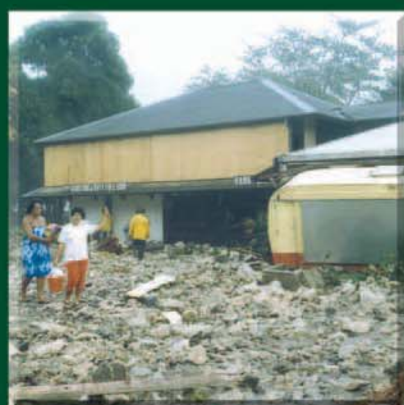
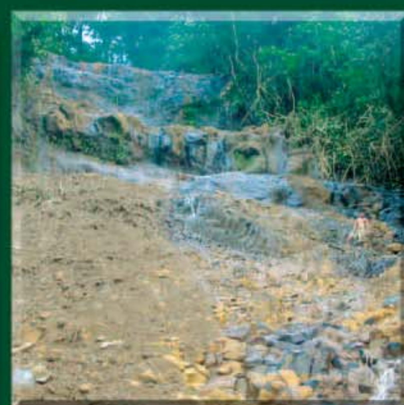
ADB

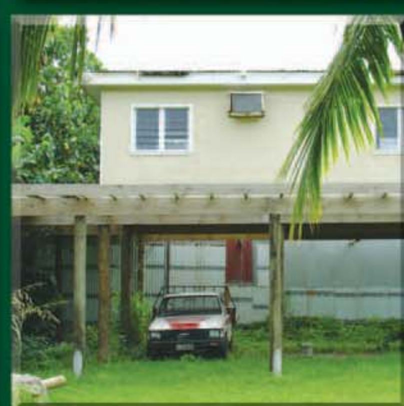
Pacific Studies Series

CLIMATE PROOFING

A Risk-based Approach to Adaptation







Summary for Policy and Decision Makers

Asian Development Bank

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Asian Development Bank Developing countries in the Pacific can adapt their capacity for dealing with, and resilience to climate change and climate variability.

Contents

Foreword

Since the early 1990s, the Asian Development Bank (ADB) has been at the forefront in assisting countries in the Asia and Pacific region to address climate change, through various technical assistance programs and lending operations.

ADB recently attracted the increasing interest of various aid providers (such as Denmark, Canada, and the Netherlands) for grant funding of its program on renewable energy, energy efficiency, and climate change (REACH). Under the REACH program, ADB administers three grant funds: i) the Netherlands Cooperation Fund for Promotion of Renewable Energy, Energy Efficiency, and Greenhouse Gas Abatement ($4.5 million); ii) the Canadian Cooperation Fund for Climate Change ($3.2 million); and iii) the Danish Cooperation Fund for Renewable Energy and Energy Efficiency in Rural Areas ($3.5 million).

ADB's Climate Change Adaptation Program for the Pacific (CLIMAP) assists Pacific developing member countries to enhance their adaptive capacities and resilience to climate change and climate variability, including extreme events. It also assists these countries to prevent and address the adverse effects of global climate change, particularly sea-level rise and changing climate variability in coastal and marine areas. This is achieved through risk assessment, adaptation planning, and policy development, by climate proofing infrastructure, and through community and other development initiatives. This assistance involves preparation/design of adaptation measures at the project level as well as capacity building, including institutional strengthening and human resources development for adaptation.

CLIMAP builds on ongoing and recently completed adaptation programs through a consultation and analysis process. It follows an integrated approach covering economic, financial, technical, and legal aspects as well as social, environmental, and networking dimensions. This requires the active and sustained engagement of various experts and stakeholders from the scientific community, decision makers, and public and private sector operators, as well as nongovernment organizations and representatives of civil society.

ADB foresaw the need to prepare a series of case studies that demonstrate a risk-based approach to adaptation to climate change, including the mainstreaming of adaptation. These would link to, and support, initiatives being taken to prepare for mainstreaming adaptation in ADB's own policies and procedures.

