lens "floats" on the underlying denser seawater and is tapped through shallow, hand-dug wells. This water supplements the rainwater catchment and storage tanks which are widely used and commonly the main source of drinking water in the outer islands.

Most communities in Kosrae state are served with piped systems mainly from stream intakes via gravity distributions. 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 in the central water supply distribution system. Approximately, 55 percent of connected households are on 24-hour water service. Rural areas have a few community systems such as that in Kitti where a filtration and chlorination process precedes the distribution network.

In Chuuk State, there are centralized water supply systems only in the capital center of Weno (Moen) and on part of Tonoas (Dublon). 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 than 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 one on the western side of Yap (Map and Rumung municipalities), spring water is collected and distributed to the villages by gravity feed.

Other Island Ecosystems

A profusion of tropical shrubs, flowers and trees numbering more than six hundred species of higher plants are found in the FSM States. Hibiscus, Hong Kong orchid, ironwood, eucalyptus, Honduras mahogany, papaya, banana, coconut and Plumeria trees can be found just about everywhere. In addition to the mangrove forests previously described, other important terrestrial ecosystems in the FSM include:

- **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. These marshes are utilized for taro production in all the inhabited islands of Yap and Chuuk States as well as in the outer islands of Pohnpei State.

- **Grassland** – Grassland is largely a result of human activity and is relatively extensive in the large high islands of Yap, Chuuk, and Pohnpei States and is increasing in area due to frequent firing which destroys the forest edge and hinders tree regeneration.

- **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 States but extensive areas are still found in Pohnpei and Kosrae States. 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 twenty percent (20%) 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 sixty-three percent (63%) of the total land area in Kosrae, fifty-six percent (56%) in Pohnpei (with watershed forest reserves in the center of the island constituting about thirty percent (30%) of the total land area); and thirty-three percent (33%) in Yap compared with about ten percent (10%) in Chuuk. The forests in the center of high 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.

Flora and Fauna

These terrestrial ecosystems support **a number of species of animals** – both introduced and endemic species. 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 throughout the FSM. Although rats are not considered of value, 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 reedwarbler, 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 essentially eliminated 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 over harvesting; and the introduced monitor lizard. The fruit bat, black noddy, brown noddy, white or fairy tern, cardinal honeyeater, and Micronesian pigeon all forest and nest mainly in these locations. A number of animals and birds also live or otherwise make use of the Grasslands and Secondary Forest including the cardinal honeyeater, Micronesian starling, dusky white-eye, and blue-faced parrot finch.

Upland forest ecosystems (i.e, Primary and Rain Forests) also provide a rich habitat for a number of animals and birds. The white-tailed tropic bird, Audubon'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 areas. These forests provide habitat for several species of tree snails, some found only FSM.

THE CLIMATE OF THE FSM

Today's Setting

The islands of the Federated States of Micronesia enjoy a tropical climate with relatively even, warm temperatures throughout the year – average temperature is approximately 80°F year-round. Summers (June through September) normally bring 50 to 80 percent more rainfall than winters. In part, this summer-winter difference in rainfall is related to the fact that FSM receives at least part of its rainfall from tropical cyclone events (with the season for tropical storms normally defined as June to November for areas north of the Equator).

Natural Variability

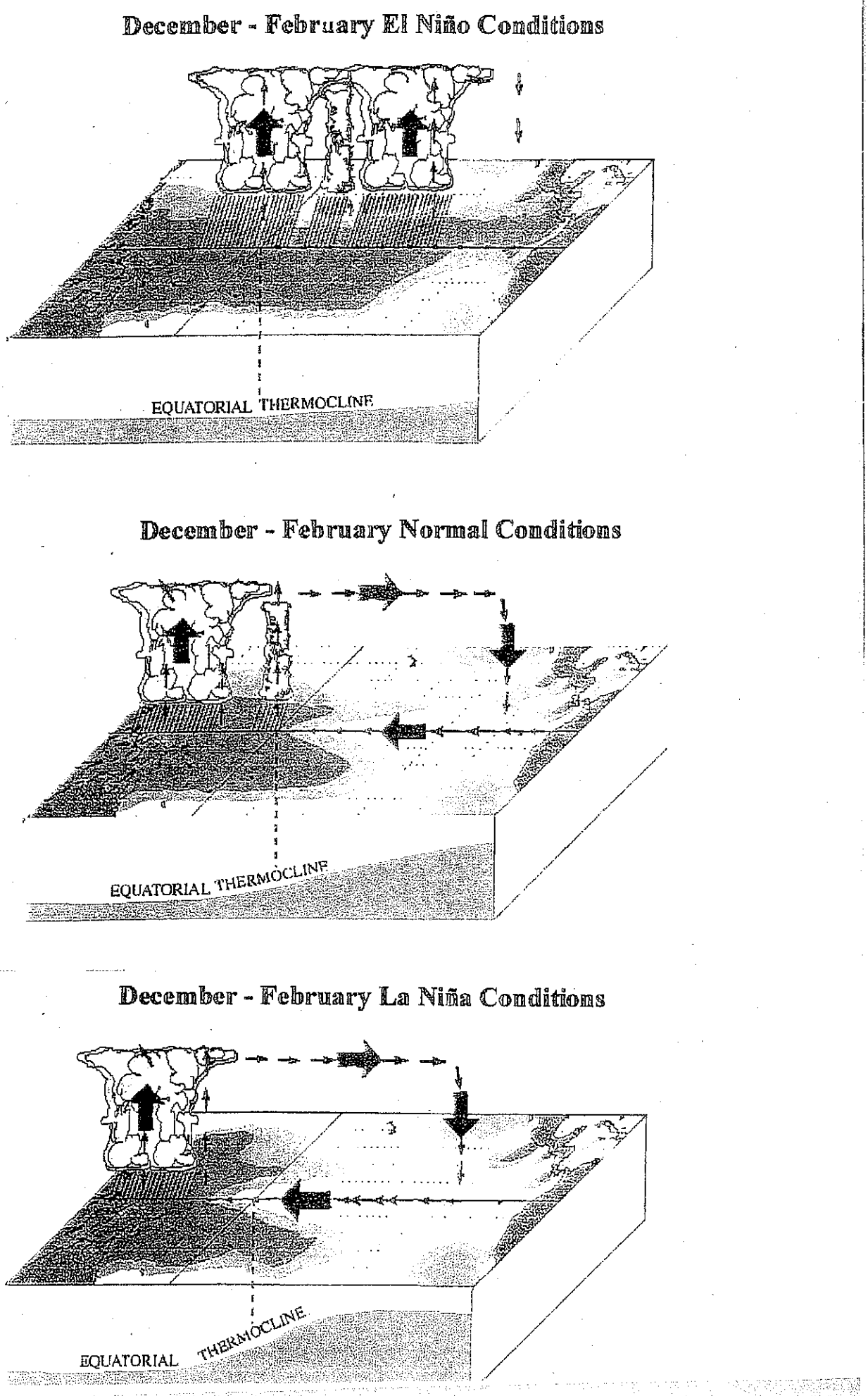
Scientists note that for the FSM, the dominant driver of year-to-year changes in climate (interannual climate variability) is the El Niño-Southern Oscillation (ENSO) cycle of ocean-atmosphere interactions in the tropical Pacific. There is both a warm and a cool phase of the ENSO cycle (i.e., periods of warmer or cooler than normal ocean temperature conditions in the central and eastern Pacific). El Niño refers to the warm phase of the ENSO cycle while La Niña refers to the cold phase. Both phases are associated with changes in winds and other important atmospheric circulation processes and, thus, produce changes in rainfall, temperature and tropical storms in the Pacific (See Figure 1.3).

The people and governments of the FSM often face significant climate-related challenges associated with the cycle of El Niño and La Niña events in the tropical Pacific:

- changes in rainfall resulting in severe drought in many jurisdictions during El Niño events;
- changes in patterns of tropical storms;
- changes in the risks of storm surge, coastal erosion and saltwater intrusion associated with temporary variations in sea level which accompany the evolution of El Niño and La Niña across the tropical Pacific (La Niña events tend to bring higher than normal sea level conditions to the FSM and El Niño tends to bring lower than normal conditions); and
- changes in the migratory patterns of important fisheries like tuna.

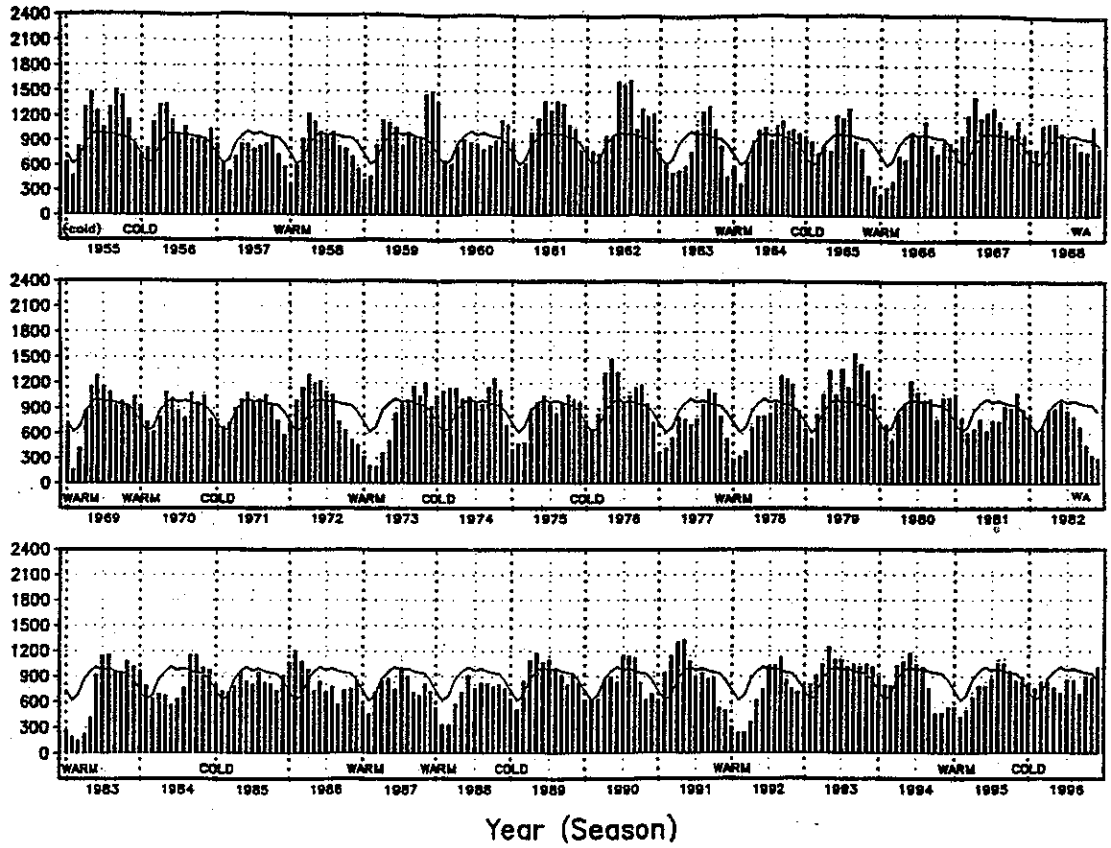
Anticipating and responding to these changes – i.e., **adapting to natural climate variability – not only has significant near-term benefits but also provides valuable insights into the vulnerability of FSM communities, businesses and ecosystems to some of the potential consequences of climate change and important adaptation experience**. This is particularly important in light of a 1999 SPREP-sponsored analysis of regional climate change scenarios (produced using six general circulation models) that suggests regional temperature and rainfall patterns roughly consistent with an El Niño-like state (Jones et al, 1999).

Figure 1.3 The ENSO Cycle depicting warm (El Niño), normal and cool (La Niña) conditions (Source: U.S. National Weather Service, National Centers for Environmental Prediction, Climate Prediction Center)



In addition to the effects of ENSO, the climate of the FSM responds to other factors. The most important additional factor relates to gradual changes in the climate over time scales of decades (or longer). Based on observations during the past thirty or so years, the FSM has tended to become slightly warmer and drier over time. This is consistent with observations that, in recent years, El Niño-like warm-water conditions in the Pacific have tended to become more common over time. While there are important detailed differences between this condition and an El Niño event, the result for the FSM is similar in both – a tendency toward drier conditions, especially during the winter, relieved only by the chance of occasional heavy rains associated with an increase in tropical storm activity during the summer and early fall.

Figure 1.4 Seasonal Precipitation on Chuuk, 1955 to 1996 (mm)



(Source: He & Barnston, 1998)

Rainfall

When warm water extends farther eastward during an El Niño event, the region of active rainfall and storm formation tends to move with it. In general this tends to bring drier than normal conditions in the western Pacific and causes tropical storms to form farther east. For the most

part, the drier than normal rainfall conditions associated with an El Niño event are felt most strongly in (Northern Hemisphere) winter months–when the El Niño event reaches its most mature and strongest state. Since this is already the drier part of the year for the FSM, an El Niño event can, and often does, mean drought conditions (see Figure 4.1 for a description of the impacts of the 1997-1998 El Niño on FSM).

During the summer months, slightly drier conditions which might be associated with El Niño-related changes in normal rainfall can be offset by an increase in tropical cyclone-related rainfall. This occurs because, during an El Niño event, the warmer than normal equatorial Pacific waters near and east of the dateline make it possible for a larger number of tropical storms to form in that region and move, initially, westward with the trade winds. It is during this westward trajectory that these storms impact the FSM. Observed rainfall data indicate that the increases in tropical cyclone activity associated with El Niño events do, indeed, tend to counteract the slight El Niño-related decline in non-cyclone rainfall in the FSM during the summer months. There is great uncertainty, however, in the precise trajectories of tropical cyclones and a greater number of cyclones in the FSM region does not, necessarily, mean that those storms will, in fact, cross over any given island location. For example, observations indicate that increased rainfall during late summer during an El Niño has occurred more frequently (but not regularly) at Yap and Pohnpei than at Chuuk. It is also important to point out that rainfall that occurs in sudden and extreme episodes (like those associated with tropical cyclones) is generally not as valuable as rainfall that occurs throughout the season in the form of ordinary showers. During the winter months, of course, the absence of tropical storm activity means that there can be no such cyclone-related moderation of the drier than normal conditions associated with an El Niño event.

Within the FSM, the rainfall differences due to the influence of ENSO are more reliable in the western States of Yap and Chuuk than in the eastern States of Pohnpei and, especially, Kosrae, which are closer to a point near the equator where the influences of ENSO reverse (i.e., right on the equator, at the date line, El Niño brings enhanced rainfall and La Niña lower than normal rainfall). Nonetheless, all of the FSM (except possibly Kapingamarangi in the extreme south) falls into the El Niño-dry, La Niña-wet category. This typical (what scientists call "canonical") ENSO influence is not guaranteed for every ENSO event, however. Occasional exceptions may occur as, for example, in the case of the 1998-1999 La Niña event in which Pohnpei received above normal rainfall (as would be expected) but Yap and Chuuk experienced rainfall conditions much closer to normal.

Tropical Storms, Sea Level and Extreme Events

Tropical cyclones (typhoons) and other severe storms occur in the FSM and, as noted earlier, can be an important source of rainfall for some regions. These storms can also bring damaging winds and storm surges which can threaten FSM populations and ecosystems. Flooding and tidal surges are usually associated with storm events (Konno and Abraham, 1998). In addition, increased sea level associated with the cold phase of the ENSO cycle (La Niña) can cause

damage to low-lying areas, such as the major damages to taro patches in the atolls of Chuuk state during 1983 (Konno and Abraham, 1998). Conversely, low-water conditions during El Niño events have been associated with increased exposure of important coral reef resources in the FSM. Konno and Abraham (1998), for example, highlighted damages to coral reefs in Chuuk associated with the 1997-1998 El Niño. Sea level anomalies related to ENSO are approximately 10 to 30 cm in the eastern and western ends of the Pacific Ocean and smaller in the mid-Pacific (Barnston, 1999). Long-term scenarios associated with climate change project a gradual rise in sea level around the globe with some geographic variations. Periodic ENSO fluctuations would be superimposed on this background of elevated sea level.

Some Future Scenarios

Likely future scenarios associated with long-term climate change have been investigated using global climate models which attempt to capture the complex, coupled interactions among ocean, atmosphere and land which characterize the Earth's climate system. In February 1999, scientists from the Australia CSIRO Atmospheric Research group summarized their analysis of the results of six general circulation models (GCM's) for four Pacific regions (including Micronesia) in a study prepared for the South Pacific Regional Environment Programme (Jones et al, 1999)[2]. Based on this analysis, they recommended the use of IPCC (1996) projections of temperature and sea-level projections until projections based on new IPCC scenarios are available. Their model-based analysis of rainfall showed an increase over the central and eastern Pacific during both summer and winter seasons while changes over other regions were smaller, though tending towards an increase with moderate confidence for the region they identified as Polynesia N (a region straddling the equator at 5N to 10S and 145W to the dateline) but low confidence for the sign of rainfall changes elsewhere in the Pacific[3]. This study notes, however, that the dominant influence in this region on rainfall (like winds, sea level, surface pressure and a number of other climate variables) is the ENSO cycle and that **the model analysis shows a "more El Niño-like mean state over the Pacific under climate change" which would result in a distribution of rainfall patterns similar to that experienced currently under El Niño conditions**. While the CSIRO scientists give low confidence to rainfall projections from these models (outside the Polynesia N region noted above), this pattern could imply a tendency toward drier and warmer conditions in the western two-thirds of the FSM, especially during northern hemisphere winter months when ENSO impacts are strongest.

