

# CHAPTER ONE— INTRODUCTION

## History of the Assessment

*“The impacts of the 1997–1998 El Niño are fresh in our minds, and the latest reports from the work of the Intergovernmental Panel on Climate Change (IPCC) confirm what all of you already know— changes in climate matter to individuals, communities, businesses and governments who call islands home. Your valuable natural resources, traditional ways of life, critical economic sectors, community support infrastructure, and, to a great extent, your future, depend on developing an effective response to the challenges presented by climate variability and change.” (Morrison, 2000)*

With these words, Dr. Charles Morrison, President of the East-West Center, welcomed participants to the “Workshop on Climate and Island Coastal Communities” convened in November 2000. The Workshop was part of a Pacific Islands Regional Assessment of the Consequences of Climate Variability and Change (the Pacific Assessment, or, the Assessment).

Set in motion with a similar workshop in March 1998, the Pacific Assessment began with a recognition of the significant effects that year-to-year climate variability has on communities in the region today; an example is the effect of the El Niño-Southern Oscillation (ENSO) cycle on rainfall, tropical storms and fisheries in the Pacific. The Assessment also acknowledged the importance of scientific research in the Pacific Region to understanding the nature and consequences of climate variability and change (see definitions in

**“Climate variability and change”** is used within this report to acknowledge two types of changes in the earth’s climate system.

**Climate “variability”** refers to relatively short-term variations in the natural climate system, such as the patterns associated with the ENSO cycle or the Pacific Decadal Oscillation (PDO).

**Climate “change”** is used in the IPCC context to refer to long-term changes— from decades to centuries— associated with increasing concentrations of greenhouse gases. Because variability and change both present significant challenges and opportunities to Pacific Island communities, both are addressed in this report.

the box below). Such research includes long-term monitoring of greenhouse gases at sites like Mauna Loa in Hawai‘i; studies of the regional and global influence of Pacific ocean-atmosphere processes such as ENSO; and studies of the ocean’s role in the carbon cycle, as well as the region’s significance in terms of biodiversity and endangered species.

Finally, the Pacific Assessment was an effort to build on the leadership of the Pacific Region in establishing and sustaining a critical dialogue on climate variability and change among scientists, businesses, governments and community leaders. Elements of this dialogue include the role of Pacific Island governments and regional organizations in raising international awareness of the potential consequences of climate change, as well as the success of innovative programs like the Pacific ENSO Applications Center (PEAC), which is designed to facilitate use of emerging climate forecasting capabilities to support decision-making.

This report summarizes the key findings and recommendations of the Pacific Assessment, a study of climate effects and response options for Pacific Island jurisdictions that was conducted as a regional contribution to the first U.S. National Assessment of the Consequences of Climate Variability and Change (the National Assessment). The National Assessment was organized by the agencies contributing to the U.S. Global Change Research Program (USGCRP) and the White House Office of Science and Technology Assessment. Appendix A provides a brief overview of the National Assessment.

The Pacific Assessment focused on the American Flag Pacific Islands, which include Hawai‘i, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands, and the U.S.-affiliated Pacific Islands, which include the Federated States of Micronesia (Yap, Pohnpei, Kosrae and Chuuk), the Republic of the Marshall Islands, and the Republic of Palau. Engagement of scientists and decision-makers from throughout the Pacific Islands, and involvement of regional organizations like the East-West Center’s Pacific Islands Development Program (PIDP) and the South Pacific Regional Environment Programme (SPREP), helps ensure that:

- participants and sponsoring agencies understand the broad regional and international implications of addressing the challenges of climate variability and change;

## PACIFIC ISLANDS REGIONAL ASSESSMENT TIMELINE OF KEY EVENTS

March 1998 .....	Scoping Workshop “Consequences of Climate Variability and Change for the Hawai‘i-Pacific Region: Challenges and Opportunities,” held at the East-West Center in Honolulu, Hawai‘i
September 1998 .....	Proposal for initial Pacific Islands Regional Assessment submitted to USGCRP agencies
September 1999 .....	Project funding received through NSF Grant (OCE-9907547); partial funding had been forwarded by the NSF in June 1999 on behalf of the NSF, DOI and NOAA
Fall/Winter 1999 .....	Core scientific team begins initial analytical work and conducts initial discussions with key groups of stakeholders
March 2000 .....	First formal meeting of the Steering Committee for the Pacific Assessment
Spring/Summer 2000 .....	Analytical studies and stakeholder discussions continue
Summer 2000 .....	Working Group for the November 2000 Workshop established
November 2000 .....	Workshop “Climate and Island Coastal Communities” (Pacific & Caribbean) held at the East-West Center in Honolulu, Hawai‘i
Spring 2001 .....	Final Report of Pacific Assessment available for review and comment

- the Assessment targets problems and issues important to Pacific governments, businesses and communities;
- the Assessment benefits from expertise and insights from throughout the region; and,
- the results of this U.S.-funded activity are made available throughout the region.