Climate Proofing—A Risk-based Approach to Adaptation is the result of a regional technical assistance (RETA) funded under REACH by the Canadian Cooperation Fund for Climate Change—Greenhouse Gas Abatement, Carbon Sequestration and Adaptation. The technical assistance was administered by ADB.

The case studies were prepared by Maunsell (NZ) Ltd., working in association with the International Global Change Institute of the University of Waikato, New Zealand. The team was directed by Edy Brotoisworo, Senior Environment Specialist, Pacific Department; who succeeded Daniele Ponzi, then Senior Economist (Environment), Pacific Department. Design, coordination, and implementation of the RETA benefited from the overall guidance of Peter N. King, former Director, Area B, Pacific Department, Robert Y. Siy Jr., Director, Area A, Pacific Department, and Indu Bhushan, Director, Area B, Pacific Department, ADB.

The leader of the team of consultants who prepared the case studies was John E. Hay of the International Global Change Institute(IGCI), University of Waikato, Hamilton, New Zealand. The team included Richard Warrick, also of IGCI, Chris Cheatham, Consultant, Suva, Fiji Islands; Teresa Manarangi-Trott, Pacific Communications, Rarotonga, Cook Islands; Joseph Konno, Consultant, Chuuk, Federated States of Micronesia; Peter Hartley, Maunsell (NZ) Ltd., Auckland, New Zealand.

ADB also acknowledges, with thanks, the assistance and cooperation of the Governments of the Federated States of Micronesia and the Cook Islands.

Philip Erquiaga
Director General
Pacific Department
Asian Development Bank

Summary for Policy and Decision Makers

A. Background

The Pacific Islands region faces increasing environmental and socioeconomic pressures exacerbated by global climate change and climate variability.[1] Adaptation to climate change and variability (CCV) is ultimately an issue of sustainable development. Even without climate change, Pacific island countries are already severely affected by climate variability and extremes, and they remain extremely vulnerable to future changes in the regional climate that could increase the risks. Countries in the Pacific have clearly recognized the need to (i) reduce their vulnerability to these increasing risks through adaptation,[2] and (ii) strengthen their human and institutional capacities to assess, plan, and respond to these challenges.

Six case studies designed to assist Pacific developing member countries (PDMCs) of the Asian Development Bank (ADB) to adapt to current and future climate risks were prepared, through use of the Climate Change Adaptation through Integrated Risk Reduction (CCAIRR) framework and methodology, to demonstrate a risk-based approach to adaptation and to mainstreaming adaptation. Two PDMCs (the Federated States of Micronesia [FSM] and the Cook Islands) were selected to show how to mainstream this risk-based approach at three levels: national development planning, sector programs, and project activities.

The case studies were prepared through a partnership between the Government of Canada (funding provider), ADB (executing agency), the Governments of the FSM and the Cook Islands

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1 Global climate change refers to a significant long-term change in the earth's climate system, whereas climate variability refers to short-to medium-term fluctuations in the climate system, and usually includes extreme weather events such as hurricanes, floods, droughts, and other related disasters caused by weather phenomena.

2 Policies, actions and other initiatives designed to limit the potential adverse impacts arising from climate variability and change (including extreme events), and exploit any positive consequences.

(implementing agencies), Maunsell (NZ) Ltd (environmental and engineering consultancy), and the International Global Change Institute, University of Waikato, New Zealand. The regional technical assistance was funded under the Renewable Energy, Energy Efficiency, and Climate Change (REACH) by the Canadian Cooperation Fund for Climate Change—Greenhouse Gas Abatement, Carbon Sequestration and Adaptation. The technical assistance was administered by ADB.

The ultimate aim of the case studies was to show *why* and demonstrate *how* reducing climate-related risks is an integral part of sustainable development. Implementation of specific risk-reduction measures at project and local levels can be facilitated if land-use planning and associated regulations and permitting procedures for structure, infrastructure, and community development projects incorporate requirements that are designed to reduce risks related to current and future climate extremes and variations. This strengthening of planning and regulatory provisions is, in turn, assisted by ensuring that national policy frameworks and strategies address the potential for climate-related risk events to have large adverse economic, social, and environmental consequences.