Currently, as part of the first National Assessment of the Consequences of Climate Variability and Change for the United States, scientists at the U.S. National Weather Service's National Centers for Environmental Prediction (Barnston, 1999) are investigating possible climate

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[2]The CSIRO study included analysis of six coupled ocean-atmosphere climate simulations: CSIRO Mark 2 GCM with and without sulphates; CSIRO DARLAM 125 km; DKRZ ECHAM4/OPYC3, Hadley Centre HADCM2 and the Canadian CGCM1.

[3]In the CSIRO study, the FSM region is defined by 0-15N and 130-175E.

changes using the United Kingdom's Hadley Climate Model (HADCM2) and the first generation Canadian Coupled General Circulation Model (CGCM1). Both of these models run 100 years into the future with atmospheric gas concentrations (greenhouse gas plus sulfate aerosols) prescribed at a rate representing a continuation of what has already been observed over the past 30 years. These models agree on large-scale patterns but, importantly, differ somewhat on smaller scales – a fact that can be extremely important for small island jurisdictions surrounded by large expanses of ocean.

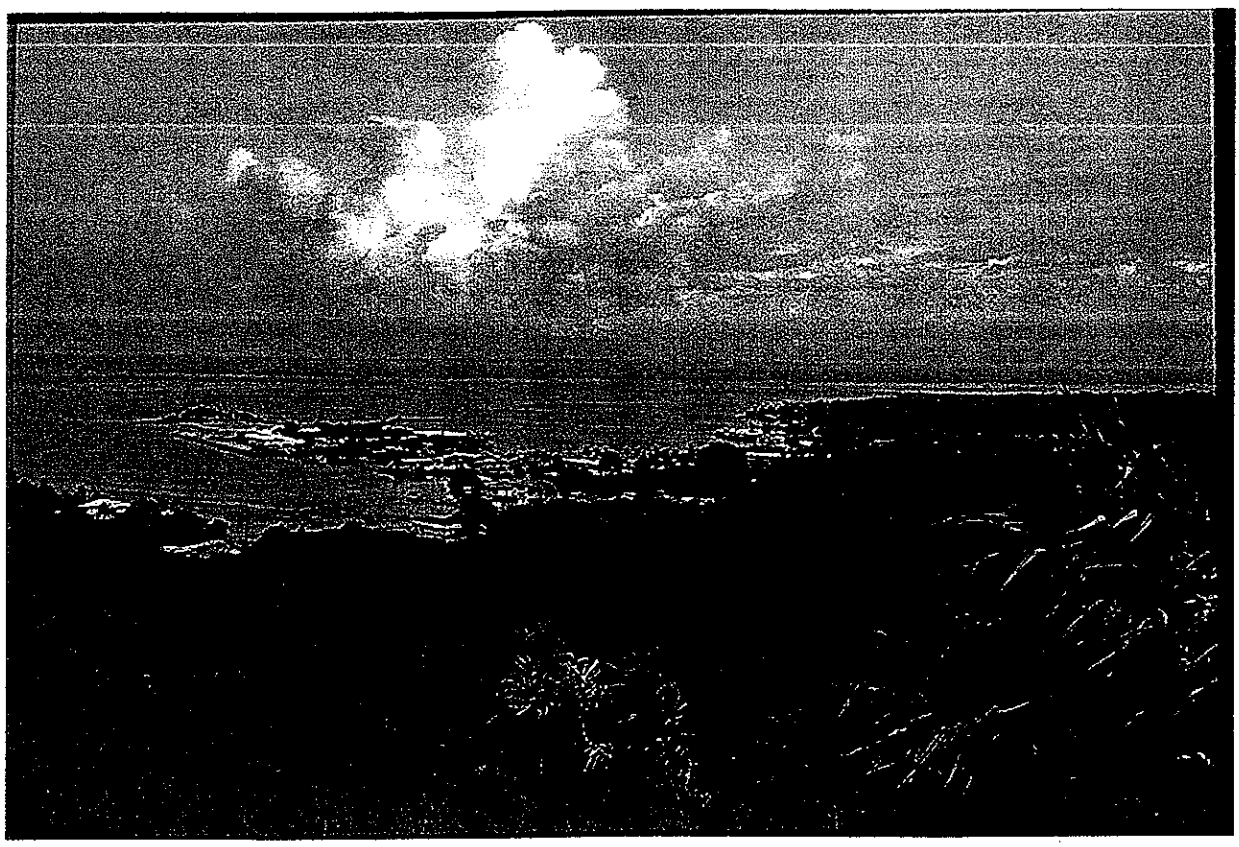
Even with these differences, both models indicate a continuation of the slight changes that have already been observed over the last few decades. This implies that the western two-thirds of the FSM (Yap and Chuuk) would show a gradual drying tendency, primarily during winter months. In summer, while some further drying may occur, it could be followed by a tendency toward more rainfall, especially in the eastern portion of the FSM (Pohnpei and Kosrae).

As noted before, the model results differ somewhat, particularly in terms of differences between the more eastern and western portions of the FSM. This model disagreement points up the fact that FSM is in a borderline location, in which it is uncertain whether the warming near the date line will produce additional moisture whose rainfall benefits will extend far enough northward and westward to include FSM, or if it will be limited to only the eastern part of the FSM. Unlike the projections for temperature, which are unanimously toward a gradual warming, the precipitation outlook is less certain. A best guess would be that eastern FSM (Pohnpei, Kosrae) will tend to receive increases in rainfall in summer but possibly not at all in winter, while western FSM (Chuuk and especially Yap) should see continued winter drying, and likely little change in summer.

The models show that the region of very warm ocean water that has resided in the western tropical Pacific will tend to expand farther toward the east into areas slightly east of the date line that now experience very warm water only during El Niño. The expected result is a gradual increase in the frequency of tropical cyclones for islands in the central and east-central Pacific, both north and south of the equator. Storm frequencies for the western Pacific may not decrease as they would presently during El Niño events; rather, they may increase because surface ocean temperature conditions there will also be slowly increasing. **The overall implications for tropical cyclones will be (1) an eastward extension of the tropical region that may normally experience cyclones, particularly during the local summer and fall seasons when cyclones are most likely, and (2) a tendency toward more cyclones for FSM, Palau, Guam, the Marshall Islands, and Hawaii.** A recent analysis of regional climate change scenarios by CSIRO also **suggests that tropical cyclones may become 10-20% more intense at a $2xCO_2$ environment (between 2030 and 2060).** This increased tendency toward more-intense cyclones for the FSM (with the possibility of an overall increase as suggested by Barnston) has implications for coastal ecosystems, communities, infrastructure, economic development and public health and safety that involves far more than just changes in rainfall and the availability of water.

Complicating this potential threat from an increase in tropical cyclones, is the projected sea level rise associated with most climate change scenarios. The Second Assessment Report of the IPCC (1996) concluded that global average sea level rise would be of the order of 0.15 meters to 0.95 meters by 2100. Translating such global estimates into local or region-specific changes is difficult and complicated by many factors, including the fact that natural variability in the climate system such as ENSO bring year-to-year changes in sea level to many jurisdictions in the Pacific.

Even with these uncertainties, a small island state like FSM – whose population and economic centers are located in coastal areas -- must take the possibility of sea level rise seriously as a threat to our people and our environment. As a result, most of the initial work on the impacts of climate change for the FSM has focused on the consequences of accelerated sea level rise, including: inundation of low-lying coastal areas with implications for both coastal ecosystems and communities; increased erosion from wind and wave action with particular concerns about damages associated with tropical storms; and salt-water intrusion with implications for freshwater availability as well as the health/survivability of some coastal ecosystems. As many studies have described, the consequences of accelerated sea level rise will be superimposed on coastal ecosystems and human communities that are already subject to natural climate variability (e.g., ENSO and tropical storms) and the pressures of increasing population and development (Kaluwin and Smith, 1997).



TODAY'S CHALLENGES AND OPPORTUNITIES: THE CONTEXT FOR A CLIMATE CHANGE POLICY

FSM communities, businesses and governments are addressing climate change in the context of a three broad challenges:

> **Promoting Economic Growth**, including issues associated with: reducing vulnerability to downturns in outside economies (especially the U.S. and Asia); recruiting new industries; addressing inadequacies in existing infrastructure (particularly for water, transportation and waste management) and improving infrastructure for key sectors (e.g. tourism and fisheries); and reducing the vulnerability of FSM economies to natural disasters such as droughts and tropical storms;
>
> **Balancing Resource Use and Management**, including issues associated with: the special circumstances created by the geographic size and isolation of island communities (e.g., limited land and water); competing demands for critical resources, with particular concern about water availability and quality; mitigating multiple stresses on critical habitats and unique ecosystems, most notably coral reefs and tropical forests with implications for endangered species and biodiversity; and recognizing the rights and culture of indigenous communities;
>
> **Ensuring Quality of Life**, including issues associated with population growth and changing demographics (e.g., the increasing importance of youth in the FSM population); providing high-quality education and jobs for the next century; and preserving the unique social, cultural and natural assets which characterize the FSM.

The national, state and local governments and people of the FSM recognize that changes in climate (both natural and human-influenced) have significant consequences in all these areas. As noted earlier, for example, communities, businesses and government agencies throughout the FSM are already dealing with the significant impacts that natural variability in the climate system, particularly those associated with the ENSO cycle including: changes in rainfall; changes in the patterns of tropical storms; temporary changes in sea level which accompany the evolution of ENSO cycle across the Pacific; changes in migratory patterns of important fisheries like tuna; and severe drought in island communities associated with El Niño events, with attendant consequences for public health and safety as well as businesses. Recent scientific studies suggest that climate change may be manifested as changes in natural climate patterns such as ENSO. A 1999 SPREP-sponsored analysis of regional climate change scenarios derived from several general circulation models, for example, suggests temperature and rainfall patterns consistent with a more "El Niño-like state" under climate change scenarios (Jones et al, 1999). As a small islands developing nation, the FSM has long recognized that it would be directly and significantly affected by changes in sea level as a result of climate change with implications for coastal communities and resources.

In light of these circumstances, the FSM Government believes that the most effective national climate policy entails a response strategy that **addresses the impacts and sources of climate-related changes in both the near- and long-term**. This response strategy, therefore, recognizes and emphasizes:

- the **"value-added" benefit of flexible approaches which provide for both adaptation and mitigation at the same time**, combining an aggressive focus on impact-oriented adaptation measures with source-oriented mitigation measures. An example of this dual approach involves the pursuit of environmentally-sound technologies that address both mitigation and adaptation objectives such as the use of renewable energy sources for water desalination projects;

- the **importance of understanding and responding to the consequences of mean oceanic and atmospheric conditions (natural climate variability such as ENSO)** to build resilience for today's communities, businesses and ecosystems and develop insights into vulnerability and adaptation challenges associated with longer-term climate change;

- the **important role that emerging scientific insights and new technology** can play in both mitigation and adaptation strategies in the FSM (e.g.,climate forecasting and assessment tools as well as energy efficiency techniques);

- the **equally-important role of integrating traditional knowledge and practices** into national plans for climate change response (e.g., encouraging community-based traditional management of coastal resources); and

- the **importance of local capacity-building** through education, training and public outreach programs designed to strengthen the capabilities of local and regional institutions and develop endogenous skills.

In adopting a national climate policy, the FSM will encourage a combination of incentives (or disincentives) as opposed to measures that require overly restrictive legislation or other types of government regulatory action. Since most of the land in Micronesia is privately owned, the government does not dictate what a private land owner can or cannot do on his or her own land or with the associated resources to which they are entitled. Instead, established government agencies (at both national and State levels) are responsible for working closely with communities to ensure the integration of environment, social and economic concerns in the planning and management of land and its resources...working together toward achieving sustainable development.

Recognizing the inter-generational issues associated with climate change, the FSM is committed to a climate policy which addresses today's problems today while taking early steps to minimize the negative consequences of long-term climate change. **Of particular note in this context, is the FSM's emphasis on public awareness and participatory community development programs in the design and implementation of adaptation and mitigation measures.** This open and inclusive approach is important because of the decentralized nature of most development and management decisions within the FSM as well as the importance of recognizing and protecting traditional rights (as reflected in the FSM Constitution). The workplan of the FSM Climate Change Program emphasizes the importance of involving "major stakeholders, including officials from the national and State governments, NGO's, and especially the community leaders" in assessing mitigation and adaptation measures – recommending their participation in "all phases of a planning process such as assessment, setting priority, planning, monitoring and evaluation where appropriate." Program plans further note that measuring success in the implementation of the FSM National Action Plan is "based primarily on a participatory planning process" involving "all of the relevant stakeholders in the formulation of a plan." In particular, the Program notes the importance of empowering local communities to "gather and analyze information on traditional ways and means (traditional skills, values and land tenure issues) to be incorporated with scientific methods of protecting the environment from climate change impacts (such as the impact of sea level rise, erosion, etc.)."

The Role of Government

One of the particular challenges associated with developing and implementing a national climate policy involves the importance which the FSM Constitution places on the authority and powers of State Governments. The FSM Constitution gives those powers to States which are not expressly delegated to the national government or prohibited to States. Considerations of the environment are among those responsibilities NOT expressly delegated to the national government by the FSM Constitution. Thus, in most cases to date, control and management of environmental resources have been delegated to or assumed by the States. To the extent that an FSM climate policy involves broad environmental management, therefore, implementing that policy would fall, largely, to the individual States. The national government still has an important role to play, however, in coordinating State activities and providing technical assistance.

The Sustainable Development Council

While certainly embracing a number of important environmental considerations, a national climate policy can also be considered a reflection of national development goals, aspirations and policies. The FSM has been assessing, among other things, what patterns and levels of resource demand and use would be compatible with different forms or levels of achieving environmental, cultural, social and economic sustainability -- a discourse often described in the paradigm of sustainable development. In this context, the FSM President's Environmental Management and Sustainable Development (SD) Council was created in the mid-1990's to address matters

affecting the environmental management and sustainable development of the nation, including issues related to climate change. Providing recommendations to the FSM President, the Council is composed of the FSM Vice President as Council Chair; representatives of all four States; and representatives of six executive branch departments (the Department of Economic Affairs, the Department of Health, Education and Social Affairs, the Department of Foreign Affairs, the Department of Justice, the Department of Transportation, Communication and Infrastructure, and the 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 capabilities are tapped when providing coordination services and technical assistance to the States.

The FSM Climate Change Program

Responding to the recognition of the importance of climate change considerations in relation to sustainable economic development in the FSM, the national government established the FSM Climate Change Program (located under the Unit on Environment and Sustainable Development at the Department of Economic Affairs). **The focus of this Program is on national capacity-building** in order to meet commitments and obligations under the Framework Convention for Climate Change. The workplan for the FSM Climate Change Program includes assessing vulnerabilities and planning appropriate response strategies. Sub-areas of responsibility include technological needs assessment, coastal zone management, forest conservation and alternative energy planning as possible approaches to contend with climatic changes and accelerated sea level rise. The Program also maintains a research library on climate change and sustainable development topics and issues. In addition, the FSM Climate Change Program currently serves as the logistical coordinating body for the Nation's Sustainable Development Council.

The fiscal year 1999 description of the National Climate Change Program identifies the following specific objectives:

- completion of the National Communication Report;
- assessment of sea level rise and climate change impact and vulnerability;
- analyze policies and measures to cope with and protect FSM from climate change and sea level rise in order to make recommendations on suggested courses of action;
- develop an internal National Climate Change Action Plan for FSM national and State policy-makers focusing on adaptation and mitigation;
- promote island-specific issues and concerns in Pacific Rim regional and international climate change negotiations and conferences;
- conduct public education and awareness programs on climate change and development issues throughout the FSM; and
- train communities and personnel in-country to cope with climate change.

International Support

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 Environment Programme's Pacific Islands Climate Change Assistance Programme (PICCAP) and, in the past, the United States Environmental Protection Agency's Country Studies Program (USCSP). These two programs have provided the FSM national government with strong financial support and technical assistance in the area of climate change planning.

CHAPTER TWO – NATIONAL GREENHOUSE GAS INVENTORY

Introduction

The Greenhouse Gas (GHG) Inventory project was initiated at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil, as a result of widespread recognition that greenhouse gas emissions into the Earth's atmosphere may be a precursor to dramatic climate change. Representatives from 176 countries attended the 1992 Conference (which became popularly known as the "Earth Summit") and 150 of those countries adopted and signed the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC is a multi-lateral agreement to reduce the global emissions of greenhouse gases to 1990 levels by the year 2000. To date, more than 170 countries, including the Federated States of Micronesia have signed and ratified the UNFCCC.

Each signatory country is obligated under the UNFCCC to:

- develop, update periodically, publish and make available to the Conference of the Parties (COP), their national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol;

- use comparable methods for inventories of GHG emissions and removals such as those outlined in the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories; and

- incorporate GHG Inventory results along with other requirements of the UNFCCC into a National Communications report to be presented to the Conference of the Parties.

To fulfill these obligations, the National Government of the FSM applied for and received a grant in 1993 from the Government of the United States under the U.S. Country Studies Program. The U.S. Country Studies Program provided support to assist developing countries and countries whose economies where in transition in preparing inventories of their greenhouse gas emissions, assessing their vulnerabilities to climate change and evaluating response strategies for mitigating and adapting to climate change. The grant under the U.S. Country Studies Program served as a catalyst in broadening the scope of the climate change program in the FSM and enabled the FSM Government to establish a Climate Change Coordination Unit within the Office of Planning and Statistics.