The Pacific Assessment was coordinated by the East-West Center (in Honolulu, Hawai‘i) in collaboration with scientific partners from the University of Hawai‘i, the University of Guam and the National Oceanic and Atmospheric Administration (NOAA); in addition, it was closely coordinated with related activities supported under the auspices of the SPREP, particularly its Pacific Islands Climate Change Assistance Programme (PICCAP). Appendix B lists members of the core scientific team for the Assessment. Members of the team’s Steering Committee made substantial contributions of time and energy throughout the process—the Assessment would not have been possible without their commitment and the generosity of their home institutions. As will be discussed in more detail, the scientific team was comprised of close to 200 participants whose expertise and insights contributed to the findings and recommendations summarized in this report.

Financial support for the Pacific Assessment was provided by NOAA, the National Aeronautics and Space Administration (NASA), the U.S. Department of the Interior (DOI), and the National Science Foundation (NSF), with NSF serving

as the granting agency. Overall guidance for the Assessment was provided by a Steering Committee, which included representatives of businesses, national governments, resource managers and scientific institutions throughout the U.S.-affiliated Pacific Islands (see Appendix C).

### The March 1998 Workshop

The Pacific Assessment summarized in this report was a direct outcome of the March 1998 Workshop “Consequences of Climate Variability and Change for the Hawai‘i-Pacific Region: Challenges and Opportunities,” which was held at the East-West Center as part of the U.S. National Assessment effort.<sup>1</sup> As described in the workshop invitation, the week-long event was organized around two objectives:

- to initiate a long-term, interactive dialogue on the sensitivity of Pacific Island communities, businesses and ecosystems to climate variability and change; and,
- to explore opportunities to use new scientific information to adapt to or mitigate the consequences of climate variability and change.

Formal presentations at the beginning of the workshop provided participants with an opportunity to consider climate variability and change from three perspectives: a fundamental scientific understanding of the behavior of earth’s climate system; an awareness of the effects of climate

<sup>1</sup> Support for the March 1998 Workshop came from NOAA, DOI, NSF, NASA, and the U.S. Federal Emergency Management Agency.

variability and change on economic development, infrastructure and community planning; and, some insights into the vulnerability of unique Pacific Island ecosystems to climate variability and change. With these shared perspectives, workshop participants convened in smaller groups to begin a more in-depth exploration of the challenges and opportunities presented by climate variability and change in six key areas: fisheries; agriculture; water resources; community planning and economic development; biodiversity and endangered species; and public health and safety. Working-group reports were discussed in a closing plenary session that also addressed critical information needs and some overarching findings and recommendations. Appendix E provides a summary of the March 1998 Workshop.

That Workshop identified some underlying assumptions that were used to help guide the Pacific Assessment, including:

- climate variability and change are superimposed on, and should be addressed in the context of, other economic, social and environmental stresses;
- year-to-year climate variability (e.g., ENSO) and extreme events already pose significant challenges in the region, and it is essential to understand current patterns of variability and how they might change;
- today's problems should be addressed today, even as we plan for the future;
- the geographic size and isolation of island communities can create special circumstances— and conversely, island communities can be models for understanding and responding to climate variability and change;
- required data and information are often missing and/or inaccessible (e.g., there are gaps in critical monitoring programs, gaps in detailed research on local impacts, and a lack of attention to the direct impacts of climate change and the consequences of mitigation options);
- infrastructure and community support services are already stressed in a number of Pacific Island jurisdictions; and,
- there is a critical need to reduce the “information gap” between scientists and intended users of climate research and information— a task that involves addressing scientific, institutional and communication/education barriers.

## Conceptual Framework for the Pacific Islands Regional Assessment

### The Climate Context

The climate system is characterized by chemical and physical cycles and complex interactions between land, sea and air. The patterns that emerge from these interacting processes act on a variety of time and space scales. Spatially, ENSO is a phenomenon that occurs in the Pacific Ocean but has global manifestations. Conversely, global phenomena, such as the increase in atmospheric temperature associated with greenhouse warming, have powerful local implications. Throughout the earth's history, ice ages have repeatedly accompanied changes in earth orbit and solar activities. On shorter time scales, seasonal patterns and year-to-year variability, such as those associated with natural cycles like ENSO, are sustained within the climate system and punctuated by extreme events.