While the field studies and other activities to develop the six case studies were undertaken in the Cook Islands and the FSM, the innovative methodologies and tools, as well as the findings, are applicable to all Small Island Developing States, and even to larger developing and developed countries.

B. Introduction to the Case Studies

The overall goal of a risk-based approach to climate change adaptation is to manage both the current and future risks associated with the full spectrum of atmospheric and oceanic hazards. The case studies were chosen to highlight the range of levels at which adaptation takes place and the linkages between them. The levels are i) project, ii) regulation and compliance, iii) short- and mid-term policy making and planning at subnational level, and iv) national strategic development planning. The studies demonstrated the importance of mainstreaming adaptation, including strengthening the enabling environment for adaptation to increase the likelihood of successful adaptation at project and community levels.

Through a consultative process the following case studies were selected for the FSM:

- climate proofing[1] Sapwohn, a coastal community in Pohnpei;
- climate proofing a roadbuilding infrastructure project in Kosrae; and
- climate proofing the infrastructure, human health care, and environment components of the FSM National Strategic Development Plan.

Similar consultations in the Cook Islands resulted in the selection of the following case studies:

- climate proofing the design of the breakwater for the newly developed Western Basin, Rarotonga;
- climate proofing Avatiu-Ruatonga, a community inland from Avatiu Harbour; and
- climate proofing the Cook Islands National Development Strategy.

In order to ensure ongoing stakeholder buy-in and sustained uptake, five principles underscored preparation of the case studies:

- undertake all activities in an inclusive, transparent, and participatory manner;
- wherever possible, use existing information and other resources;
- local experts should work alongside and at times lead their international counterparts;
- ensure that all outcomes have high relevance to key stakeholders, add value to current and planned initiatives, and are sustainable; and
- select the case studies in accordance with criteria established by ADB and expanded through consultation with stakeholders in each country (governments, nongovernment organizations, private sector, and communities).

[1] Climate proofing is a shorthand term for identifying risks to a development project, or any other specified natural or human asset, as a consequence of climate variability and change, and ensuring that those risks are reduced to acceptable levels through long-lasting and environmentally sound, economically viable, and socially acceptable changes implemented at one or more of the following stages in the project cycle: planning, design, construction, operation, and decommissioning.

In addition to the technical and policy-oriented work, considerable effort was devoted to a key dimension of adaptation, namely capacity building, including awareness raising and action and institutional strengthening.

The work undertaken included assessments of both the risks arising from current climate variability and extremes and from the future incremental changes in those risks as a result of longer-term changes in climate extremes and variability. Significantly, the case studies also demonstrate methods for prioritizing adaptation strategies and specific measures in both their costs and benefits. A major goal, and challenge, was to determine, in a rigorous and quantitative manner, the incremental costs of adaptation to climate change.

C. General Findings

For both the Cook Islands and the FSM, climate risk profiles (CRPs) were prepared. Extreme climate events that are relatively rare at present (likelihood in one year less than 0.05) are projected to become relatively common as a result of global warming (in many cases, likelihoods are projected to increase to over 0.20 by 2050).

Climate-related risks facing both the infrastructure projects and the communities are already considerable, but in all cases are projected to increase substantially as a result of increases in climate extremes and variability. For infrastructure projects, it is possible to avoid most of the damage costs attributable to climate change, and to do this in a cost-effective manner, if climate proofing is undertaken at the design stage of the project. Cost effectiveness can be further enhanced if environmental impact assessment (EIA) procedures require that all development be climate proofed (i.e., that climate proofing is part of best practice, as judged by the EIA procedures). Climate proofing communities can also be cost effective if planning and regulatory measures take into account both current and future climate-related risks.

Governments are urged to take into consideration the likelihoods of increased frequency and intensity of adverse weather and unfavorable climate conditions through climate proofing national strategic development plans to enhance the enabling environment for adaptation, establish the requirement for climate proofing sector and subnational (e.g., state, island, and community) development plans as well as individual development projects (i.e., mainstreaming adaptation), and help to ensure that actions to reduce climate-related risks are an integral part of, and are harmonized with, sustainable development initiatives.