In 1994, a consultant was hired by the Climate Change Coordination Unit to conduct the first GHG Inventory for the FSM. This Inventory was based on 1990 data as specified under the UNFCCC. In 1996, the South Pacific Regional Environment Programme (SPREP) initiated the Pacific Island Climate Change Program (PICCAP); a three-year program funded mainly by the Global Environmental Facility (GEF) and the United Nations Institute for Training and Research

(UNITAR). PICCAP became operational in 1997 and provides technical and financial assistance to each of the ten Pacific Island countries who are members of the Program, including the FSM. Under the auspices of PICCAP, a regional training workshop on GHG Inventory Methodologies was conducted in April 1998 with participants representing all PICCAP countries (including the FSM). Using the insights gained at that training workshop and the IPCC Guidelines for National Greenhouse Gas Inventories, the FSM initiated the greenhouse gas inventory effort which produced initial calculations of emissions from the energy sector for presentation to COP4 in 1998. The full results of this effort are presented in the recently-completed 1994 Inventory of Greenhouse Gas Emissions for the Federated States of Micronesia (Furow, 1999) and summarized in this Chapter.

Description of Activity

Using the methodologies outlined in the *1996 IPCC Guidelines for National Greenhouse Gas Inventory*, the FSM has completed an emissions inventory for the baseline year of 1994. All four states of the FSM were covered in the **1994 Inventory of Greenhouse Gas Emissions for the Federated States of Micronesia** which addresses the six sectors identified by the IPCC for use in national inventories (Foruw, 1999). This Chapter provides a summary of the key findings and policy implications of the 1994 Inventory. Table 2.1 provides a national summary of key greenhouse gas emissions for the FSM pursuant to the guidelines for non-Annex 1 countries. Table 2.2 provides a complete national summary of the results of the 1994 Inventory conducted for the FSM.

Because the FSM has a very small population (105,506) and limited land area, the activities outlined for most of the sectors identified by the IPCC do not have much practical relevance for the country. The only exception is the energy sector, which has been identified as the principle source of greenhouse gas emissions in the FSM as well as other small island states and, therefore, was the principal focus of the FSM 1994 Inventory. The primary greenhouse gases covered in the FSM 1994 Inventory are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). Other greenhouse gases including carbon monoxide (CO), oxides of nitrogen (Nox) and non-methane volatile organic compounds (NMVOCs) such as propane, butane and ethane were also covered to the extent that data were available.

Table 2.1 FSM GHG Summary (COP2 Guidelines--Non-Annex 1 Countries) **Greenhouse Gas Source and Sink Categories**	CO2	CH4	N2O
Total (Net) National Emission (Gigagram per year)	**235.972**	**0.339**	**0.0094**
1. All Energy	**235.95**	**0.179**	**0.0041**
Fuel Combustion [1]	**235.95**	**0.179242**	**0.004104**
Energy and Transformation Industries	N/C	0.001584	0.000317
Industry	N/C	0.000951	0.000248
Transport	N/C	0.013592	0.001146
Commercial-Institutional	N/C	0.006015	0.00018
Residential	N/C	0.156471	0.002138
Agriculture/Forestry/Fishing[2]	N/C	0.000629	0.000075
Other (please specify)	N/C	N/C	N/C
Biomass Burned for Energy[3]		0	
Fugitive Fuel Emission		***0***	
Oil and Natural Gas Systems		0	
Coal Mining		0	
2. Industrial Processes	**0.022**		**0**
3. Agriculture		**0.04**	**0**
Enteric Fermentation		0.04	
Rice Cultivation		0	
Savanna Burning		N/A	
Others (please specify)		N/A	N/A
4. Land Use Change and Forestry	**N/A**		
Changes in Forest and other woody biomass stock	N/A		
Forest and Grassland Conversion	N/A		
Abandonment of Managed Lands	N/A		
5. Wastes[4]	**0**	**0.12**	**0.0053**
Solid Waste Disposal Sites		0.1	
Wastewater Handling		0.02	
Human Sewage			0.0053
5. Other Sources as appropriate and to the extent possible (please specify)	**X**	**X**	**X**

Note:

[1] Carbon dioxide emissions from fuel combustion is calculated using the "reference approach" in the IPCC Guideline. This methodology does not support CO_2 calculations at the sub-sectorial level (e.g., Energy Industry, Transport, etc.). Data on fuel consumption at the sub-sectorial level were not available for calculations. However, fuel consumptions at such detail levels were **estimated** to facilitate the calculations of the other greenhouse gases including CH_4 and N_2O. Methane and nitrous oxide emissions under fuel consumption, therefore, are based on estimates.

[2] Newly added sub-sector

[3] Non-CO_2 gases emitted from burning biomass fuels are already accounted for under the sectors outlined above (e.g., residential) and therefore would be listed here as zero value.

[4] Newly added sector

Table 2.2 FSM National Greenhouse Gas Summary from 1994 Inventory (Foruw, 1999)

Greenhouse Gas Sources	CO_2 Emissions (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_2 (Gg)	HFCs (Gg)		PFCs (Gg)		SF_6 (Gg)	
									P	A	P	A	P	A
Total National Emissions and Removals	235.972	0	0.339	0.0094	2.254	6.64	1.088057	0.5262						
I. ENERGY	235.95		0.179	0.0041	2.254	6.64	1.088	0.5262						
A. Fuel Combustion	235.95		0.179	0.0041	2.254	6.64	1.088	0.5262						
1. CO_2 Emission (Reference Approach)[1]	235.95													
2. Non-CO_2 (Source Categories)			0.179	0.0041	2.254	6.64	1.088	0.5262						
B. Fugitive Emissions from Fuels			0	0	0	0	0	0						
1. CH_4 from Coal Mining and Handling			0											
2. CH_4 from Oil and Natural Gas Activities			0											
3. O_3 precursors and SO_2 from Oil Refining					0	0	0	0						
II. LAND USE CHANGE & FORESTRY[2]	0	0	0	0	0	0	0	0						
A. CO_2 from Changes in Forests & other Woody Biomass Stocks	n/a	n/a												
B. CO_2 from Forest and Grassland Conversions	n/a	n/a												
C. Non-CO_2 from On-site Burning of Forests			n/a	n/a	n/a	n/a	n/a	n/m						
D. CO_2 Removal from Abandonment of Managed Lands	0	n/a												
E. CO_2 Emission/Removal from Soils	n/a	n/a												
III. AGRICULTURE	0	0	0.04	0	0	0	0	0						
A. CH_4 and N_2O from Domestic Livestock			0.04	0										
B. CH_4 from Rice Cultivation			0											
C. N_2O from Agricultural Soil				n/a										
D. Non-CO_2 from Burning of Ag. Residues	0	0	n/a	n/a	n/a	n/a	n/a	n/m						
E. Non-CO_2 from Savanna Burning	0	0	n/a	n/a	n/a	n/a	n/a	n/m						
IV. WASTES	0	0	0.12	0.0053	0	0	0	0						
A. CH_4 from Solid Waste Disposal Sites			0.1											
B. CH_4 from Wastewater Handling			0.02											
C. N_2O from Human Sewage				0.0053										
V. INDUSTRIAL PROCESSES[3]	0.022	0	0	0	0	0	0.000057	0	0	0	0	0	0	0
A. CO_2 from Lime Production	0.022													
B. NMVOCs from Road Paving w/ Ashpalt							n/a							
C. NMVOCs from Breadmaking and Other Food Processes							0.000057							
D. Products Containing HFCs and PFCs									n/a	n/a	n/a	n/a	n/a	n/a
VI. SOLVENTS[4]	n/m	0	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m

Note: [1]The Reference Approach used does not account for non-CO_2 gases which are also released during fuel combustion. Calculating actual emissions for these gases requires detailed information from "end-use activities" such as transportation, electrical generation, etc.

[2]Greenhouse gas emissions from land-use changes and forestry are not calculated due to a lack of relevant data. Nevertheless, it is assumed that there is a net positive uptake of CO_2 in this sector due to regrowth of plants and forests, although the actual amount is difficult to determine.

[3]Only those industrial processes that are relevant in the FSM are listed.

[4]The methodology for solvents has not been finalized by IPCC at the time of this study and therefore emissions from this sector was not calculated.

n/a = data not available

The methodologies used in the FSM 1994 Inventory can be summarized as follows:

- **Carbon dioxide emissions from fuel combustion** – IPCC "reference approach" which estimates total carbon dioxide emissions based on the amount of fuel supplied to the economy for national consumption. This approach does not depend on detailed information regarding fuel type, technology and operating conditions. The fuels considered in the FSM 1994 Inventory consist mainly of imported secondary fossil fuel (gasoline, kerosene/jet fuel, diesel, aviation gasoline, lubricants and liquid propane gas) and locally-produced biomass fuels (coconut husks, coconut shells and wood). Since data on actual biomass fuel consumption are not readily available, estimates are made using the FSM 1994 population census and an estimated annual per capita consumption. Primary liquid fossil fuels (e.g., crude oil or natural gas liquids) and solid fossil fuels (e.g., coal, shale and peat) are not used in the FSM.

- **Non-CO_2 Emissions from fuel combustion by source categories** – estimated using emissions factors and fuel statistics organized by sub-sectors within the energy sector (energy industries, manufacturing industries and construction, transportation, commercial/institutional, residential and agricultural/forestry/fishing). Methane, nitrous oxide, oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds are calculated separately from sulfur dioxide since the former depend on combustion technologies while emissions of sulfur dioxide depend on the composition of fuels. Because data from these sub-sectors ("end use activities") were not available, the FSM 1994 Inventory estimates the amount of fuel by types in each sub-sector by taking a percentage of the total fuel imported or produced in the country and applying it to each specific sub-sector. These percentages are somewhat arbitrary and, therefore, based on the judgement and personal experience of the compiler. The fuels considered in the FSM 1994 Inventory consist mainly of imported secondary fossil fuels and locally-produced biomass fuels.

- **Land-use Change and Forestry** – IPCC guidelines based on the following premises: (1) the natural flux of carbon dioxide to or from the atmosphere is assumed to be equal to changes in carbon stocks in existing biomass and soils; and (2) the rates of change in land-use and the practices used to bring about the change (e.g., burning or clear-cutting) are used to produce assumptions that determine the impacts on carbon stocks and biological response to a given land use. As will be discussed later in this Chapter, further research is needed to explore the potential capacity of both terrestrial and marine ecosystems in the FSM to serve as carbon sinks.

- **Agriculture** – formulas outlined in the IPCC guidelines used to estimate emissions primarily from domestic livestock (e.g., pigs, goats and chickens) and burning of savanna as the primary sources of greenhouse gas emissions from the agriculture sector in the FSM. In the absence of detailed survey information, the FSM 1994 Inventory relied on estimates of livestock in the country based on past experience (e.g., each state is assumed

to have between 1 and 3 commercial pig operations and estimates of family-related pigs and chickens are extrapolate from the number of households identified in the 1994 FSM population census).

- **Industrial Processes** – based on IPCC guidelines for those industrial processes applicable to the FSM: (1) carbon dioxide emissions from lime production; (2) NMVOCs emissions from road paving with asphalt; (3) NMVOC emissions from bread baking and other food production processes; and (4) products containing HFCs and PFCs. Based on data limitations, the FSM 1994 Inventory contains calculations only for carbon dioxide emissions from lime production and NMVOC emissions from bread making processes. Nevertheless, it is assumed that greenhouse gas emissions from this sector are extremely low since the FSM has a very limited industrial base.

- **Waste** – IPCC guidelines for estimating greenhouse gas emissions associated with: methane production from solid waste disposal sites (SWDS); methane production from wastewater handling; and nitrous oxide production from human sewage. It should be noted that most solid waste disposal sites in the FSM consist of "open dumps" which do not have controlled placement of waste and, thus, would be classified as unmanaged. The primary source of wastewater in the FSM is from domestic or municipal waste streams; with essentially no wastewater streams from industrial sources.

- **Solvents** – This sector was not included in the FSM 1994 Inventory since the IPCC has not finalized appropriate methodologies. Emissions form this source in the FSM are likely to be minimal, however, since solvent products imported into the FSM would be the only source of greenhouse gas emissions (primarily NMVOCs). There are no solvents produced in the country nor are they imported in bulk for reprocessing.

Findings and Projections

The emission of CO_2 from the energy sector represents the primary source of greenhouse gas emissions in the FSM. The CO_2 emission total for the FSM in 1994 is 235.972 Gigagrams with CO_2 emissions from secondary (liquid) fossil fuels and is calculated to be 235.950 Gigagrams. Because data was not available for carbon dioxide emissions associated with land-use change, forestry or agriculture, the actual national total is likely somewhat higher. It is important to note, however, that those sources are expected to be significantly lower than the energy sector and in some cases involve ecosystems and practices which could be represent carbon sinks. The other source of carbon dioxide identified in the FSM 1994 Inventory is associated with lime production. Estimated at 0.022 Gigagrams in 1994, these emissions are associated with the production of lime for human consumption (an essential ingredient in chewing betelnuts) rather than for agricultural purposes (which is principal focus for the IPCC guidelines).

Methane (CH_4) emissions in the FSM are estimated at 0.339 Gigagrams in 1994. This represents combined emissions from fuel consumption, domestic livestock, solid wastes, and wastewater handling and treatment. Data on other sources (such as on-site burning of forests, savanna burning and the burning of agricultural residues) were not available. Inclusion of these other sources would, likely, increase the national emission total for methane, particularly since savanna burning may be the largest source of methane release in the FSM.

For nitrous oxide (N_2O), the combined national total is estimated at 0.0094 Gigagrams in 1994. This figure accounts for emissions associated with human sewage (0.0053 Gigagrams) and fuel consumption (0.0041 Gigagrams). Data on other potential sources (on-site burning of forests, savanna burning and burning of agricultural residues) were not available. Inclusion of these other sources would, likely, increase the national emission total for nitrous oxide.

Emissions of oxides of nitrogen (NO_x) in the FSM are estimated at 2.254 Gigagrams associated with the burning of biomass fuels and secondary liquid fossil fuels. Data on other potential sources (on-site burning of forests, savanna burning and the burning of agricultural residues) were not available. Inclusion of these other sources would, likely, increase the national emission total for oxides of nitrogen.

Emissions of carbon monoxide (CO) in 1994 are estimated at 6,.645 Gigagrams and represent the principal non-CO_2 gas emitted from fuel consumption. Data on other potential sources (on-site burning of forests, savanna burning and the burning of agricultural wastes) were not available. Inclusion of those other sources could increase the national emission totals for carbon monoxide.

Emissions of non-methane volatile organic compounds (NMVOCs) are estimated at 1.088 Gigagrams. This figure represents emissions associated with fuel combustion combined with breadmaking (and other food) processes. Data on other potential sources (on-site burning of forests, savanna burning, burning of agricultural residues and asphalt road paving) were not available. Inclusion of these other sources would, likely, increase the national emission total for NMVOCs.

Emissions of sulfur dioxide (SO_2) in 1994 is estimated at 0.526 Gigagrams, all of which is derived from fuel combustion (secondary liquid fossil fuels and biomass fuels). Sulfur dioxide is also likely to be emitted from activities associated with land-use change, forestry and agriculture although the amount of these additional emissions is expected to be very small in the FSM. Sulfur content in biomass other than fuelwood is extremely low (less than 0.03%). Moreover, on-site burning of forests and the burning of agricultural residues are not practiced extensively in the FSM. Savanna burning may be an additional source of emissions but the low sulfur content of savanna vegetation likely renders it an insignificant source. Since the IPCC has not formulated guidelines for the calculation of emissions from these other sources, estimates were not included in the 1994 Inventory.

The rest of the greenhouse gases emitted in the FSM include halocarbons (e.g., HFCs, PFCs) and sulfur hexafluoride (SF_6) although they are emitted only in very relatively insignificant quantities. Those emissions are associated with the use of products which contain these chemicals (fire extinguishers, refrigeration and air conditioning units, foam products, aerosol cans, and solvents) and are classified under the "industrial processes" and "solvent" categories in the FSM 1994 Inventory. Data on these compounds were not available but the amounts are expected to be very small since the FSM does not utilize or consume large quantities of these products.

Policy Implications

Since the absence and/or quality of data represents the principal difficulty encountered during the conduct of the FSM 1994 Greenhouse Gas Emissions Inventory, enhancing the ability of individual FSM states and the national government to collect and maintain relevant data sets in an important priority for the future. Country Team members, for example, could be asked to maintain appropriate data sets for their states with national government support for technical guidance, coordination and synthesis. Since resources are limited, emphasis should be placed on filling data gaps in areas of significant national interest.

Exploring current and potential carbon sinks in both the terrestrial and marine environments of the FSM, for example, would also provide valuable information to support land use and resource management policies and practices. Similarly, improved data on emissions from "end-use" activities would improve the next FSM emissions inventory and would also help national and state governments explore options for energy efficiency, conservation and alternative energy sources. Since the energy sector is believed to be the largest source of greenhouse gas emissions in the FSM, exploring various energy policy options (and technologies) can both mitigate the consequences of greenhouse gas emissions and support economic development in the nation.

Possible Projects

In addition to addressing a number of critical data and information gaps identified during the conduct of the 1994 FSM Inventory (described in Chapter Six), the FSM Country Team suggests that high-priority be given to pursuit of a project designed to produce a quantitative evaluation of the carbon sink potential of the FSM addressing both terrestrial (e.g., forests) and marine (e.g., coral reef) ecosystems. Chapter Five presents a more detailed summary of this proposed project.

CHAPTER THREE – MITIGATION

For purposes of this National Communication and the UNFCCC, mitigation refers to activities undertaken to reduce the emissions of greenhouse gases associated with human activities. As can be seen from Chapter Two, FSM's Greenhouse Gas Inventory, the nation's human-influenced source of greenhouse emissions represents a negligible percentage of the world's total human sources of carbon dioxide, methane, nitrous oxide and other greenhouse gases into the atmosphere. There has even been some speculation that, because of the "carbon sink" capacity of FSM's forests and marine ecosystems, the nation could, in fact, provide for a net uptake of greenhouse gases. Most of the emissions of greenhouse gases in the FSM comes from the use of petroleum-based fossil fuels for transportation and the production of energy. As a result, mitigation options related to reducing/controlling the emissions of fossil fuels will be considered in the context of national and state energy policies

FSM Climate Change Mitigation Policy

The FSM was one of the first countries to sign and ratify the UNFCCC and the Nation remains concerned about the role that the impacts of climate change may have for the natural and socio-economic well-being of the country. Even though the FSM is not a significant contributor to the global emissions of greenhouse gases, pursuing a climate policy of "no action" would clearly be counter-productive in both the short- and long-term. While a policy that focuses solely on local impacts seems attractive and rational, the FSM is an active member of the international community and recognizes that it does not exist as a nation in isolation. The FSM acknowledges its international obligations 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.