Historically, climate has been conceptualized as the statistical interpretation of precipitation and temperature data recorded over time for a given region. Observing atmospheric variations and discerning patterns remains key to predicting climatic conditions and extreme weather events. The scientific community has done a good job of this, as evidenced by our understanding of ENSO as a dominant pattern in the Pacific, and our recognition of other patterns such as the PDO. Similarly, science is showing how humans are affecting these patterns through increased emissions of greenhouse gasses. Recently, our understanding of climate has been greatly enhanced by dynamic integrated-systems approaches.

Understanding how the climate system works requires a study of bio-geo-physical processes. Understanding why climate matters requires a study of the interaction of climate with environmental and social systems at various time and space scales. Climate variability and change pose both challenges and opportunities for human communities that are simultaneously navigating changing demographic, economic, social and political conditions. Understanding how social systems respond to climate change and variability requires knowledge of how they are affected by those conditions today and how they might respond in the future if those conditions change. Historical analogs give us some insight into climate changes and corresponding social responses.

Climate, whether manifested as extreme events or persistent conditions, is experienced first as a physical phenomenon. Temperature, wind and rain all affect the biophysical environment; when extreme events such as tropical storms occur, people suffer injuries, habitats are destroyed (or enhanced) and the built environment is damaged. Climate is inextricably linked with hydrological processes and is a major factor in the process of soil formation. It sets the stage for the establishment of habitats, affects the pace of primary productivity, and influences species density and distribution. As one of the oldest of earth's systems, climate predates life on earth and sets the conditions in which terrestrial environments emerged. Ecosystems and communities evolve in the context of long-term trends, but they also are subject to extreme events that fall outside the norm. We are sensitive to the frequency, intensity and persistence of these conditions, as well as potential changes in long-term trends. Over the course of history, life on earth has evolved many remarkable adaptations to climate and climate variability, including reproductive, morphological and behavioral adjustments. In short, climate change and variability are expressed as environmental change and variability.

The physical environment is the material foundation for all human activities. Great amounts of time and energy are spent to convert the physical environment so that it provides subsistence— through development of water supplies, planting of crops, foraging for food, and construction of shelter. No matter how far some people may be from these physical activities, their survival continues to rely on the material world. Accordingly, any environmental change (induced by climate or other phenomena) introduces new opportunities or challenges for human communities. To better understand how climate change will affect these communities, it is important to consider how they rely on the natural and built physical environments, and how climate variability and change will affect these environments.

In recent years, concern over the consequences of climate change has led many to investigate the potential effects on human communities. Early appraisals focused on physical hazards alone, while more recent approaches, recognizing that human communities are at once physical and social, also have taken into account the social characteristics and organization of communities likely to experience dangerous conditions.

<sup>2</sup> Consistent with guidelines for the National Assessment, participants in the Pacific Assessment were provided with a summary of climate change over the next 100 years based on the results of two coupled ocean-atmosphere models: the first generation coupled a general circulation model of the Canadian Center for Climate Modeling and Analysis (CGCM1) and a similar general circulation model used by the United Kingdom's Hadley Centre for Climate Prediction and Research (HADCM2). Both runs used the core scenario for the National Assessment, which is a 1% rate of annual increase in carbon dioxide and sulfate aerosols (the GHG+A scenario).

## Vulnerability to Climate Conditions

To date, interest in climate change has developed in the context of physical and biological impacts with limited exploration of social and economic effects. However, understanding what climate change and variability mean for ecological and social systems, and how we might respond, requires more than an understanding of basic processes and biophysical impacts. The application of vulnerability studies to the climate problem promises to enrich not only our understanding of social-climate interactions, but also our ability to respond to change and extreme events (see definition of “vulnerability” in the box below).

**Vulnerability** is described as a “multidimensional concept involving at least exposure— the degree to which a human group or ecosystem comes into contact with particular stresses; sensitivity— the degree to which an exposure unit is affected by exposure to any set of stresses; and resilience— the ability of the exposure unit to resist or recover from the damage associated with the convergence of multiple stresses.” (Clark et. al., 2000).