D. Climate Proofing a Roadbuilding Infrastructure Project in Kosrae, Federated States of Micronesia

The infrastructure development plan for Kosrae includes completion of the circumferential road, closing what is a 16-kilometer (km) gap. Funds for the road project are to be provided under the Compact of Free Association with the United States of America. Construction of at least 10.6 km of the road's northern portion was scheduled for 2004. The primary purpose of this development is to complete the road around the island of Kosrae and provide all-weather land access to the remote village of Walung (population 230) in the southwest. It is the only community without reliable links to the island's other municipalities.

Completion of this link will also allow easier access to the presently undeveloped interior of the island along the western coast, providing scope for agriculture and new settlement in the area. Construction of power lines along the road, to join Walung to the existing electricity distribution system from two directions along the new route, is also planned. This will convert the present "radial" configuration of the power distribution system in Kosrae to a more reliable ring-main, with benefits for the whole island.

Part of the planned route will have to traverse or circumnavigate a large freshwater swamp, which is dominated by a tree locally called *ka* (*Terminalia carolinensis*). The swamp, the largest remaining stand of *T. carolinensis* in the world, is officially designated as an Area of Biological Significance.

The drainage works for the original road design (both built and as-yet-unbuilt sections) were based on a maximum hourly rainfall of 178 millimeters, which supposedly had a return period of 25 years. An analysis of more reliable data indicated that an hourly rainfall with a return period of 25 years is 190 mm. By 2050, however, the hourly rainfall with a 25-year return period will have increased to 254 mm as a consequence of climate change.

A recommendation that the design of the road be modified so the drainage works could accommodate an hourly rainfall of 254 mm was accepted by the state government of Kosrae and a climate-proofed design was prepared and costed by state employees. The incremental cost of climate proofing the road design and construction for the as-yet-unbuilt section is in the vicinity of $500,000. While the capital cost of the climate-proofed road would be higher than if the road were constructed to the original design, the accumulated costs, including repairs and maintenance, would be lower after only about 15 years. This is because repair and maintenance costs would be lower for the climate-proofed road. The internal rate of return was found to be 11%.

A 3.2-km portion of the road section has already been constructed, including the drainage works. The design for these was also based on an hourly rainfall of 178 mm for a 25-year recurrence interval. Analyses show that it is more costly to climate proof retroactively: $776,184 for a 3.2-km section of existing road ($243,000 per km) as opposed to $511,000 to climate proof 6.6 km of new road ($77,000 per km). A cost-benefit analysis, however, revealed that the retroactive climate proofing is still a cost-effective investment, with an internal rate of return of 13%.

The FSM Government and the state government of Kosrae were informed of these findings, as well as possible funding options for climate proofing the unbuilt section of road. The options included

- not climate proofing the road, since
  - ➢ more important investments may have to be made (e.g., in health care),
  - ➢ the climate may not change in the way that is projected, and
  - ➢ an extreme event (e.g., hourly rainfall of 254 mm) can happen at any time, and it is only possible to consider average recurrence intervals.
- using internal funds, i.e., from the state budget;
- using national funds;
- using Compact II funds, on the basis that the true ("most likely") costs of the project have increased;
- seeking additional funding from international development agencies, such as
  - ➢ the Global Environment Facility (GEF),
  - ➢ multilateral financial institutions (e.g., ADB),
  - ➢ bilateral aid provider (e.g., Government of Canada), and
  - ➢ public-private partnerships, possibly including a road toll.

The last set of options is a possibility, since the high ecological value of the *T. carolinensis* and associated ecosystems might encourage a philanthropic organization to fund the additional construction costs required to ensure that the road is climate proofed and in addition will not place valuable ecosystems at risk.