Many of the response options being considered by the FSM represent "combined" measures which provide for both adaptation and mitigation benefits at the same time. One example of this approach, involves the FSM's decision to address climate response measures in the context of a broad program of environmental management. In doing so, for example, the FSM can implement measures which sustain critical terrestrial and marine habitats (e.g., forests and coastal ecosystems like coral reefs) for their own sake and, in so doing, potentially enhance the nation's ability to sustain or increase its natural sinks for carbon dioxide (a mitigation measure).

DESCRIPTION OF ACTIVITIES

Reducing Greenhouse Gas Emissions

As noted in Chapter Two, most of the emissions of greenhouse gases in the FSM comes from the use of petroleum-based fossil fuels for transportation and the production of energy. As a result, mitigation options related to reducing/controlling the emissions of fossil fuels will be considered in the context of national and state energy policies. FSM's approach to reducing energy-related greenhouse gas emissions will address three general categories described in a Regional Mitigation Analysis Report by Ellis and Fifita (1999):

- **Demand-side management** – which refers to activities aimed at reducing energy consumption at the level of the user (e.g., conservation strategies, design and labeling of energy efficient appliances and technologies, various measures targeted at ground transportation, and education and training programs);

- **Supply-side management** – which refers to activities aimed at reducing the use of fossil fuels (e.g., increasing the efficiency of existing energy systems; increased use of renewable energy sources such as biomass for heat and electricity, coconut oil fuel, wind power and photovoltaics); and

- **Sink enhancement** – which refers to activities aimed at increasing local sinks for removing carbon dioxide from the atmosphere with particular emphasis on development of appropriate forestry management programs.

With respect to sink enhancement efforts, it is important to note that mitigation forestry should not be developed under arrangements that would allow other countries to avoid their mitigation responsibilities (Ellis and Fifita, 1999).

In their 1999 study on greenhouse gas mitigation in the PICCAP countries, Ellis and Fifita outlined a number of specific mitigation options which are included here as Table 3.1 . While each of the options identified by Ellis have intrinsic merit, they must be reviewed in the context of the special circumstances of the FSM (or any individual nation). In the case of the FSM, consideration must be given to issues associated with cost, access to new technology, the technical as well as cultural appropriateness of certain technologies, and national commitments to enhance economic growth and improve the quality of life for the FSM people.

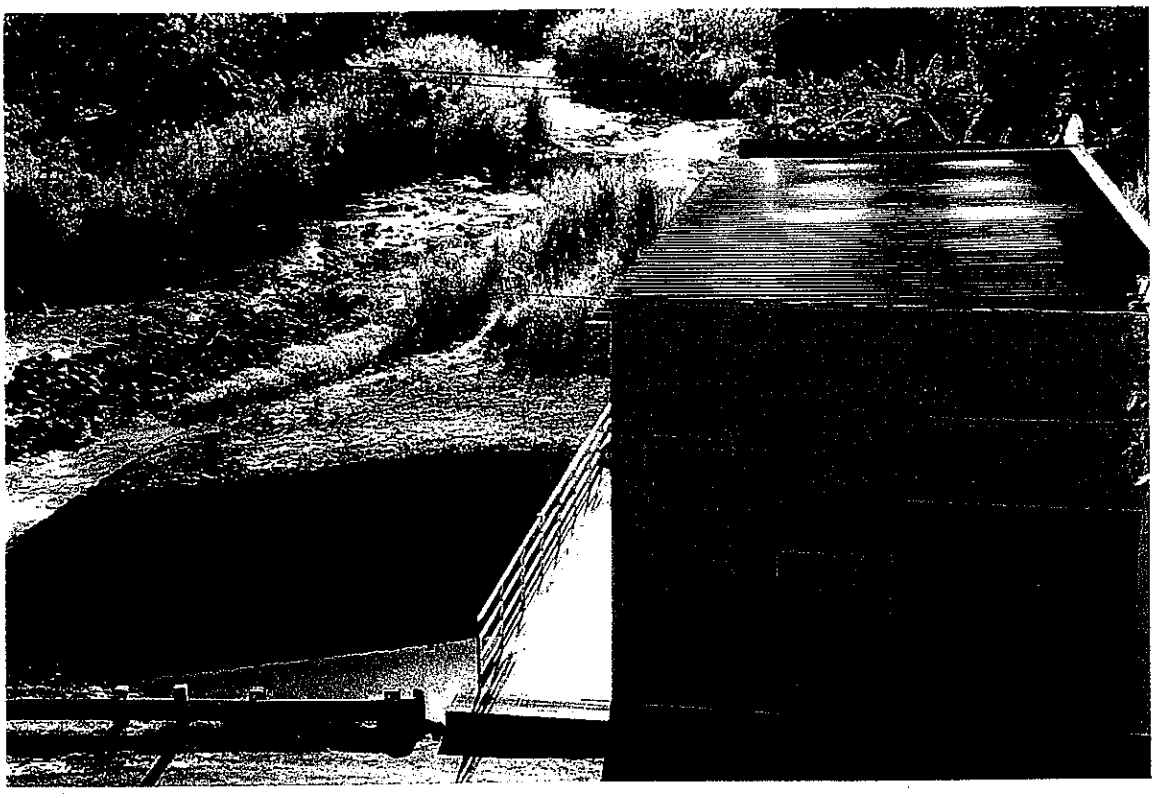
Table 3.1 Options for Mitigating Greenhouse Gas Emissions (Ellis and Fifita, 1999)

	Power Generation	Power Distribution	Power Consumption	Ground Transport	Forest
Pricing/Tax	• Carbon tax on all fossil fuels • Tax on ageing and inefficient gensets • Preferential tax / exemptions of non-fossil consuming technologies	• Preferential tax / exemptions on supplies for upgrading the distribution systems network	• Tax on inefficient appliances • Preferential Tax / exemption on more efficient appliances • Tariff review	• Carbon tax on all petroleum fuels • Tax vehicles according to engine sizes • Preferential tax / exemptions on non-fuel consuming transport system	• Make forest establishment expenses tax deductible • Sell emissions offset rights
Subsidy	• Subsidise lighter fuels • Subsidise more efficient gensets • Subsidise emission control/monitoring instruments	• Subsidies for upgrading power distribution networks	• Subsidise more efficient appliances	• Subsidise the public transport sector • Subsidise more efficient cars • Subsidise non-fuel consuming transport systems	• Compensate for loss of stumpage revenue • Provide free seedlings • Provide improved roading
Regulation/ Policy	• Emissions level • Fuel quality • Power Mix • Efficiency of gensets • More use of renewables	• Levels of line losses • Power thefts	• Minimum equipment standards	• Engine sizes • Emission levels	• Tree planting obligation after harvesting
Information	• Renewable energy awareness and training programmes	• Technical assistance with loss identification	• Efficiency labelling schemes • Efficiency audits • Public awareness and training programmes	• Fuel consumption labelling schemes • Public education and maintenance training programmes	• Public awareness and training programmes
Equipment Supply	• Emissions control and monitoring instruments • More efficient gensets • Power from wind, hydro, biomass, PV, coconut oil, geothermal, waves, OTEC	• Cables • Transformers • Reliable metering equipment to detect losses	• Affordable and efficient appliances • Solar water heaters • Biomass for heat • PV	• Public transport vehicles	• Nurseries
Institutional	• Commercially-oriented power sector	• Commercially-oriented power sector	• Full costs of power supply recovered in the power tariff • Commercially-oriented power sector	• Traffic control measures to smooth traffic flows • Establish a co-ordinating agency to improve public transport efficiency	• Create company, trust, or other structure to facilitate afforestation projects

Because the energy sector is the FSM's primary source of greenhouse gases, potential projects should be geared toward minimizing emissions from this source. The FSM 1994 Inventory identified the following policy implications and possible projects which could be undertaken to mitigate the emission of greenhouse gases from the energy sector in the FSM:

- encourage the adoption of energy-efficient technologies (e.g., utilizing more efficient generators and providing appropriate financial incentives);
- monitor automobile emissions and take appropriate steps to reduce the emissions of carbon monoxide (the second highest GHG emission source in the FSM);
- encourage the use of renewable energy sources;
- establish programs to enhance FSM's sink capacity (e.g., tree planting/forest conservation programs and coral reef preservation activities).

The increased use of renewable energy sources offers an interesting opportunity for the FSM. According to a study on sustainable development and energy use in the Pacific islands (Johnston, 1995), solar, biomass, hydro (for larger islands), and geothermal are identified as "good" potential renewable resources for at least parts of the FSM. Wind resource potential is more limited and little, if any, information is available on the potential of OTEC and wave energy as resource options for the FSM. Increasing the percentage of FSM's energy that comes from indigenous, non-petroleum sources could become an important part of FSM's mitigation strategies. Conversely, consideration of forest management and land use practices that enhance the capacity of local vegetation to serve as sinks for carbon dioxide offers another opportunity for the FSM to reduce its net emissions of greenhouse gases. Policy making related to biomass alternatives to fossil fuels will have to balance these considerations. The hydropower plant depicted below reflects the FSM's commitment to making use of renewable energy sources.



Providing incentives for the use of alternative energy sources and energy efficiency mechanisms in government and private-sector buildings and development projects offers another interesting mitigation option, particularly as it relates to facilities associated with the emergence of new economic sectors like tourism. Similarly, increasing the efficiency of vehicles used in the transportation sector also has potential in the FSM where transportation accounts for 62% of petroleum consumption.

Ensuring full implementation of the UNFCCC is an essential component of a climate response strategy for the FSM and the international community as a whole. Adequate support for the **Clean Development Mechanism** provisions of the Kyoto Protocol to the UNFCCC is seen as an important component of providing the financial support and expertise necessary to assist the FSM (and other developing countries) to explore new technologies and practices for adaptation.

Possible Projects

What follows is a list of some possible projects that could be undertaken to improve the mitigation component of FSM's national climate change program and fulfill its responsibilities under the UNFCCC:

- energy conservation capacity-building within FSM utilities;
- design and implementation of solar energy pilot projects;
- creation and maintenance of a solar energy information clearinghouse;
- consideration of a subsidy program for solar energy; and
- a feasibility study on other renewable energy sources.

Additional details on these projects is provided in Chapter Five.

Since the FSM accounts for only a very small percentage of the worldwide emissions of greenhouse gases, consideration of mechanisms to reduce those emissions represent only part of a national commitment to respond to the challenges and opportunities of climate change. In the FSM, mitigation efforts are set in the broader context of ensuring that the governments, communities, businesses of the FSM all do their part to mitigate climate change. This reality places even greater importance on national and international commitments toward capacity building and adaptation as high priorities in the context of climate change.

CHAPTER FOUR – CLIMATE VULNERABILITY AND ADAPTATION

For the purposes of this National Communication, **vulnerability** can be characterized as a reflection of the sensitivity of a given community, sector, or ecosystem to changes in climate combined with a measure of the ability of those systems to respond in such a way as to minimize the adverse effects of those changes or capitalize on any opportunities they might bring. Thus, policy makers can seek to decrease or limit vulnerability by either reducing sensitivity to change – if possible – or by increasing resilience to change or both. **The FSM is committed to pursuing principles of adaptation that seek to address both components of vulnerability.** For purposes of these discussions, adaptation represents the combined policies and measures undertaken to reduce the vulnerability of the FSM to climate change. Wherever possible, the Government of the FSM is dedicated to exploring opportunities to increase the resilience of FSM communities and economic sectors to climate change impacts through policies and actions that also have the added benefit of achieving mitigation goals. Adaptation responses in the FSM also include anticipatory actions designed to enhance the capability of governments, communities/individuals and businesses in the FSM to minimize some of the potential adverse consequences of climate change and to capitalize on potential positive consequences.

Today's Challenge – Responding to Climate Variability

Increasingly, scientists and policy makers engaged in debates about adaptation to climate change are recognizing the importance of understanding and responding to the consequences of natural climate variability and long-term climate change (Crosson and Rosenberg, 1991). As described in Chapter 1, for example, the people and governments of the FSM already face significant climate-related challenges associated with the cycle of El Niño and La Niña events in the tropical Pacific:

- changes in rainfall resulting in severe drought in many jurisdictions during El Niño events;
- changes in patterns of tropical storms;
- changes in the risks of storm surge, coastal erosion and saltwater intrusion associated with temporary variations in sea level which accompany the evolution of El Niño and La Niña across the tropical Pacific (La Niña events tend to bring higher than normal sea level conditions to the FSM while El Niño events bring lower than normal sea level); and
- changes in the migratory patterns of important fisheries like tuna.

Anticipating and responding to those challenges – i.e., adapting to natural climate variability – not only has significant near-term benefits but also provides valuable insights into the vulnerability of FSM communities, businesses and ecosystems to some of the potential consequences of climate change and valuable adaptation experience. By way of example, we have included a brief description of the impacts of the 1997-1998 El Niño on the FSM and how the governments and people of the FSM responded to that event (Figure 4.1).

Figure 4.1

THE 1997-1998 EL NIÑO – A CASE STUDY IN VULNERABILITY AND ADAPTATION

The 1997-1998 El Niño event offers a vivid example of how climate affects the people of the FSM and how information about potential consequences can be used to support decision making and benefit society. While El Niño events have a number of consequences for the FSM and other Pacific island jurisdictions, this case study will focus primarily on El Niño-related changes in rainfall that led to severe drought conditions in the FSM (and many other Pacific island jurisdictions). The information this case study comes from the work of the Pacific ENSO Applications Center (PEAC) which represents a partnership among the U.S. National Oceanic and Atmospheric Administration (NOAA), the University of Hawaii, the University of Guam and the Pacific Basin Development Council (PBDC).

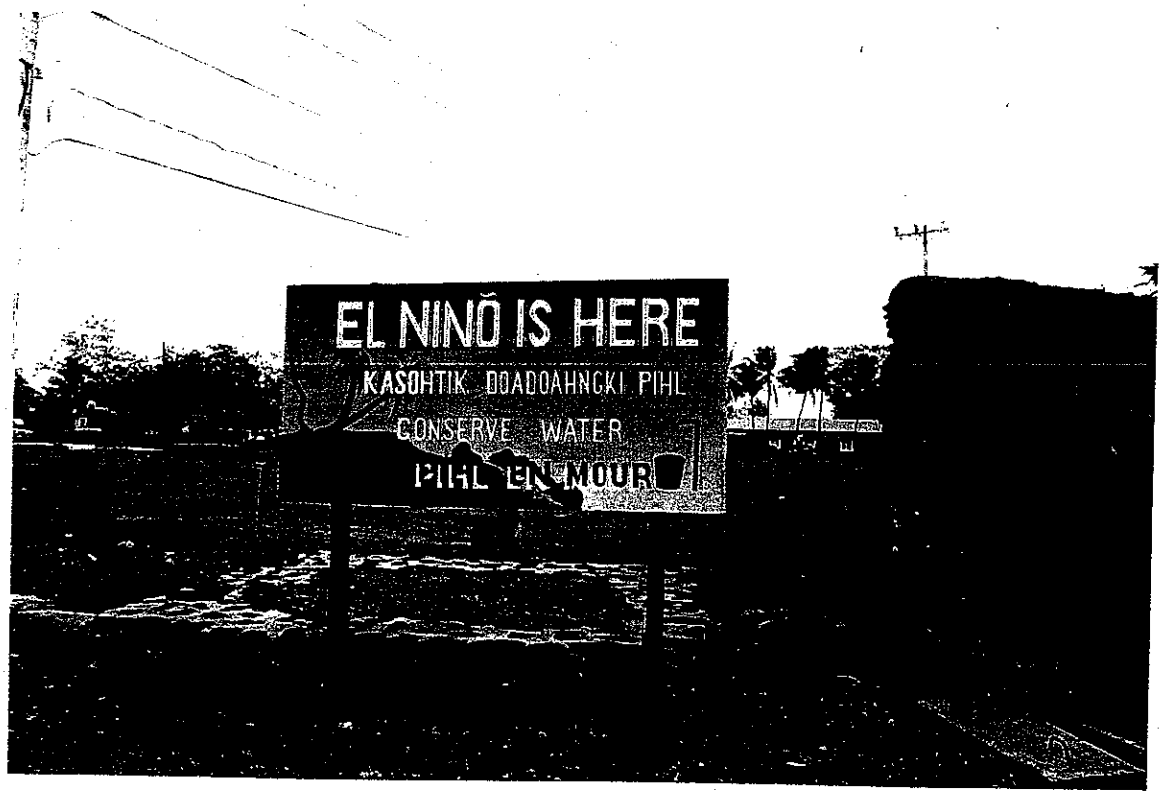
By May of 1997, most ocean-atmosphere observations and predictive models indicated that a significant El Niño was developing. Based on these observations and model results, the Pacific ENSO Applications Center provided early forecasts of El Niño-related reductions in rainfall and initiated an aggressive program of government briefings and public education. The FSM Government established a "drought task force" designed to undertake disaster mitigation planning. In addition to addressing governmental actions (such as water conservation and allocation plans), the drought task force supported public information campaigns that informed the public of what they might expect from El Niño and identified measures that could be taken to mitigate damaging consequence, such as conserving water, preventing outbreaks of certain diseases often associated with drought conditions, and reducing the risk of wildfires which often increase under drought conditions. In Pohnpei State, for example, a video and public service announcements were produced and aired on local television and radio stations several times daily; information hotlines were set up; brochures were produced and distributed; and presentations on El Niño and drought were made in local schools. Water management agencies in Pohnpei and Yap developed and implemented water conservation plans. Throughout the FSM, people repaired water catchment systems and local vendors were able to supply new household catchment systems to meet the demand that resulted from the public information campaign. Chuuk State alone incurred costs of $1.5 million as a result of the 1997-1998 El Niño. In November 1997, the Congress of the FSM appropriated $5 million to address the potential impacts of the anticipated drought conditions.