The Pacific Assessment team hoped to provide an opportunity for businesses, governments, community leaders, resource managers and scientists to explore the region's vulnerability in terms of impacts (a combination of sensitivity and exposure) and resilience (adaptive capacity). Thus, the approach adopted for the Assessment focused first on identifying how and why climate matters to Pacific Islands today, and then on exploring ways in which Pacific Island communities could reduce their vulnerability, either by reducing exposure or sensitivity, or enhancing resilience, or both.

The advantage of a focus on vulnerability is that, today and in the future, it can empower Pacific Island jurisdictions to consider a proactive rather than reactive approach to improving their ability to respond to climate variability and change. Historical experience and the results of model-based scenarios<sup>2</sup> of future climate were used to help stimulate the discussion, but the focus was on improving regional ability to anticipate and respond to changes in climate today and in the future. A vigorous and sustained commitment to support adaptation measures in Pacific Islands is particularly important in light of three key findings reported in the IPCC's Third Assessment Report:

- human influences will continue to change atmospheric composition throughout the 21st century;
- global average temperature and sea level are projected to rise under all scenarios in the IPCC Special Report on Emissions Scenarios (SRES); and,
- anthropogenic climate change will persist for many centuries (IPCC, 2001).

## The Pacific Assessment— Objectives and Approach

Reflecting discussions about the National Assessment at the 1997 Aspen Summer Institute, and building on insights that emerged from the March 1998 Workshop, the Pacific Assessment sought to achieve two, mutually-supportive objectives:

- development of a more complete understanding of the regional consequences of climate variability for Pacific Island jurisdictions, considering economic, social and other environmental stresses; and,
- support for a dialogue among scientists, governments, businesses and communities in the Pacific Region that promotes the use of climate information to support decision-making.

This dialogue will allow diverse stakeholders to develop a shared understanding of climate effects and possible responses, and to use climate information to support

decision-making. This concept of shared learning and joint problem-solving emerged as a defining characteristic of the Assessment and reflects an evolving paradigm of assessments as a process of dialogue among scientists and stakeholders.

Thus, the Pacific Assessment can be viewed as a component of broader efforts to develop and use climate information to support decision-making (see Figure 1 below).

The programmatic backbone of the Assessment, and the central process animating this new regional climate information system, is the work of sustaining the partnerships necessary to produce, communicate and use new information and shared insights into climate variability. Pursuant to recommendations from the March 1998 Workshop, the Assessment team has given highest priority to exploring the implications of climate variability and change for:

- water resources (e.g., droughts associated with the El Niño, and potential changes in rainfall patterns associated with long-term climate change);
- public health and safety in island coastal communities; and
- economic development and resource management in key sectors such as tourism, agriculture, and marine and coastal resources, especially as these are affected by changes in patterns of extreme events such as hurricanes and typhoons.

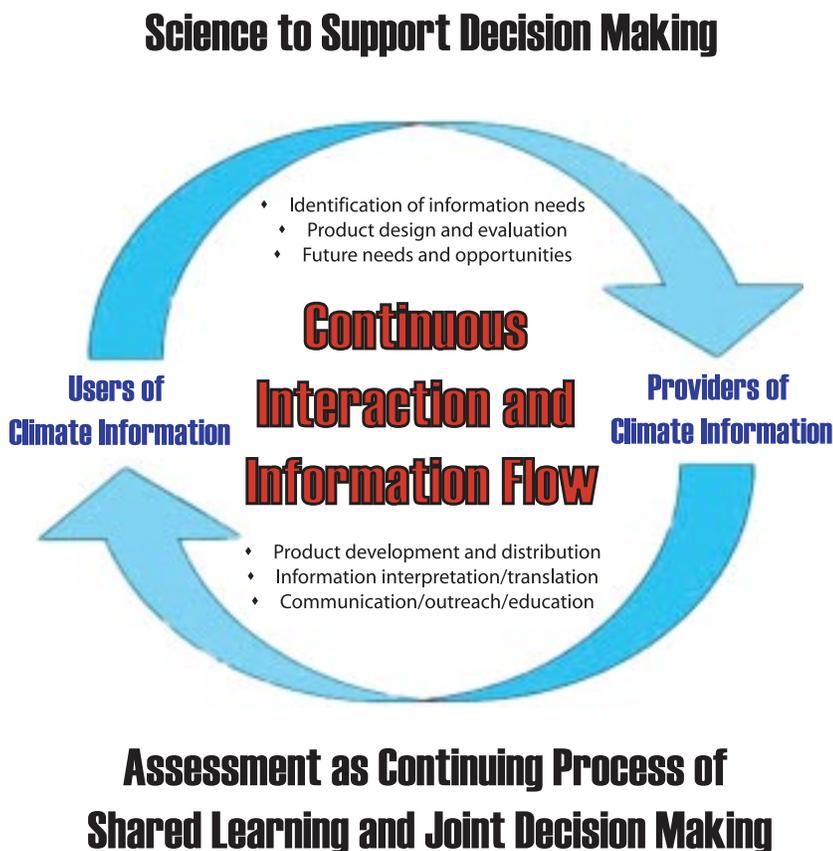


Figure 1.  
Conceptual model of a Pacific Climate Information System (PCIS), which incorporates science and broad-based collaboration into public decision-making.