Based on the information available to it, the Kosrae state government has decided it will not proceed with construction of even the northern section of the new road until additional funds are available to complete the climate proofing. The national and state governments are preparing a proposal to the GEF for funding the incremental costs of completing the entire road section. In addition to climate proofing the road, GEF would be asked to meet the incremental costs of "biodiversity proofing" the road, including ensuring the continued protection of the valued ecosystems, including the Area of Biological Significance. Prior to commencing construction, all the environmental and other approvals required by the state of Kosrae would, of course, have to be in place.

E. Climate Proofing the Design of the Breakwater for the Western Basin, Avatiu Harbor, Rarotonga, Cook Islands

The Cook Islands Ports Authority is in the process of developing the Western Basin of Avatiu Harbour in Rarotonga to accommodate an increasing number of fishing vessels, provide sufficient wharf to minimize delays in offloading fresh fish, and allow the fishing vessels to use the harbor in most sea conditions other than those associated with cyclones. The Western Basin is being developed in stages, based on demand and commensurate with development of the fishing industry and availability of funding. The first stage, involving an expenditure of NZ$1 million sourced through a government grant, overseas aid grant, cash reserves, and a loan, was for a wharf facility, but with no added protection against storms beyond what is provided by an existing breakwater.

The design brief for the Western Basin states that the breakwater and quay walls should be designed for a nominal design life of 60 years. Fixtures should be robust enough to withstand a cyclone with a 10-year return period. The brief acknowledges that severe damage will be sustained by fixtures in a cyclone with a 50-year recurrence interval. It goes on to say that the main quay should be designed to withstand the wave forces associated with a cyclone with a 50-year return period, with only minimal damage. Cyclone wave heights should be based on a 50-year return period, and a calculated significant wave height of 10.75 m (10 percentile wave heights of 13.65 m).

A separate feasibility study is being undertaken by parties not involved in the present case study. The feasibility study relates to the design and construction of a permanent breakwater system for the Western Basin. Had the feasibility study proceeded as originally planned, the principal steps in the risk characterization and management procedures were to be the following:

- Determine design water level and waves (wave height, period, and incident direction), taking into account climate change scenarios, including sea-level rise and the implications for extreme events, including likely changes in their frequency and magnitude.
- Calculate wave transformation from offshore (deep water) to the breakwater and harbor.
- Determine conditions for wave run-up on the breakwater side and wave over-topping.
- Identify design options that will reduce risks (including those to the breakwater, vessels, and port infrastructure) to acceptable levels, including
  - ➢ height and cross section of breakwater, and
  - ➢ configurations and weight of armor blocks that will be resistant to wave forces.
- Calculate the costs and benefits for each design option, including incremental costs and benefits associated with taking into account the climate change scenarios.

Regrettably, the companion feasibility study has been delayed, necessitating that the present case study involve only the first of the above steps. The work involved provided assessments of possible future changes in i) cyclone intensity, as translated into changes in significant wave height; and ii) mean sea level, as a component of change in total water elevations during cyclones. These changes would provide input for climate proofing the design of the breakwater.

The relationship between maximum wind speed and significant wave height for a given return period was determined using past studies of tropical cyclone risks for the study area. It thus represents "current" climate. However, both the historic record and some global climate models (GCMs) suggest that the frequency and intensity of cyclones in the vicinity of Rarotonga are increasing and may continue to increase, asymptotically.

Consideration was given to the impacts of global warming on changes in cyclone intensity and, hence, significant wave heights. A major review concluded that tropical cyclone intensities (as measured by maximum cyclone wind speed) are likely to increase as a result of global warming. In light of these findings, a 2.5–10% increase in cyclone intensity per degree of warming was used to implement the first of two methods. This information was incorporated into SimClim (a software tool for simulating climate risks and evaluating adaptation options) as three options for cyclone intensity change (low, mid, and high), as were the relationships between maximum cyclone wind speed, significant wave height, and return periods based on observational data. Under current climate conditions, the 50-year significant wave height is estimated to be about 10.8 m. Under the climate projected for the year 2060, the 50-year significant wave height increases to about 12.0 m.