Even with these precautions, the 1997-1998 El Niño produced such extensive drought conditions that water rationing became necessary in many jurisdictions throughout the Pacific. In Pohnpei, for example, municipal water was available every day but limited to only a few hours during the height of the drought. In the outer islands of Pohnpei State, water had to be supplied by ship and tanker trucks. The drought produced agricultural losses throughout the Pacific (except in Guam). A limited damage assessment in Pohnpei indicates that serious losses of both food and cash crops were sustained. Over half of the banana trees evaluated, for example, had died or were severely stressed. Kava (sakau) was probably the most serious economic loss because it has recently become an important cash crop. In Yap State, taro losses were estimated at 50-65% and betel nut prices increased more than 500%, although only 15-20% of the trees were lost. In addition Yap and Pohnpei suffered from increased wildfires which reduced local air quality conditions as well as significant direct damages such as increased sedimentation from erosion in the areas affected by the fires. There is some evidence that the 1997-1998 El Niño produced an eastward shift of important skipjack tuna stocks out of FSM waters.

Still, the consequences could have been worse. Advance warning and a focused program of education and outreach clearly helped mitigate the negative consequences of this recent example of how climate affects real people in real places. FSM governments, communities and businesses are learning how to factor new information about climate variability into their decisions and are looking for information about how those patterns might change under projections of climate change. Scientists and decision makers in FSM and throughout the Pacific are learning how, by working together, they can begin to address the challenges and opportunities of climate variability and change.

(Source: Pacific ENSO Applications Center, 1999)

The photo below provides an example of efforts to raise public awareness about the consequences of climate variability in the FSM. This roadside sign from Pohnpei conveys a warning about the 1997-1998 El Niño event and encourages the conservation of water.



Source: U.S. National Weather Service, Pacific Region Office

Initial Vulnerability Assessments for the FSM–Description of Activities

Vulnerability assessments were undertaken between 1993 and 1999 in three States of the FSM: Yap, Kosrae and Chuuk. Collectively, the three studies provide an initial assessment of the potential effects of climate change on the four types of islands found in the FSM with an emphasis on the consequences of accelerated sea-level rise. It is important to note that each, individual study was undertaken using slightly different methods and techniques using the 1991 and 1994 IPCC technical guidelines and climate change scenarios.

The Yap study commenced in 1993 and was completed in 1994. Project work was carried out by the US Geological Survey (USGS) in collaboration with the National Ocean Service of the US National Oceanic and Atmospheric Administration (NOAA). Field studies were conducted on the Yap Main Islands and Falalop Islet on Ulithi Atoll. A brief visit was made to the high emerged limestone island of Fais. The study concentrated on identifying and describing the characteristic shoreline area of the islands being investigated. Coastal profile data were collected from eleven representative sites around island shorelines. Three critical shoreline environments were identified: mangrove forests, sandy beaches and coral reefs. These critical environments are considered to be generally representative of the coastal landlords that are at risk from accelerated sea level rise along with the other possible effects of climate change.

The vulnerability assessment of Kosrae Island was initiated in 1994 with a Phase I study. Consultant reports documenting environmental conditions and an assessment analysis were submitted to the FSM Climate Change Coordination Unit in 1995 and 1996. Phase 2 of the assessment was completed in 1997-1998 and was guided by the 1991 IPCC Common Methodology. The two sea level rise scenarios considered for the assessment were 0.25 and 0.95 meters (1.0 and 3.3 feet).

The objectives for the Kosrae study focused on the already rapidly changing coastal environment of the island in the context of existing and changed socio-economic conditions. A 30-year time frame was set for evaluating changes in the population and resource base. The implications of other environmental and natural resource management problems being faced by the Kosrae State Government were also addressed through the study. The analysis encompassed the physical and economic impacts on the natural and socio-economic systems of the coastal areas that are considered vulnerable to climate change. Specifically, the study's focus on rapidly-changing shorelines where a majority of people on Kosrae reside, with attendant social and economic pressures on coastal resources, highlights the human dimension of vulnerability to climate change. Since over 90 percent of the population of the FSM live on the shoreward margins of islands of volcanic origin (i.e., the "high islands" like Kosrae), the Kosrae study is indicative of the human scope of the climate change challenge facing the Nation as a whole.

The third FSM national vulnerability and adaptation assessment undertaken to date addressed the islands of Weno and Satowan in Chuuk State. The selection of Weno and Satowan by the FSM/PICCAP Climate Change Country Study Team was made largely on the basis of: the

availability of data; the distribution of the population; existing social and economic conditions; and the representativeness of islands of Chuuk State to FSM as a whole. The potential effects of climate change on water resources, coastal resources, agriculture and fisheries were evaluated. The analysis for each sector covers climatic impacts and adaptation in the context of existing socio-economic conditions and the implications arising from climate-induced changes.

The general framework used for the Chuuk assessment was based broadly on the seven steps proposed in the 1994 IPCC Technical *Guidelines for Assessing Climate Change and Adaptations*: determination of the scope of the study; selection of the methods to be used; generation of scenarios; the evaluation of biophysical and socio-economic impacts; assessment of autonomous adjustments; and the evaluation of adaptation strategies. The time horizons adopted for the study were 2050 and 2100. These time periods were projected to be associated with a projected 3.5°C increase in global temperature and a 0.95 meter rise in sea level (using the high end of the range of possible sea level rise scenarios used in the IPCC Second Assessment Report).

Work carried out as an integral part of the Chuuk State study included collation and critical review of existing information on the biophysical and socio-economic resource base and the documentation of baseline conditions and projections. Field work was undertaken to provide profiles of atoll landforms. Indicative data were developed to determine the elevation of Satowan and the susceptibility of the shoreline of this atoll to erosion and other climate change-induced impacts.

Findings and Projections

The studies of Kosrae, Yap and Chuuk provide initial qualitative and quantitative assessments of the vulnerability of atolls and high islands in the FSM to climate change and related effects including accelerated sea level rise. Recognizing the differences in approaches and methodologies used in these studies, this synthesis of findings and projections concentrates on the qualitative results. Quantitative information is quoted as it applies to particular cases. The three studies document the current environmental conditions and make projections on the impacts of climate change on the existing physical and socio-economic systems. Although the findings of each study vary in specific details, collectively the three studies provide some perspectives on the sensitivities of the islands of the FSM to:

- the existing climatic forces which result in erosion of the shorelines, expansion of mangrove habitats, and patterns have drought which have public health and nutrition consequences; and

- ongoing climate-related changes which are cumulative with the existing pattern of impacts on the water, coastal, agricultural and fisheries resources of the FSM.

The findings of the three initial FSM vulnerability and adaptation assessments are summarized below in the context of how changes in key climatic conditions (temperature, rainfall and extreme events) might affect the two classes of islands studied: atolls and reef islands without lagoons; and high islands. In addition, the following summary highlights some of the key findings regarding the sectors reviewed in detail in the Chuuk study, namely water, the coastal zone, agriculture and fisheries.

As a result of climate change, these initial FSM assessments projected that:

- temperatures will continue to rise;
- total rainfall will decrease and there will likely be greater variability in the intensity, frequency and distribution of rainfall;
- there will be a resultant increase in severe droughts;
- sea-level will rise according to IPCC projections; and
- the intensity and frequency of extreme events (e.g., tropical storms and storm surge) will increase.

In addition, the Chuuk vulnerability and adaptation assessment study suggests that there may be an increase in flooding due to the projected increase in extreme events and erosion due to sea level rise (Konno and Abraham, 1999).

Atolls and Reef Islands without Lagoons

The atolls and reef islands of the FSM are already being affected by a combination of shoreline erosion and human activities. The erosion is common on reef platform and lagoon sides of the atolls where they are found. Erosion rates in the order of 0.3 metres per year have been reported in some areas. Natural erosion processes are being compounded by a number of human activities, including: the collection of reef rocks; removal of sand from beaches; dredging coral sand and gravel; and the ad-hoc construction of shoreline protection walls and other measures. Historic records provide evidence of the effects of storm damage and localized inundation in relation to existing patterns of settlement following extreme events.

Atolls and reef islands are expected to suffer severely as a consequence of accelerated sea-level rise and associated impacts. These islands have elevations up to about 7.0 metres with an average of 3.0 to 4.0 metres above present mean sea level. While most infrastructure on FSM atolls is above the mean sea levels predicted under climate change scenarios, historic experience suggests that high tides and storm events are expected to result in considerable damage to shoreline protection works and roads in low-lying (near-shore) areas, causeways and airports.

High Islands

The low-lying coastal margins of the high islands are already being degraded by:

- coastal erosion and the construction of protection works;
- natural biophysical changes to mangrove and freshwater systems as a result of shoreline retreat and saltwater intrusion; and
- the effects of human activities associated with agricultural practices, landfill for construction and the disposal of solid and liquid domestic waste.

The effects of climate change and accelerated sea-level rise will aggravate existing environmental problems on high islands. Critical natural systems such as beaches, freshwater wetlands and mangroves are expected to continue to be degraded, possibly at an accelerated rate due to human activities, thereby reducing the resilience of natural systems already under stress. The initial FSM vulnerability and adaptation assessments indicate that the expected impacts of accelerated sea- level rise and other climate-related impacts on the low-lying areas of high islands will include:

- changes to the structure and biodiversity of reef systems with minimal effects on the morphology of coral reefs;
- loss of seagrass habitats from lagoons and sheltered reef flats;
- considerable increase in coastal erosion with resultant shoreline retreat;
- loss of coastal agricultural land;
- a slight increase in freshwater wetland systems;
- an increase in mangrove forest areas at the expense of sandy beach systems;
- increased risk from severe storms and other extreme events for human settlements in coastal margins; and
- increased risk to housing and infrastructure, especially coastal roads and filled areas.

In addition, changes in rainfall may affect ecosystems at higher elevations as well.

Water Resources

The initial FSM vulnerability and adaptation assessments indicate that the water resources of the FSM are threatened by projected climate change. On atolls, the threat results from a combination of anticipated droughts and lower rates of recharge of the groundwater lens as a result of reduced rainfall as well as loss of the freshwater lens as a result of saltwater intrusion and shoreline erosion. Public health and nutrition problems may also arise as a result of saltwater intrusion and a general reduction in the quality and quantity of groundwater resources on the more highly-populated atolls.

Even with an anticipated reduction in rainfall, there should be minimal threat to the water resources of high islands. The topography, vegetation cover and soil conditions of the high islands aid in the capture of water and, therefore, make water resources on these islands less vulnerable than on atolls. The FSM's initial assessment studies suggest that **with proper management** there should be sufficient surface catchments and adequate and accessible aquifers to meet projected water supply demands. However, some of the catchments, aquifers and ground water recharge areas on the more populated high islands are already under development pressure. Should the need for catchment and groundwater management be ignored, the security of water resources even on the high islands could be in jeopardy as a result of climate change.

Agriculture

Prolonged periods of drought over the past twenty years have been observed to have adverse effects on the agricultural productivity of atolls and reef islands. Both taro and breadfruit, for example, have been significantly affected by changes in the water table under adversely dry conditions. The impacts of the 1997-1998 El Niño (described in Figure 4.1) present a vivid, recent example of how climate-related changes can affect agriculture in the FSM. **Projections of climate change used in the initial FSM assessment studies suggest that reduced rainfall and more frequent and intense droughts could increase the risk, particularly to people who are wholly or partially dependent on taro and breadfruit for subsistence needs.**

The situation on high islands is a little better. Agricultural productivity on high islands seems to be better buffered against the adverse effects of reduced rainfall and enhanced drought conditions associated with climate change. **On the other hand, the most productive agricultural areas of high islands are in low-lying coastal areas which, as we have already discussed, could be at risk from the consequences of accelerated sea level rise which would accompany climate change.** Enhanced crop diversity and selection (e.g., salt- and/or drought-tolerant species) could provide an effective adaptation tool. Appropriate, long-term land use strategies designed to protect and conserve land resources for agriculture are also expected to be important components of efforts to respond to the challenges of climate variability and change.

Coastal Resources

In their regional synthesis of the vulnerability and adaptation assessment studies completed by ten Pacific island countries (including the FSM), John Hay and Graham Sem suggest that "increasing risks of coastal erosion, flooding and inundation represent the most direct and severe effects of climate and sea level changes" and note that these impacts will be exacerbated by any changes in seasonal storms, high tides and storm surges (Hay and Sem, 1999). As already noted, the coastal resources of both atolls and the low-lying margins of high islands of the FSM are already at severe risk from a combination of shoreline erosion and human activities.

Without implementation of integrated coastal management policies, the resource base of the most highly-populated islands will be at even greater risk in the future. This situation would be further exacerbated by climate change through the anticipated losses of natural resources and important coastal systems such as sandy beaches and coral reefs.

When responding to the challenges of shoreline and lowland change, limited retreat has been identified as an adaptation option for some of the high islands. This form of adaptation through the relocation of the large proportion of the coastal population can only occur, however, with the concurrence of the owners of the more elevated land. As a result, this adaptation approach would require long-term land use planning accompanied by changes in traditional patterns of land tenure.

In contrast to the high islands, retreat may not be an option for people on some of the more highly populated atolls. For these people, off-island re-settlement would be the only available option. This option would have to be achieved without disruption to host communities and with sensitivity to and careful regard for the traditional values and practices of both the displaced and host communities.

Fisheries

As noted in Chapter One, the tuna fishery within the FSM Exclusive Economic Zone already accounts for a 17% share of the nation's GDP and is expected to be an important element of the Nation's future economic development. The continuing viability of the tuna fishery depends upon factors related to the sustainable yield of the stocks, the world market for tuna and tuna products and the effects of environmental stresses, including the effects of climate variability and change. The potential impacts of climate on the tuna fishery of the FSM have yet to be fully evaluated. Such an evaluation would have to consider changes in ocean temperature, circulation and productivity might affect tuna and other important fish stocks and detailed information on how climate change might affect those important characteristics of the ocean environment around the FSM are not yet available. In addition, recent evidence suggests that natural variability in the climate system, like the cycle of El Niños and La Niñas, has an effect on tuna (and other fish stocks) important to the FSM and many Pacific island countries. If, as some climate projections suggest, climate change might affect (or manifest itself through) changes in patterns of natural variability like El Niño, we must improve our understanding of how those patterns affect tuna and other important fisheries in the FSM today and as well as our understanding of how those patterns might change in the future. In addition, we must develop a more complete understanding of the human dimensions of the fisheries of the FSM, including issues related to: how tuna and other fisheries fit in broad economic development plans for the Nation; recent and anticipated changes in fishing pressure; other environmental stresses which might be affecting important stocks; and the importance of tuna and other stocks (particularly reef fishes) as subsistence food for the people of the FSM.

The findings of these initial FSM vulnerability and adaptation assessments are consistent with broader regional and international analyses of the possible effects of climate change and sea level rise on key sectors in developing countries (including small island states) and the identification of possible adaptation measures to address those impacts. Table 4.1 provides a sampling of the possible effects of climate change and accelerated sea level rise for Pacific island countries (PICCAP, 1999).

Table 4.1 **An example list illustrating the wide range of possible effects of climate change and sea level rise in a selection of "sectors" in Developing Countries**

Coastal Zone	Inundation and flooding of low-lying areas Coastal Erosion Possible increase in cyclone-related effects Changes in sediment production due to changes in coral reef systems
Water Resources	Changes in freshwater lenses and other groundwater resources Salt intrusion of groundwater resources Changes in surface water resources Changes in surface run-off, flooding and erosion
Agriculture	Changes in commercial crop yields Changes in subsistence crop yields Changes in plant pest populations Possible changes associated with changes in ENSO, drought & cyclone patterns Changes in soil quality
Fisheries	Changes in distribution and abundance of offshore fish species Changes in productivity of inshore fisheries Changes in fish breeding sites
Ecosystems	Coral bleaching and coral degradation (also possible increased upward coral growth) Changes in mangrove health and distribution Degradation of sea grass meadows Changes in forest ecosystems Changes in wetland systems
Human Health	Increased incidence of vector borne diseases (e.g., malaria and dengue fever) Increased heat stress and heat related illnesses Indirect effects on nutrition and well-being secondary to effects in other sectors such as agriculture and water resources Deaths, injuries and disease outbreaks related to possible increases in extreme events such as cyclones, floods, droughts

Source: PICCAP, 1999

POLICY IMPLICATIONS

The governments and the people of the FSM are committed to protecting and utilizing the resources of the Nation in a sustainable manner for today and for future generations. As suggested by recent experience and the initial FSM vulnerability and adaptation studies described above, understanding and effectively responding to the challenges of climate variability and change will be an important element of our success or failure in fulfilling this commitment. This section provides a brief outline of some international, regional and national policy considerations which will affect the FSM's ability to address climate-related issues today and in the future.

Identify specific opportunities to implement adaptation measures to reduce vulnerability in key sectors – The FSM national government will work with the state governments, community leaders, businesses and non-governmental organizations to identify, explore and implement specific adaptation measures designed to address the vulnerabilities identified in key sectors. In pursuing these options, the FSM will work closely with other Pacific island countries and regional organizations like SPREP to develop shared solutions to common problems. Table 4.2 identifies some of the possible adaptation measures which FSM is considering to address some of the vulnerabilities identified in the initial assessments described in this National Communication.