Although the Assessment focused primarily on the direct consequences of climate variability and change within Pacific Island communities, the organizers and participants acknowledged the importance of recognizing that the effects of climate variability and change on other jurisdictions in the Asia-Pacific Region (and throughout the world) also have environmental and economic implications for Pacific Islands.

The Assessment supported analytical studies, a large, multi-stakeholder workshop and focused discussions with representatives of key sectors. The studies helped illuminate the nature and consequences of historic and projected climate trends, and included analysis of model-based scenarios of climate change over the next 50 and 100 years. The November 2000 Workshop focused on the role of climate in island coastal communities. Focused, small-group discussions included consideration of climate variability and change issues by: representatives of the Pacific Basin Coastal Zone Management officials at their 16th Annual Conference in January 1999; the Hawai'i Congress of Planning Officials at their September 1999 Conference; participants in a fall 1999 workshop on ENSO and water resources held in Fiji under the auspices of PEAC and SOPAC; and participants in a workshop on climate and health held in Samoa in 2000 under the joint auspices of the World Health Organization (WHO) and the World Meteorological Organization (WMO).

Participants in the Pacific Assessment were asked to consider vulnerability in the context of two questions:

- What systems, activities, communities and populations are particularly exposed and sensitive to climate, and how? and,
- How might we enhance the adaptive capacity of these systems, activities, communities and populations?

To further enhance adaptive capacity, particularly in light of recent developments in science and decision-making, participants were asked to think strategically about the following:

- What information/research is needed to reduce sensitivity or enhance adaptive capacity (build resilience)?
- How can information about climate be used to enhance planning, policy formulation and decision-making?
- What cooperative partnerships could be pursued to enhance adaptive capacity?

The insights that emerged from the Assessment dialogue on these five questions provide the basis for this report.

## Organization of this Report

This report provides an integrated summary of the scientific analyses conducted as part of the Pacific Assessment, and the insights that emerged from the March 1998 and November 2000 Workshops and small-group discussions.

The report was reviewed and approved by the Pacific Assessment Steering Committee, and participants in both Workshops were invited to comment on the draft report. In addition, the draft was made available for public review and comment via posting on the East-West Center climate website ([www2.eastwestcenter.org/climate/assessment](http://www2.eastwestcenter.org/climate/assessment)). A detailed summary of the comments received and addressed during review of this report is available from Principal Investigator Eileen L. Shea, Climate Project Coordinator at the East-West Center.

Subsequent chapters of this report will provide:

- A description of the Pacific Islands region, including an overview of regional climate and socioeconomic conditions and a summary of the results of the model-based scenarios of climate change (Chapter Two);
- A discussion of climate-related challenges and opportunities faced by Pacific Island communities, focusing on vulnerability in the six key sectors used to organize the November 2000 Workshop (Chapter Three); and,
- A discussion of planning for the 21st Century, with emphasis on development of effective response options; identification of critical information gaps and research needs; support for critical regional partnerships that use climate information in decision-making; and a concluding discussion of future activities (Chapter Four).