The second method was based on daily maximum wind speed as estimated by a GCM. The most important finding arising from this analysis is the suggestion that over the coming 50 years or so, the return periods for the most extreme wind speeds will reduce significantly, falling by approximately half by 2050.

Regardless of the method used to estimate the current and projected significant wave heights with a 50-year return period, the risk of damage to the breakwater in the future will also be influenced by changes in mean sea level. The sea-level projections incorporated both a regional component based on GCM results and a local component based on trends in mean sea level as estimated from tide gauge data. After accounting for the climate-related rise, the local trend appears to be about 1.7 mm yr^{-1}, most likely related to vertical land movement. By the year 2060, mean sea level is projected to be 50 to 80 cm higher than today.

In summary, when climate proofing the design of a breakwater, two of the key considerations are how global warming will affect changes in cyclone intensity and frequency (and hence changes in the return periods of design wind speeds and significant wave heights) and mean sea-level change. The brief for the development of the Western Basin indicates that the breakwater should be designed for a nominal design life of 60 years. Given this specified design life, and the preceding projections of return periods for extreme winds and hence significant wave heights, and of sea-level rise, the breakwater design should be based on a significant wave height of at least 12 m and allow for a sea-level rise of at least 0.5 m.

F. Climate Proofing Avatiu-Ruatonga, a Community Inland from Avatiu Harbor

The community of Avatiu-Ruatonga is located on the northern coast of Rarotonga, between the national capital of Avarua and the international airport. The main port for the Cook Islands is located within the study area. Except in the vicinity of Avatiu Harbour, the land is a narrow coastal reef flat and a narrow beach ridge (elevation between 3 and 4 m). Behind the beach ridge is lower-lying land, much of which is swamp, and part of which is used to grow taro. At the southern boundary of the study area, the land begins to rise steeply: in the southeastern portion of the study area, elevations are already above 9 m. The land further to the south forms the steep catchments of the streams that flow into the study area and discharge into the ocean just to the east of Avatiu Harbour.

The resident population of 396 occupies 127 dwellings. In addition, there are 9 unoccupied dwellings, 64 commercial buildings, 10 community buildings and 6 storage facilities. Government buildings are three in number and joint government-commercial two. Several bulk liquid storage tanks are located there. Collectively, all structures have an estimated replacement value of NZ$47,750,000. Most of the above structures are located on higher land, the exceptions being the port buildings and the predominantly residential buildings located inland from the harbor. Some of the latter are built on land with elevations at or just below sea level. Many of these structures, and others in adjacent low-lying areas, are flooded as a result of either heavy rainfall events and/or high sea levels. The latter usually relate to storm surge events. These also damage structures on land at higher elevations close to the coast.

Hourly rainfall data were used to estimate the likelihoods of heavy rainfall events associated with flooding in the study area. Rainfall totals over 2-hour periods were analyzed, reflecting the time of concentration for the main stream flowing through the study area. Likelihoods for 2-hourly rainfall totals of 140 and 200 mm were determined for both the present and for 2050. At present, a two-hourly precipitation total of 200 mm has a return period of around

12 years. But by 2050 the same event will be more common: the return period is projected to decrease to only 7 years. Or stating it another way, by 2050, the two-hourly precipitation total with a return period of about 12 years is projected to be 236 mm.

A basic flood model was developed for the Avatiu-Ruatonga case study area, using the Rational Method to estimate flows in streams running into the study area. The level of flooding upstream of the Main Road bridge was estimated based on the difference between stream flows and the bridge's capacity. The "storage" volume of the swamp area was calculated using elevation data; by calculating the volume of water discharging into this area, less the estimated volume being discharged to the harbor, flooding levels could be estimated. Initial runoff parameters in the model were determined using recorded rainfall and stream flow data. Validation of the model was undertaken by comparing model outputs with observed flood extent and depths for the last major rainstorm to affect the area.