Table 4.2	Possible FSM Climate Change Adaptation Options
Water Resources	Conduct a comprehensive inventory of existing water resources
	Assess the status of storage and distribution systems and secure resources for necessary improvements
	Encourage improvements to residential and commercial catchment systems and identify/support new technology
	Identify opportunities to adjust water conservation and management policies to incorporate information about climate variability and change
	Document the experience gained during the 1997-1998 El Niño and build on the concept of drought management task force(s) to assist governments, communities and businesses in responding to climate-related events
	Identify opportunities to improve watershed management
Coastal Resources	Identify buildings, infrastructure and ecosystems at risk and explore opportunities to protect critical facilities
	Develop and implement integrated coastal management objectives that enhance resilience of coastal systems to climate change and sea level rise
	Consider the need for beach nourishment and shoreline protection programs in high-risk areas
	Integrate considerations of climate change and sea level rise in planning for future construction and infrastructure
Agriculture	Document the experience gained during the 1997-1998 El Niño and build on the concept of drought management task force(s) to assist governments, communities and businesses in responding to climate-related events
	Develop policies which protect both subsistence and commercial crops during extreme events
	Explore opportunities to diversify crops and select drought and/or salt-tolerant species where appropriate
	Document low-lying agricultural areas at-risk from the effects of sea level rise and consider protection measures where appropriate and necessary
Fisheries	Enhance data collection and analyses required to improve understanding of the impacts of El Niño and La Niña events on tuna and other critical fisheries
	Identify and protect critical habitats for key inshore and near-shore species–particularly those important for subsistence fisheries
	Support monitoring and monitoring programs designed to imp understanding of the regional and local consequences of climate variability and change for tuna and other important fisheries

Other adaptation policy considerations include:

Full implementation of the UNFCCC by the international community--While the FSM is clearly committed to action on our own, it is clear that the actions of other nations will have a significant impact on the ability of the FSM to respond to the challenges of climate change in the future. In addition to ensuring compliance with current emissions targets and timetables (discussed further in Chapter Three), it is also important for the international community to design and implement flexibility mechanisms, like the Clean Development Mechanism (CDM) which could significantly enhance the capability of the FSM to respond to climate change. **In this context, support for capacity building and adaptation projects stand out as particularly high priorities**.

Enhance capabilities to understand and respond to natural climate variability, particularly ENSO -- As described earlier, natural variability in the climate system already poses significant challenges for the FSM and experience with the 1997-1998 El Niño demonstrates the value of using climate information (in the form of forecasts) to help reduce damages and avoid costs. In addition to having near-term benefits, an organized effort to improve the ability of communities, governments and businesses to anticipate and respond to El Niño and La Niña events will also provide valuable insights into the vulnerability of the people and natural resources of the FSM to projected long-term changes in climate (including changes in the ENSO cycle) and provide a testbed for evaluating potential adaptation measures (e.g., options for water conservation and distribution plans during droughts, crop selection and diversity, etc.). An organized program focused climate forecasting, application and assessment like the one proposed here will require significant cooperation among scientific institutions and governments throughout the Pacific region and collaboration with/support from scientific institutions and development organizations worldwide.

Ensure an effective program of observations/monitoring, research, modeling and assessment to significantly improve understanding of the regional and local consequences of climate variability and change – While the FSM can and will continue to undertake some national studies, the international community and regional organizations have a responsibility to provide appropriate contributions; no single country or scientific program can do the job alone. In this context, the FSM and its international partners should reinforce and support their commitments to: the World Meteorological Organization (WMO) and its weather and climate-related programs like the World Climate Research Program (WCRP), the World Weather Watch (WWW), the Global Climate Observing System (GCOS); the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions of Global Change Programme (IHDP); as well as the continuing activities of the Intergovernmental Panel on Climate Change (IPCC). More attention should be given to understanding the regional and local impacts of climate variability and change and to exploring regionally- and locally-appropriate adaptation and mitigation options and technologies. In this context, regional organizations and programs

like the South Pacific Regional Environment Programme should continue to provide leadership in securing the resources to support regional studies and capacity-building efforts like those implemented as part of the Pacific Islands Climate Change Assistance Program (PICCAP).

Integrate considerations of climate change in resource management, community planning and economic development decisions as a critical element of an effective adaptation response by the FSM. Recent analysis of adaptation options in the Pacific Islands region points to the importance of "anticipatory" as well as "reactive" adaptations to climate change and identifies the need for a policy framework which supports the application and integration of adaptation measures into national and local development strategies (Ellis and Fifita, 1999). The FSM national climate strategy embraces the concept of anticipatory adaptation issues and, as evidenced in government actions associated with the 1997-1998 El Niño, understands the value of integrating climate information into decision making in key sectors. The national and state governments of the FSM is already exploring ways to incorporate considerations of climate change into long-term planning for integrated coastal management and economic development.

In this latter context, it **is particularly important to include considerations of climate change in planning and decisions related to the emergence of tourism as a potentially significant new economic sector** because:

- the tourism sector can place significant demands on water resources and supporting infrastructure;
- many tourism opportunities involve capitalizing on marine and coastal resources and, therefore, are likely to place demands on coastal areas and infrastructure already under pressure;
- without proper planning, new facilities and infrastructure designed to support tourism in coastal areas could be at-risk from the effects of sea level rise; and
- international agreements related to bunker fuels (including aviation fuels) could have a significant impact on the cost and viability of supporting a significant tourism sector in geographically-isolated areas like the FSM.

Enhance public awareness about the consequences of climate change – The FSM's climate change policy emphasizes public awareness and participatory community development programs in the design and implementation of adaptation and mitigation measures. With this in mind, the FSM is actively engaged in development of an effective program of education and public awareness in order to reach all sectors in the community. As will be described in more detail in Chapter Five, this program will include: curriculum development for elementary and secondary schools; development and modification of course materials for the College of Micronesia; production and airing of television and radio programs on climate variability and change and broad distribution of copies of those programs for use in schools, public meetings and

government training programs; production of information brochures and other print materials in easily accessible and understandable formats; community workshops in each of the four island States (including the outer islands); expanded education and training programs for government officials, including opportunities for advanced technical training.

Integrate traditional knowledge and practices – The FSM's emphasis on public participation and education is, in part, a reflection of the importance placed on recognizing and protecting traditional rights (as reflected in the FSM Constitution). Since most of the land areas in Micronesia are privately owned, for example, the government does not dictate what a private land owner can or cannot do on his or her own land or with the associated resources to which they are entitled. Instead, established government agencies (at both national and State levels) are responsible for working closely with communities to ensure the integration of environment, social and economic concerns in the planning and management of land and its resources...working together toward achieving sustainable development. In addition, traditional subsistence practices remain a significant factor in considerations related to many FSM resources and sectors (e.g., fisheries and agriculture). Equally important is the fact that local individuals and communities – particularly those actively engaged in subsistence activities – are valuable sources of information about past and present climate and environmental conditions and insights into the viability of adaptation and mitigation options in FSM society.

POSSIBLE PROJECTS

Working with Federal government agencies, state governments and local communities, the FSM climate change program has begun developing ideas for specific projects which would address the adaptation issues discussed in this Chapter. These projects are described in more detail in Chapter Five but can be summarized as follows:

Climate Change Data Collection and Analysis Projects

- production of reliable, up-to-date maps of FSM jurisdictions showing detailed topography, natural features and built environment;
- establishment of baseline climate monitoring stations using selected reference sites to document current conditions, provide for continuous monitoring of critical parameters (e.g., temperature, rainfall, sea-level), and provide a reliable baseline from which to measure change;
- establish an ongoing program of vulnerability and adaptation assessment modeling;
- initiate a sustained program to provide and apply information on climate variability to support decision making in key sectors (e.g., water resource management, agriculture, fisheries, disaster preparedness).

Agriculture and Water Resource Projects

- evaluation of the vulnerability of FSM streams to ENSO-related droughts;
- a comprehensive assessment of FSM groundwater resources, including efforts to identify and protect drought-resistant groundwater sources;
- construction of solar desalination pilot plants; and
- expansion of community-based watershed management programs (like those initiated in Pohnpei and Kosrae).

Coastal Resources Projects

- a coastal resources baseline data project to provide quantitative data in vulnerable coastal communities and ecosystems; and
- design and implementation of a community-based, integrated coastal management planning project.

Fisheries

- evaluation of the impact of climate variability and change on the movement of tuna (and other pelagic fisheries).

Other possible projects which have received preliminary attention include an agriculture feasibility study on crop diversification and the selection of drought- and salt-tolerant species and investigation of the feasibility of breeding/raising tuna.

CHAPTER FIVE – POSSIBLE PROJECTS

INTRODUCTION

The FSM has affirmed its commitment to fulfill its obligations under the UNFCCC by adopting National and State policies that are consistent with the Convention's requirements. The challenge now facing the FSM is to convert these policy statements into positive results by implementing a well-planned strategy of mitigation, adaptation and capacity-building projects.

The most severe impediment to implementation of these projects is a lack of in-country resources. The FSM shall contribute substantially to the implementation of climate change projects. Many of these projects, however, will require international donor assistance for their successful completion. Adequate support from the **flexibility funding mechanism** of the Kyoto Protocol and the UNFCCC will be important in providing the financial support and expertise necessary to adopt new technologies and practices to adapt to adverse affects of climate change and sea level rise. The FSM, along with other geographically isolated developing countries where tourism is an emerging economic sector, will also be interested in the outcome of UNFCCC discussions related to aviation (and other bunker) fuels. The FSM will seek assistance through these and other bilateral and multilateral funding mechanisms to implement the project activities outlined below.

Climate Data Collection and Analysis Projects

Mapping Project - Throughout the FSM, the collection of data is hampered by the lack of reliable, up-to-date maps showing detailed topography, natural features and the existing built environment. This project will facilitate the production of such maps. With the development of GIS systems, aiding vulnerability and adaptation decision-making in the FSM, there is an urgent need for large-scale baseline maps. This will allow existing and future geographic information to be correctly related, and aid the accurate quantification of the spatial extent and relative magnitudes of vulnerability.

Establish climate baseline monitoring stations using specific islands as reference sites for the various island types which comprise the FSM. Building on the work conducted in the initial FSM vulnerability and adaptation assessments, reference monitoring stations would: allow for documentation of current conditions in representative areas; provide for continuous monitoring of critical information on climate variability; and provide a reliable baseline from which to measure change. These baseline monitoring stations would include sustained measurements of key physical parameters such as temperature, precipitation and sea level. In this latter category, at least one sea level baseline monitoring station could be established in an area already experiencing high rates of sea level rise (e.g., the establishment of a monitoring and research site at Colonia as suggested in the Yap assessment). In addition to monitoring critical physical climate conditions, baseline monitoring stations could be established in some representative

ecosystems (e.g., mangrove forests and coral reef ecosystems) to monitor the health of those areas and their response to climate variability and change. Identification of a selected set of reference sites would allow for limited local resources to be expended wisely and provide a focus for monitoring support from regional and international sources.

Establish an ongoing program of vulnerability and adaptation modeling and assessment designed to provide a more integrated perspective on the consequences of climate variability and change for the FSM and the Pacific region. As noted earlier, the initial FSM vulnerability and adaptation assessments were somewhat limited in their focus and breadth. Capabilities now exist in the Pacific region to extend those initial studies and provide a more integrated perspective on the consequences of climate variability and change for the FSM.. The FSM plans to work with regional organizations and scientific institutions to develop a specific vulnerability and adaptation modeling and assessment project which would provide more comprehensive information about the local consequences of climate variability and change could be used to focus national and regional discussions about effective adaptation and mitigation response options. To be most effective, such an integrated assessment modeling effort should be closely coupled with an ongoing program of sustained observations and monitoring of physical climate conditions (e.g., temperature, rainfall and sea level), ecosystem health, and critical aspects of the human dimensions of climate change, including detailed data on key sectors (e.g., agriculture and fisheries) and information on the consequences of policies undertaken to reduce vulnerability, strengthen adaptive capacity or reduce the emissions of greenhouse gases.

Initiation of a sustained program of developing and applying information on climate variability to support decision making. Emerging capabilities to forecast year-to-year climate patterns (like El Niño/La Niña) and experience during recent events like the 1997-1998 El Niño in the FSM and throughout the Pacific, suggest that significant benefits can accrue from an organized effort designed to provide and apply information on climate change and variability. A number of institutions engaged in climate forecasting, assessment and research throughout the region have recently begun discussions related to organizing their efforts in the context of a Pacific Climate Information System which would, among other objectives, significantly enhance the capabilities of the FSM (and other Pacific island countries) to gain access to and apply useful and usable information on year-to-year climate variability. The FSM plans to continue its efforts to explore in-country mechanisms for using this type of information locally (as was done by the drought task force created during the 1997-1998 El Niño) and encourages the participating organizations and potential sponsors to support ongoing efforts like the Pacific ENSO Applications Center and the emergence of an enhanced and reliable Pacific Climate Information and Prediction System.

Produce a quantitative evaluation of the carbon sink potential of FSM ecosystems (including forest ecosystems and marine ecosystems such as coral reefs). Such an evaluation would be consistent with calls for "consideration of country-specific data and information" related to the Land-Use, Land-Use Change and Forestry provisions of the UNFCCC and would provide valuable support for FSM efforts to both quantify current net emissions of greenhouse gases and

evaluate mitigation. As noted earlier, the FSM and many small island states are also interested in the potential of marine ecosystems – particularly coral reef ecosystems – to serve as carbon sinks. Although attention under the UNFCCC has been focused on terrestrial sinks (particularly forests), a quantitative evaluation of the sink potential of FSM ecosystems would include an evaluation of marine ecosystems as well. More generally, the FSM would like to see more attention given to the role of the ocean in the carbon cycle. A better understanding of how ocean sinks might be enhanced would have local, regional and global significance.

Public Awareness Projects and Human Resource Development

Climate Change Curriculum Development Project - Climate change is a new area of science, and is of such importance that its causes and impacts should be learned as part of the formal schooling process. To achieve this aim the FSM National Government shall coordinate a climate curriculum development project. This project will include a series of workshops for science teachers and instructors, leading to the development of new curriculum, course work and materials for FSM students at all levels.

Climate Change Awareness (electronic media) - Electronic media (radio, television, video) is the most effective means available in the FSM for targeted public awareness campaigns. A joint National-State climate change public awareness campaign will facilitate the production of radio, and television programs, including the distribution of video and audio cassettes to areas and islands without broadcast electronic media. These programs will be state or island-specific and shall be presented in the local language. These materials will have most effect if they are entertaining as well as informative, and will address a variety of topics to maintain public interest over time.

Climate Change Awareness (printed materials) - The State governments, with assistance and coordination from the National Government, will also develop and disseminate printed materials explaining the causes and consequences of climate variability and change. These will use accessible terms and be produced in the vernacular of each State or island grouping.

Climate Change Community Workshop Project – A national program of community workshops will be undertaken to increase awareness on the basic science of climate-related issues and its adverse affects. The purpose of these workshops is to engage traditional leaders, church leaders community-based organizations, businesses and NGO's in discussions about adaptation and mitigation strategies. These workshops will play a particularly important role in information dissemination and exchange with communities living in the outer islands without access to print media and/or television and provide an opportunity for all FSM communities to play an active role in climate-related decisions that will affect their future.

Climate Change Scholarship Program – A scholarship aimed towards developing in-country expertise in fields related to climate variability and change. This scheme shall be administered by the National Government and focus on training talented FSM students in fields such as coastal engineering, coastal planning, meteorology, climatology, marine biology, agricultural science, alternative energy etc.

Energy Sector Projects

Energy Conservation Project – This project is designed to build capacity within the FSM's four utilities companies for the wise use and conservation of energy resources. Such capacity-building shall include the both the technical aspects of energy and conservation, and training in the methods and techniques of public awareness activities designed to change people's energy consumption habits.

Solar Pilot Projects – In recent years a number of technical assistance projects have assessed the FSM's potential for solar energy generation. These studies have found that a significant proportion of the FSM's energy needs could be fulfilled by solar energy. This project will provide an operating example of a solar energy production system in each of the four States. These will be placed in high-profile situations and the projects will be undertaken in such a way as to maximize the transfer of technical information and skills to local technicians and tradespersons. The pilot projects will also produce benefits by improving public awareness regarding the benefits of decreasing the FSM's reliance on imported fossil fuels.

Solar Energy Information Clearinghouse Program - Accompanying the solar pilot program will be an information clearinghouse on solar energy technologies and solar equipment providers. This information will be of great use to FSM agencies or companies considering the installation or expansion of solar energy generation systems.

Subsidy Program for Solar Energy – In conjunction with the other solar projects, the National Government shall administer a program of subsidies to promote the installation of new solar energy generation systems in the FSM. Providing these subsidies (30%-50%) will encourage both the public and private sectors to consider a transition to this proven renewable energy source.

Feasibility study on other renewable energy resources – While solar energy production is proven to be a feasible energy generation option for the FSM, the situation with regard to other types of renewable energy is less clear. Some studies have indicated good potential for micro-hydro systems on the high islands, while there is very little information available on tidal, wave, biomass or other emerging technologies. The feasibility study will be state-specific and include quantitative information on the nature of the resource and an assessment of the scientific, technological, institutional and cultural barriers to their use.

Agriculture and Water Resources Projects

Salt Water Intrusion: mitigation and adaptation project – One of the major threats that climate change poses to the FSM is the risk that vital agricultural lands will be severely degraded by salt water intrusion resulting from sea level rise. There is an urgent need for detailed studies on the risks posed by salt water intrusion induced by climate change, and a plan of action produced to mitigate its effects.