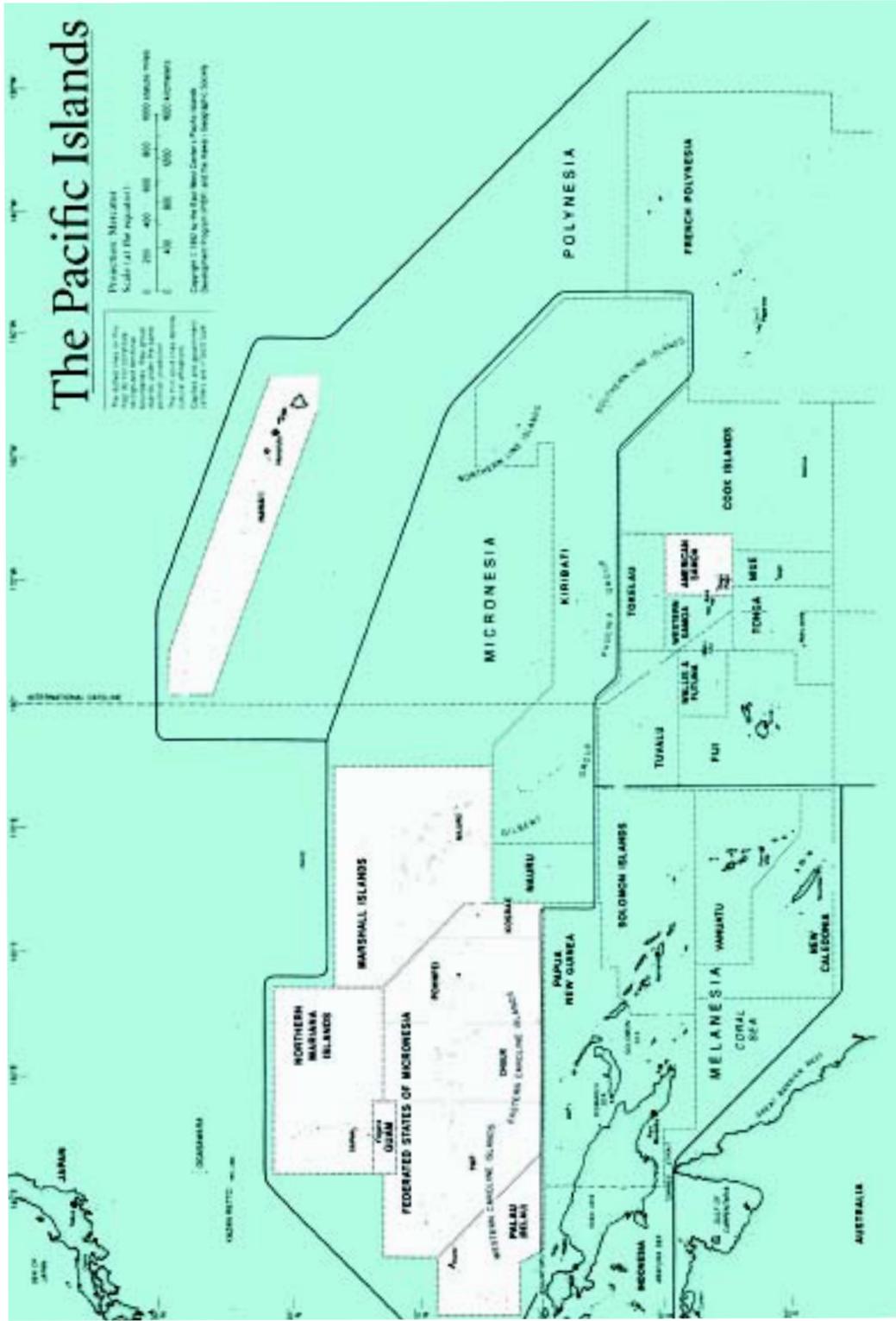
Additional details on the Assessment process are contained in the following appendices:

- An overview of the U.S. National Assessment (Appendix A);
- Key members of the Pacific Assessment core scientific team (Appendix B);
- Members of the Steering Committee for the Pacific Assessment (Appendix C);
- Selected materials related to the November 2000 Workshop on Climate and Island Coastal Communities, including the Workshop Summary, Workshop Agenda, Members of the Steering Committee, List of Working Group Chairs and Rapporteurs, and List of Participants (Appendix D);
- Selected materials related to the March 1998 "Workshop on the Consequences of Climate Variability and Change for the Hawai'i-Pacific Region: Challenges and

Opportunities” including the Workshop Summary, Members of the Steering Committee, List of Working Group Chairs and Rapporteurs, and List of Participants (Appendix E); and

- A proclamation issued by the governor of Hawai‘i on the occasion of the March 1998 Workshop (Appendix F);

Rather than an end product, this report represents the beginning of a sustained process of dialogue and information-exchange among scientists, businesses, governments and communities in the Pacific Region. It is our hope that this report will serve as a guidepost for those seeking to better understand current and future climate-society interactions in the region, and will also inspire people from all walks of life to explore together how climate affects our lives.



Shown in the white areas of this map, the American Flag and U.S. Affiliated Pacific Islands (AFUSAD) are the principal participants in the Pacific regional climate assessment, which supports collaborative research and planning to mitigate the negative effects of climate variability and change.