Evaluating the Vulnerability of FSM streams to the effects of El Niño Droughts – One of the possible effects of climate change involves an increase in the frequency and intensity of El Niño or El Niño-like conditions which would increase the likelihood of associated droughts in the FSM. In the FSM, virtually all of the small communities on high islands rely on small streams as their major source of water. Because of the small size of the catchments and the limited amount of underground storage, those streams are vulnerable to drought. The extent to which a given stream source is vulnerable to drought conditions, however, is not know with any degree of accuracy. This makes adaptation related to drought planning difficult to formulate. The proposed project would provide for the development of vulnerability indices for small surface streams in order to arrive at a more precise relationship between the physical factors in the catchment and the degree of vulnerability of that stream to an extended drought. With this information in hand, drought mitigation measures can be undertaken (e.g., installing temporary storage tanks) once information about an impending drought is made available.

Groundwater Assessment and Protection Project – Groundwater resources are already an important component of FSM's potable water supplies, especially on low islands. The significance of these resources may increase exponentially should climate change result in a reduction rainfall to some areas. Even seasonal reductions may lead to an increased reliance on groundwater resources. There is a need to thoroughly assess the FSM's groundwater resources, and a need to introduce measures to ensure that these resources are not degraded through contamination. It is particularly important to identify groundwater sources that are not (or less) vulnerable to prolonged drought conditions (e.g., currently untapped deep well systems). This project aims to undertake these assessments and facilitate the production of groundwater management plans by the State Governments.

Watershed protection – FSM's forested watersheds, particularly those of Kosrae and Pohnpei, are an essential component in the provision of drinkable water on the islands where they are present. An active community-based watershed campaign has been operating on Pohnpei since 1989, and Kosrae has recently commenced a similar program. These initiatives are based around building the capacity of village-level committees to make planing and management regarding how watershed areas should be used. These successful programs are fully consistent with the aims of the UNFCCC, and shall benefit from assistance under the Convention's auspices.

Constructing solar desalination pilot plants – On the outer islands of the FSM, drinking water is normally provided from rainwater catchments. Non-potable water is obtained from shallow dug wells, which yield fresh to brackish water. During drought conditions (such as those associated with El Niño conditions, for example), rainwater catchment tanks generally run dry withing two months of drought commencement and residents have to resort to shallow-well water. This shallow-well water often pose public health risks, however, as these areas are subject to pollution and, as noted before, are often brackish. An alternative source of safe drinking water is needed on the outer islands to minimize those public health risks and avoid potential epidemics. The technology of solar desalination has been around for a number of years and significant improvements have been made over the past 10 to 15 years. This technology has not, to date, been used in the FSM. The proposed project would provide for the construction of four to six solar desalination plants at different capacities at different locations in the outer islands of each of the FSM states in order to assess the feasibility of using these plants on an operational basis.

Coastal Resources Projects

Coastal Resources Baseline Data Project - Quantitative baseline data in vulnerable areas is lacking throughout the FSM. There is a need to develop the collection of quantifiable baseline data on coastal erosion and coastal hazards, particularly to:

- Establish a beach profile recording network throughout the islands to permit a coordinated approach to measuring coastal erosion rates throughout the FSM.
- Further development and upgrading of the tide monitoring network throughout the FSM
- Development of an in-country database of wave conditions and trends throughout the region from available satellite and global wave model information.
- Quantification of hinterland risk through detailed surveying of vulnerable areas to accurately establish land levels, floor elevations and location of other infrastructure.
- Expert assistance and capacity building in the interpretation of quantifiable process data to accurately assess appropriate coastal erosion and coastal hazard adaptation strategies for each island.

Integrated Coastal Management Planning Project – Successful coastal management in the FSM requires community involvement. In 1998 the Kosrae State Government commenced a 'Coastal Management Project', which aims to facilitate the production of "Community Coastal Management Plans", to be developed by village-level committees, as well as a state-level plan. The project has a major capacity-building component. Coastal plans consider issues affecting the reef, coastal habitats and ecosystems, infrastructure and the built environment, economic and development priorities etc.

The national Coastal Planning Project shall build upon Kosrae's experiences, ensuring that resource-users are given the opportunity to contribute to the management of the resource. The aim of the project is for all coastal resources in the FSM to be covered under a local, state and national coastal management plan, including accompanying legislation where required.

Fisheries

Evaluation of the impact of climate variability and change on the movement of tuna (and other pelagic fisheries) – Recent scientific evidence suggests that changes in ocean conditions associated with the El Niño-Southern Oscillation (ENSO) cycle in the tropical Pacific are associated with significant changes in the migratory patterns of tuna stocks which are important to the FSM economy. Because of FSM's reliance on growth in the tuna fishery as an important element of their economic future, it is essential for fishing interests and resource managers to understand the interaction between ENSO and the abundance and location of tuna (and other pelagic fisheries) in detail. These insights will be valuable in the near-term and will help to support the development of appropriate adaptation measures should climate change bring variations in ENSO patterns as some studies suggest. In addition, information on the regional impacts of climate change on ocean temperatures, productivity and circulation are generally lacking and vital to an understanding of how climate change will affect pelagic fisheries of interest to the FSM. The FSM would benefit from a targeted research program aimed at unraveling the complex but important interactions between climate and those fisheries.

Other possible projects which have received preliminary attention include an agriculture feasibility study on crop diversification and the selection of drought- and salt-tolerant species and investigation of the feasibility of breeding/raising tuna.

CHAPTER SIX
INFORMATION AND RESEARCH NEEDS

GREENHOUSE GAS INVENTORY

The principal problems encountered during the conduct of the FSM 1994 Greenhouse Gas Emissions Inventory involved either the lack or quality of the data. With the exception of the aggregate fuel data from the energy sector, all other data used to complete the Inventory were derived from estimates. This includes fuel consumption at the detailed "end use activities" level. For the most part, the absence of appropriately-detailed data is a function of limited resources which must be applied to the highest priority national needs. Collecting and maintaining detailed, statistical data on all sectors is a difficult and costly task for a small island country like the FSM. This general problem, shared by many small island states, is exacerbated by the large, geographic distances that separate the individual states in the FSM and the need to include the numerous small, outlying islands which characterize some of those jurisdictions.

Recognizing these constraints, the FSM 1994 Inventory suggests targeting limited resources on a small number of critical greenhouse gas data needs which will also provide valuable information to support broad national objectives:

- Fuel consumption from "end-use" activities in key sectors such as agriculture;
- HFC, PFC and SF_6 consumption (included because of the high global warming potential of these compounds even though they do not constitute a large percentage of FSM emissions); and
- Carbon dioxide removals – current and potential – particularly those associated with land use change and forestry practices and marine ecosystems.

The FSM believes that other aspects of carbon removal – such as coral reefs and ocean ecosystems – should be addressed in terms of national inventories. In addition to providing a more accurate representation of net national emissions, exploration of these potential marine sinks could prove beneficial nationally regionally and globally. Including information on carbon removal in marine environments in national inventories would require updating IPCC guidelines to include appropriate methodologies as well as additional research on the underlying processes involved.

Conduct of the FSM 1994 Inventory also highlighted specific problems with the methodologies for calculating sulfur dioxide emissions used in the IPCC guidelines. It is not clear, for example, why SO_2 emissions are calculated for biomass burning (in the context of fuel consumption) but not for on-site burning of forests, agricultural residues or savanna burning, all of which could fall under the IPCC category of "other biomass."

MITIGATION

Some of the most significant constraints on the identification, exploration and implementation of more aggressive mitigation measures to reduce greenhouse gas emissions in the FSM include:

- lack of detailed, easily-accessible information on the renewable energy potential for individual states and the country as a whole;
- limited information the current role or future capacity of FSM ecosystems (managed and naturally-occurring) to serve as sinks for carbon dioxide;
- limited access to new technologies and limited expertise in the use of those technologies;
- financial and human resource costs associated with the acquisition and maintenance of new technologies;
- dependence of existing energy infrastructure and transportation systems on petroleum consumption; and
- need to balance economic development goals – particularly in emerging sectors like tourism – with concerns about the long-term sustainability of those ventures in the context of climate change (and other societal, economic and environmental goals).

VULNERABILITY AND ADAPTATION

The conduct and review of these initial vulnerability and adaptation assessments highlight a number of methodological and operational issues with implications for future assessments and the development of effective strategies to respond to current and projected climate-related changes. This section is based on a summary of these lessons learned in the initial assessment studies and then concludes with a broader description of critical information gaps and future assessment needs:

- a clear need to **expand assessment work to include climate-related consequences not directly related to sea level rise in a more integrated perspective** of the challenges and opportunities associated with climate variability and change. For example, understanding the impact of projected sea-level rise on the freshwater lens in FSM jurisdictions should be coupled with information on the direct impacts of changes in rainfall and tropical storms for the Nation's freshwater resources. Understanding how sea level rise might affect critical coastal ecosystems and habitats should be coupled with an understanding of how changes in ocean temperature and circulation patterns might affect future stocks of important fisheries like tuna. Direct biophysical impacts of

climate variability and change should be integrated with representations of changing patterns of demographics and economic development to understand the climate-related challenges facing FSM communities and ecosystems. This requires the development and use of new tools like integrated assessment models and analytical techniques.

- **the need to address differences in the nature (form, format and content), availability and quality of data and information** required to support vulnerability and adaptation assessments (e.g., aerial photographs, topographic maps, and information on socio-economic systems). For example, serious methodological problems arise when trying to assess current and future rates of shoreline erosion on some islands in the FSM where there are no appropriately-scaled and contoured topographic maps and no meteorological, tidal and ocean-state data. A similar problem exists with lack of information on current economic activities and development plans.

- the need for **adequate baseline information from which to measure changes and assess impacts**. Historical beach and atoll profiles are also needed to illustrate the nature of current elevations and landforms and to document the patterns of erosion and deposition on natural and engineered shorelines. Another example of the need for enhanced baseline information involves the need for information on the variability of ocean-state conditions such as tides, the direction of waves and oceanic swell, short-term changes in sea level conditions associated with El Niño and La Niña and prevailing patterns of ocean circulation and productivity.

- **the need for adequate information on the nature and rate of current changes to critical systems**. For example, existing erosion problems are already considerable for the high islands and highly-populated atolls. Rates of erosion in excess of 0.50 metres per year have been measured on sensitive shorelines in Kosrae. Another example involves the absence of reliable data on the position of mean sea level across and between the island States of the FSM. In addition to the importance of this data for accurate baseline maps and beach profiles, the absence of historic and time series data on sea level variations over time (including short-term changes associated with El Niño and La Niña) makes it difficult to accurately assess the consequences of changes in sea level for coastal ecosystems and communities.

In this context, one of the highest priority needs emerging from initial FSM assessment efforts and broader discussions of the climate-related challenges for Pacific island nations involves an **enhanced understanding of the nature and consequences of natural climate variability** for the FSM, including (but not limited to) information on patterns of rainfall, prevailing wind, wave and sea level conditions, tropical storms, extreme events such as prolonged droughts or floods, and impacts on critical resources like coral reefs and fisheries.

- **the absence of detailed information on patterns of resource use, ecosystem change and changes in species diversity (both marine and terrestrial) at local, island, State, national and regional scales along with research on critical climate-ecosystem interactions** (e.g., coral reefs, fisheries, forest resources and endangered species). Representatives from the FSM and other participants in a March 1998 Workshop on the Consequences of Climate Variability and Change for the Pacific islands took note of this problem and highlighted the difficulties associated with securing adequate resources to support the detailed, local and regional research that would be required to address this information gap (Shea, 1999).

- **the need for enhanced information on changing environmental, demographic and economic patterns and trends**, with an emphasis on how the interactions among these factors affect the quality of life and economic development opportunities. Understanding current socio-economic conditions as well as existing stresses on the natural resource base of the FSM is essential if we are to assess how climate-related changes might complicate the economic development and resource management picture for the future. Developing effective response strategies requires a significantly-enhanced baseline of data and information on the "human dimensions" of climate variability and change in the context of existing conditions and stresses.

- a need for **enhanced information on available/potential response options** including the appropriate integration of traditional knowledge and practices, information on the potential consequences of proposed policy decisions and an improved understanding of how information on climate variability and change can be used to support improved decision making. Addressing this need will involve technology development and information exchange related to adaptation and mitigation tools, techniques and policy measures designed to reduce the vulnerability of the FSM to climate variability and change and implement flexible development plans which effectively integrate considerations of climate variability and change. Achieving this latter objective will also require an understanding of how international and national mitigation policies might affect local development options (e.g., the effects of international policies for aviation fuels on emerging economic sectors like tourism and how national policies for energy conservation and efficiency can contribute to achieving greenhouse gas mitigation goals). In addition, there is a need for additional fundamental research on how climate information can be integrated into existing decision making frameworks in key sectors and an exploration of the lessons learned from adapting to natural climate variability.

OTHER CRITICAL LIMITATIONS

The geographic spread of the four island States in the FSM presents particular challenges with respect to **the significant costs associated with the field work** required to support vulnerability and adaptation assessments. This issue involves not only the high direct costs associated with travel in the region but also the "hidden" costs associated with prolonged stays due to the infrequency of flights or ships traveling between the islands. This latter issue is particularly important since it means that limited technical personnel are away from their home institutions for extended periods and thus unable to fulfill their regular responsibilities.

More generally, the **limited number of scientific, technical and professional staff** available to FSM governments poses significant challenges. In the absence of sufficient funding for dedicated staff to conduct vulnerability and adaptation assessments, climate change responsibilities are often given a lower priority than more pressing and immediate environmental management tasks related to water supply, sanitation, municipal waste management and current challenges to shorelines and coastal ecosystems such as the high rates of erosion in many areas. As a result, these human resources are not available to assess climate-related challenges and develop and implement long-term adaptation and response strategies. Addressing this human resource constraint is an important component of capacity-building in the FSM.

This problem of competing priorities is further complicated by the general public perception that climate issues represent a future challenge with a long time horizon. As a result, there is a **need for a significantly enhanced program of community education and outreach** to increase public awareness and understanding of the challenges of climate change for the FSM. Meeting this need requires the development of educational materials and the implementation of a suite of outreach activities (such as scientific presentations, workshops and small-group meetings) designed to provide opportunities for scientists, communities, businesses, government agencies and public interest groups to exchange information and jointly explore how climate affects them and what they can do to respond to those challenges. The National Government of the FSM believes that this program of education and outreach should be set in the broad context of increasing public awareness of how individual, community and government actions can improve the partnership between the peoples of the FSM and the natural environment which sustains them.

Meeting any and all of these information needs will, of course, require **significant investments of people, time and money**. Currently both the National Government of the FSM and the individual State governments face fiscal constraints which limit their ability to undertake detailed vulnerability and adaptation assessments or pursue many of the technological or administrative options available to respond to climate variability and change. This problem is shared by most Pacific island jurisdictions and other developing countries throughout the world. Addressing this challenge will require careful focusing of available national resources and an international commitment among more developed countries to support programs, policies and measures through which they can contribute to capacity-building in countries like the FSM.

CHAPTER SEVEN
EDUCATION, PUBLIC AWARENESS, TRAINING AND CAPACITY BUILDING

Education and Public Awareness

The UN Framework Convention on Climate Change emphasizes the important role that education and public awareness will play in effectively responding to climate change through appropriate adaptation and mitigation strategies. In their regional synthesis of the vulnerability and adaptation assessments for Pacific island countries, Hay and Sem (1999) call for an "action-oriented public awareness programme" as an integral part of a "well-conceived climate change response program." In this context, FSM's climate change policy **emphasizes public awareness and participatory community development programs, through formal and informal means, in the design and implementation of adaptation and mitigation measures**. With this in mind, the FSM is actively engaged in development of an effective program of education and public awareness in order to reach all sectors in the community.

Until recently, climate change education efforts in the FSM have been limited to the participation of Federal and state government representatives in climate-related meetings, workshops, conferences and training/capacity-building courses. As a result, the FSM governments now have a small group of individuals who have developed expertise in issues related to the nature and consequences of climate change for the FSM. This cadre of informed government officials is playing a significant role in the evolution of an effective climate change policy in the FSM. Unfortunately, priorities associated with governmental participation in international negotiations and limited resources have made it difficult to disseminate climate change information to a broader audience – until now. The Pacific Island Climate Change Program Country Team has started quarterly high school programs to educate the students on the basic science of climate change.

The FSM has identified a number of climate change education and public awareness projects, including:

- climate change curriculum development for teachers and students at all levels;
- climate change awareness programs utilizing electronic media and print materials;
- climate change community workshops to increase awareness of the basic science of climate change and its local/regional consequences; and
- a climate change scholarship program aimed at developing in-country expertise in fields related to climate change and variability.

The FSM is currently developing a **community-based education and public awareness program** to ensure **grass roots access to information** about the science and implications of climate change for the FSM. The goal is to ensure the accessibility of information to all groups and sectors including women, youth, community groups, schools, individual households and businesses. As summarized below, this education and public awareness program will include: curriculum development for primary and secondary schools; college-level course development; radio, television and video programs as well as printed materials designed to reach a wide audience; and a series of community workshops on each of the four islands of the FSM.

As climate change is a new area of science, it is vital that the whole country is aware of this new and developing subject area. It is, therefore, pertinent to **develop and incorporate climate change into the curriculum for primary and secondary schools** to address climate issues. Thus the FSM plans to implement a targeted program designed to incorporate climate issues into the curriculum for primary and secondary schools. Targeting elementary and primary school children and their teachers, this project will undertake the following tasks:

- Obtain copies of available information materials and curriculum resources (e.g., climate change curriculum modules recently developed by the South Pacific Regional Environment Programme and educational materials associated with the Schools of the Pacific Rainfall and Climate Change Experiment -- SPaRCE);

- Develop supplemental materials tailored to provide specific insights into local conditions and consequences;

- Review current curriculum and recommend specific changes and work with the Departments of Education at national and state levels to integrate the recommendations; and

- Conduct teacher training and support activities in all states.

The FSM Department of Education and individual State Departments of Education will be responsible for implementing this project with support from: the FSM Climate Change Country Team; National and state environmental agencies and departments including EPA's, Forestry, Marine Resources and Agriculture; local environmental NGO's; regional scientific and education organizations (e.g., SPREP, PREL, US National Sea Grant College Program).

The government also plans to develop and modify **course work and materials at the College of Micronesia - FSM** to address climate issues. Targeting College-level students and their instructors, this project will undertake the following tasks:

- Obtain copies of available information materials and curriculum resources;
- Develop supplemental materials tailored to provide specific insights into local conditions and consequences;
- Review current courses and identify opportunities to enhance the integration of information on climate variability and change; and
- Work with the College of Micronesia to implement recommended course modifications.

The FSM Department of Education, the College of Micronesia–FSM and the Climate Change Country Team will be responsible for implementing this project with support from: Regional scientific and education organizations (e.g., SPREP, PREL, US National Sea Grant College Program) and national and state environmental agencies.

In the government's efforts to reach all levels of civil society, **radio programs** on the science, consequences and policy implications of climate variability and change for the four states of the FSM will be developed. These state-specific programs, targeted at traditional leaders, households and villages, community leaders and organizations, local businesses and local NGOs, will be produced in the local vernacular in an effort to encourage information exchange and discussion at the village level. This program will address a variety of topics to maintain public interest over time and undertake the following tasks:.

- Announcements and news bulletins (such as those produced during the 1997-1998 El Niño event);
- Radio spots conveying general scientific information on the consequences of climate variability and change for the FSM;
- Interviews with members of the Climate Change Country Team, visiting consultants and representatives of supporting organizations in the region (e.g., SPREP, SOPAC, etc); and
- Question and answer/public participation programs.

The FSM Climate Change Country Team, along with local radio stations and personalities as well as national and state education and environmental agencies, will be responsible for implementing this program with support from: regional scientific and education organizations.

Television and video programs will also be prepared in English and in the local vernacular of the four States and outer islands. These programs will be distributed for use in formal and informal education programs with a target audience including: traditional leaders, households and villages, community leaders and organizations, local businesses, local NGOs, schools and libraries and hotels and tourist attractions. This project will address the following tasks:

- Develop and produce pre-recorded video programs on climate variability and change in English and the local vernacular of each FSM State;
- Periodic showings via cable TV (where available);
- Distribution of videos for use in schools; and
- Distribution of videos for use at community events, local gatherings and community workshops.

The FSM Climate Change Country Team, in conjunction with television stations and personalities will have responsibility for implementing this program with support from: regional scientific and education organizations and national and state environmental and education agencies

The government will also need to develop and disseminate **print materials** in vernacular of easily accessible and understandable materials that convey basic information about the consequences of climate variability and change for the FSM. Targeting traditional leaders, households and villages, community leaders and community groups, local businesses, local NGOs, schools and libraries and hotels and tourist attractions, this program will address the following tasks:

- Develop and disseminate attractive, easily-understood print materials, including posters, stickers and brochures;
- Provide materials for distribution and use at special events, community workshops, business meetings and other gatherings; and
- Provide materials for distribution and use at schools, libraries, hotels, tourist attractions, and community centers.

The FSM Climate Change Country Team along with national and state environmental and educational agencies will have responsibility for implementing this program with support from regional scientific and education organizations.

A series of Community Workshops will be designed to increase awareness of the basic science of climate-related issues and its adverse effects at the national, state and local levels and to engage traditional leaders and church leaders in local communities, businesses and NGO's in discussions about adaptation and mitigation strategies. These workshops will play a particularly important role in information dissemination and exchange with communities living in the outer islands without access to print media and/or television and provide an opportunity for all FSM communities to play an active role in climate-related decisions that will affect their future. Targeting traditional leaders, women's groups, youth groups (including church-based groups), village communities and households, local businesses and local NGOs, this program will undertake the following tasks:

- Coordinate the organization of community workshops with appropriate state agencies, traditional leaders and local community groups;

- Develop and/or gather appropriate support materials and information resources;

- Implement a series of introductory workshops designed to facilitate information exchange on each of the four island states, including populated outer islands, providing an opportunity for:

  - scientific presentations on climate variability and change;
  - presentations and group discussions on local consequences;
  - presentations and group discussions on adaptation and mitigation options and strategies; and
  - open discussions through Q&A sessions.

The FSM Climate Change Country Team and local community groups will have responsibility for implementing this program with support from national and state environmental agencies and departments (e.g., Yap, Pohnpei and Chuuk EPA's and Kosrae DRC).

Implementation of this broad suite of education and public awareness activities will require the active participation and support of all relevant national, state and local government agencies as well as regional and international scientific and educational organizations and programs. Technical support in the form of materials and expertise will be required from regional and international scientific and educational organizations and programs and financial support from international donors will be necessary. In implementing a program of public awareness and education, the country is faced with a number of constraints, including:

- limited qualified personnel and financial resources;
- limited media materials and medium to circulate materials;
- difficulties with information dissemination and exchange associated with the broad geographic dispersion and isolation of islands within the FSM; and
- communication barriers associated with the eight indigenous languages in FSM.

Training and Capacity Building

The Federated States of Micronesia is dedicated to developing the capacity within the National and State governments to effectively address the climate change challenges facing the nation. The FSM is prepared to meet its obligations under Article 6 (Education, Training And Public Awareness), specifically:

6(a): Promote and facilitate at the national and, as appropriate, sub-regional and regional levels, and in accordance with national laws and regulations, and within their respective capacities:

> (iii). Public participation in addressing climate change and its effects and developing adequate responses; and
>
> (iv). Training of scientific, technical and managerial personnel; and

6(b). Cooperate in and promote, at the international level, and, where appropriate, using existing bodies:

> (ii). The development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries.

The Federated States of Micronesia is one of the countries most threatened by the impacts of global warming, especially accelerated sea-level rise. However, education and skills levels within the country are generally low, especially in scientific and technical fields. The nation anticipates that it will need to develop skills in the following areas:

- undertaking country studies
- vulnerability assessment;
- economic evaluation of various policy options (cost-benefit analysis);
- participatory planning and decision-making;
- incorporating climate change into new development proposals;
- designing, developing and implementing climate change projects;
- public awareness and education
- preparing and implementing adaptation and response strategies;
- monitoring of climate change (systematic observation networks);
- development of national programs addressing climate change;
- development and implementation of mitigation strategies.

Some particularly important disciplines and skills include: climatology, including expertise in climate observations, forecasting and applications as well as enhanced skills in climate assessment models and techniques; coastal engineering; biological and environmental sciences, including expertise in both terrestrial and marine environments and resources; resource management; and community planning.

Current Status of Human Resources

Legally, the primary responsibility for environmental protection lies with the four State governments of the FSM. In addition, the geographic, economic, and social realities of capacity building in a developing nation comprised of 607 islands, eight indigenous languages, and 105,506 people spread over a large area of the Pacific Ocean, favor an approach focused on developing specific skills amongst a relatively large number of people in all four States. To address this unique situation, the FSM has adopted a "country team" approach to developing a national climate change strategy and building national capacity. Each State Governor was asked to designate a State agency that will serve as the focal agency for climate change. Current agencies are:

- FSM National government - Unit on Environment and Sustainable Development, Department of Economic Affairs;
- Chuuk State - Chuuk Environmental Protection Agency
- Kosrae State - Kosrae Development Review Commission
- Pohnpei State - Pohnpei Environmental Protection Agency
- Yap State - Yap office of Planning and Budget

Representatives from each of these agencies, along with an NGO representative (The Nature Conservancy) and two FSM National government representative, make up the seven member FSM Climate Change Country Team, under the guidance of the Unit on Environment and Sustainable Development of the FSM Department of Economic Affairs. The team, whom currently meet quarterly in alternating States, has the following responsibilities:

a. To organize and hold national workshops on the challenges and opportunities of climate change issues;

b. To prepare an FSM Strategy to meet the commitments under the UNFCCC (including recommendations on establishing an effective institutional framework for coordinating policy development, planning, identifying of needs, including future activities and projects related to the future national communications and implementation of the UNFCCC);

c. To conduct technical studies on nation-wide greenhouse gas emission inventory, vulnerability assessment, capacity building (e.g., public education and awareness), adaptation and mitigation options (including appropriate technology transfer) and other relevant work which may be needed in the preparation of the FSM implementation strategy; and

d. To participate in technical workshops and relevant international conferences and meetings relating to the implementation of the UNFCCC.

Through the coordinated Country Team approach, significant capacity building in focused climate change adaptation and mitigation skills has already occurred. The FSM has also benefitted greatly through partnership with the South Pacific Regional Environmental Programme's Pacific Islands Climate Change Assistance Programme (PICCAP). This program continues to provide the FSM government with limited financial support and technical assistance in the areas of climate change planning. Under the two programs, a number of National and State government staff have received general and specialized training in climate change, including understanding of the commitments of the FSM under the UNFCCC, vulnerability assessment and adaptation, estimating greenhouse gas emissions, dealing with sea-level rise, participating in systematic observation networks, and preparing national communications. Through the team approach, participation in these training opportunities has been distributed amongst the four States and the National governments to assure climate change expertise in all parts of the nation. Future training and participation in regional and international technical meetings and fora will be planned carefully to assure that all States are given the opportunity to develop the necessary capacity they need.

Limited technical expertise needed to effectively deal with climate change is already resident in existing government and private agencies. For example, each State now has an independent public utilities authority, most of which have resident expertise in various mitigation and adaptation strategies, e.g., promoting and implementing water and energy conservation measures, increasing and protecting groundwater and other fresh water supplies. Each State also has some level of planning capacity to ensure that positioning, design and protection of infrastructure and buildings is in line with future climate change projections. Health and environmental agencies are well-developed and supported in all States, and staff are experienced in sanitation improvement, disease control and quarantine, disaster preparedness, and other areas of expertise that will be needed to deal with climate change. The FSM Climate Change Country Team and the respective governments need to focus efforts on involving these agencies in the development of the national climate change plan both to build their awareness of potential impacts and increase capacity and preparedness.

Constraints for Utilizing Human Resources

In addition to financial limitations, competing professional priorities and the adverse effects of the public sector reform process, the main constraint to utilizing human resources in the FSM has been the lack of coordination between the various National and State agencies. This constraint has already been considerably overcome through the climate change country team process and active involvement of State agency staff in training and other technical meetings. However, efforts must be increased to engage an even greater cross-section of State and National government and non-government agencies with existing and potential climate change expertise through state and national workshops and other fora. Additional efforts in building public awareness of potential climate change impacts will also help to engage the nation's entire population in climate change planning and project implementation. The focus of these public awareness and education efforts has been described earlier in this Chapter.

Options for Complementing Current National Human Resources

Because of the country's relatively small size, limited technical expertise, and budgetary constraints, it is anticipated that the FSM will depend considerably on regional and international technical and financial assistance to complement existing national human resources. The FSM has been a participant in the United States Country Studies Program (USCSP), through which some technical expertise and assistance was provided to the FSM. The FSM is currently an active participant in the South Pacific Regional Environmental Programme's Pacific Islands Climate Change Assistance Programme (PICCAP) which provides scientific and technical advice to FSM in the implementation of the UNFCCC.

Education, public awareness, training and capacity-building efforts related to climate change will be undertaken in the context of renewed commitment to "develop technical support for existing and future environmental programs" as discussed during the September 1999 Second FSM Economic Summit.

CONCLUSION

In September 1999, national and state government officials and representatives of FSM communities and businesses convened for the Second FSM Economic Summit whose theme was "Charting the Course for Sustainable Growth and Self Reliance." In his opening remarks, President Leo A. Falcam noted that:

> **"Our economic strategy – the course we will chart – must be considerate of our proud citizens, our priceless culture and out pristine natural environment."**

Environmental considerations were a significant part of the discussions of policies and strategies developed during the Summit and the Policy Matrices produced during the Summit reflect the interdependence of environmental and economic considerations for the future of the FSM. The Summit identified a number of national policies with implications for the FSM climate change program including:

- expand and promote an environmental ethic – through curriculum development and community-based education efforts to address critical issues, including climate change;

- improve cooperation and coordination between different levels of government – with specific calls to: (1) expand the UNFCCC National Country Team concept; and (2) establish improved communication mechanisms to ensure broad dissemination of information on key issues such as climate change;

- develop technical support for existing and future environmental programs – including addressing technical training needs in environmental monitoring, resource management, emergency preparedness and waste management – all of which have implications for the Nation's climate change strategy;

- the environmentally-sound and efficient use of energy – including a call for national campaigns on energy efficiency and environmental issues related to energy; the institution of minimum efficiency standards; and compliance with EPA standards for the generation, storage and distribution of energy services;

- environmentally sustainable agricultural production – including strategies to encourage responsibility among community leaders for addressing environmental issues in agricultural planning and providing for the active involvement of communities in planning agricultural production through the use of environmentally-sensitive resource management approaches (e.g., watershed management); and

- ensure sustainable developments of inshore marine resources and preservation of the inshore marine environment – including the development of community-based, integrated coastal management plans which are considered to be essential to enhancing the capacity of the FSM to respond to the effects of climate change.

In closing his remarks to the Second Economic Summit, President Falcam called on the participants to:

> "**work together in an atmosphere of Micronesian consensus building**."

This philosophy of developing shared solutions to problems is central to the FSM approach to climate change and, we would submit, an essential ingredient of effective implementation of the UNFCCC.

REFERENCES

Abraham, R. and J. Konno. 1999. *An Adaptation Assessment of Weno and Satowan Islands, Chuuk State, Federated States of Micronesia, to Climate Change and Accelerated Sea Level Rise.* A report prepared for the FSM Country Team, PICCAP, FSM Environmental Management and Sustainable Development Unit. FSM National Government: Palikir, Pohnpei, FM.

Asian Development Bank. 1996. *The Federated States of Micronesia Background Report to the National Fisheries Policy Study (Volume 2).* A report under A.D.B.T.A. No.2551. Asian Development Bank: Manila, Philippines.

Barnston, Anthony. 1999. *Preliminary analysis of general circulation model climate change scenarios for the FSM and other Pacific island jurisdictions.* Personal communication.

Crosson, P.R. and N. J. Rosenberg. 1991. *Adapting to Change.* RESOURCES: Issue #103, 17-20. Resources for the Future: Washington, DC.

Ellis, M. and S. Fifita. 1999. *Greenhouse Gas Mitigation in PICCAP Countries.* A report for the South Pacific Regional Environment Programme: Apia, Samoa.

FSM Office of Planning and Statistics. 1996. *National Census Report: 1994 FSM Census of Population and Housing.* FSM National Government: Palikir, Pohnpei, FM.

Foruw, T. 1999. 1994 *Inventory of Greenhouse Gas Emissions for the Federated States of Micronesia.* FSM National Government: Palikir, Pohnpei, FM.

Gawel, M. 1993. *State of the Environment Report for the Federated States of Micronesia.* A report prepared for the South Pacific Regional Environment Programme: Apia, Samoa.

Goodwin, R; Hadley, R. and Keyan Zheng. 1998. *Vulnerability Assessment of Kosrae Island to Climate Change and Accelerated Sea-Level Rise.* Department of Economic Affairs, FSM National Government: Palikir, Pohnpei, FM.

Hay, J.E. and G. Sem. 1999. *Evaluation and Regional Synthesis of National Assessments of Vulnerability and Adaptation to Climate Change.* South Pacific Regional Environment Programme: Apia, Samoa.

He, Y.; Barnston, A. and A. Hilton. 1998. *A Precipitation Climatology for Stations in the Tropical Pacific Basin: Effects of ENSO,* NCEP/Climate Prediction Center Atlas No. 5. U.S. National Weather Service/NCEP/CPC: Washington, DC.

Johnston, P. 1995. *Sustainable Development and Energy Use in the Pacific Islands: A Preliminary Evaluation of Opportunities and Constraints.* South Pacific Regional Environment Programme: Apia, Samoa.

Jones, R.N.; Hennessy, K.J.; Page, C.M.; Pittock, A.B; Suppiah, R.; Walsh, K.J.E. and P.H. Whetton.1999. *An Analysis of the Effects of the Kyoto Protocol on Pacific Island Countries, Part Two: Regional Climate Change Scenarios and Risk Assessment Methods.* South Pacific Regional Environment Programme: Apia, Samoa.

Kaluwin, C. and A. Smith. 1997. *Coastal Vulnerability and Integrated Coastal Zone Management in the Pacific Islands Region.* JOURNAL OF COASTAL RESEARCH: Special Issue # 24, 95-106. Coastal Education and Research Foundation, Inc.: Washington, DC.

Lehody, P.; Bertignac, M.; Hampton, J. and J. Picaut. 1997. *El Niño-Southern Oscillation and tuna in the western Pacific.* NATURE: Vol. 389, 715-718.

Miles, E. 1991. *A Fisheries Policy for the Federated States of Micronesia.* A report for the Micronesian Maritime Authority. Seattle, WA.

Park, T. 1999. *Working Paper NFR-5: 1998 FSM Fisheries Review.* A report prepared for the Standing Committee on Tuna and Billfish. Micronesian Maritime Authority: Pohnpei, FM.

Pacific ENSO Applications Center (PEAC). 1999. *Preliminary analysis of the impacts of the 1997-1998 El Niño in the Pacific* (in progress). Personal communication.

Pacific Islands Climate Change Assistance Programme (PICCAP). 1999. *Climate Change Adaptation: Incorporating Climate Change Adaptation into Development Activities in Pacific Island Countries.* South Pacific Regional Environment Programme: Apia, Samoa.

Richmond, B. M. and T. E. Reiss. 1994. *Vulnerability of the Natural Coastal System to Accelerated Sea-Level Rise, Yap Islands, Federated States of Micronesia: Case Study Preliminary Results.* US Department of the Interior, US Geological Survey: Menlo Park, California.