The full consequences of the increased likelihood of more frequent and intense rainstorms can be seen when the impacts of all the changes in the precipitation regime are integrated over a given number of years into the future. Calculations show that over the next 50 years damage costs without climate change and with climate change will be NZ$13 million and NZ$14 million, respectively, after applying a discount rate of 3 percent. Comparable values to 2100 are NZ$16 million and NZ$19 million, respectively. Thus the Avatiu-Ruatonga area is already experiencing high damage costs as a result of extreme rainfall events. These will be exacerbated by climate change. A proposed airport extension will also exacerbate flooding, unless flood reduction measures are included in the design. Even in the absence of climate change, damage costs would be NZ$15 million and NZ$19 million to 2050 and 2100, respectively.

The model was also used to identify three key hydraulic controls on the flooding being experienced in Avatiu-Ruatonga. Costs for realistic increases in the flow capacity at these control points were determined. Subsequently the cost effectiveness of each of these adaptation options was investigated in turn; a high benefit-cost ratio for deepening the bed of the main stream was shown, even under present conditions. Thus, this adaptation qualifies as a "no regrets" adaptation initiative, that is, it would generate net social benefits even without climate change.

Another approach to reducing damage costs is to introduce changes to the building code, and to land use planning and EIA regulations, such that when new buildings are constructed, or existing buildings are substantially renovated, these works are required to reduce the flood risk.

Several realistic regulatory and voluntary measures were identified and their cost effectiveness assessed. For the selected scenarios, all regulatory measures appear cost effective, even under present conditions, and thus also qualify as “no regrets” adaptation initiatives.

The study area is also subject to coastal flooding from tropical cyclones. Similar analyses were undertaken to assess damage costs associated with sea surges and the nature of interventions that would reduce the risk to an acceptable level. As with the breakwater case study, the sea surge risk modeling made use of the extensive coastal engineering studies that were carried out during the 1990s to provide design data for coastal protection works. A chain of relationships—from wind speed and wave height to total water run-up elevation, and their associated return periods—was established and related to the potential wave overtopping for a site with a given height for the beach ridge. Scenarios of future changes in tropical cyclone intensity enter into the chain by way of changing wind speed; changes in sea level enter into the chain by changing total wave run-up elevation. Flood depth and extent were calculated by determining the total run-up elevation and overtopping volume for a cyclone with a given return period. The overtopping height was determined to be the difference between run-up elevation and the height of the beach ridge. The water was distributed over the study area (downslope) with a negative exponential function, with results validated on the basis of evidence of the aerial extent and depth of saltwater flooding during Cyclone Sally in 1987.

Calculations analogous to those for runoff flooding revealed that sea surges are a major risk to structures, infrastructure, and other assets in the study area, and of course also to the people who reside and/or work there. Over the next 50 years, damage costs without and with climate change will be NZ$31 million and NZ$41 million, respectively, after applying a discount rate of 3 percent. Comparable values to 2100 are NZ$26 million and NZ$40 million, respectively. Thus the Avatiu-Ruatonga area is already experiencing high damage costs as a result of extreme high storm waves and sea surges. These will be exacerbated markedly by climate change.

Several realistic regulatory and voluntary measures were again identified and their cost effectiveness assessed. Damage costs can be reduced through application of the above measures and all qualify as "no regrets" options.

A totally unrealistic adaptation measure is used to highlight the scale of intervention that would be required to protect assets if some or all of the above regulatory and voluntary measures are not implemented. The hypothetical scenario involves building a 5-m-high sea wall at the shoreline, at a cost of NZ$5,000/m length. While the intervention would cost some NZ$0.75 million, over the next 50 years it would reduce sea surge damage costs by NZ$20 million in the absence of climate change and by NZ$27 million for the chosen climate change scenario.

G. Climate Proofing Sapwohn, a Coastal Community in Pohnpei, Federated States of Micronesia

The community was established after Pingilap, an outer island of Pohnpei, was devastated by a typhoon in 1905. The "environmental refugees" were eventually relocated to Sokehs Island and allocated land that became vacant after the 1907 uprising. Most of the houses, commercial buildings (small stores) and community structures (a church and *nahs* – meeting places) are built on a narrow strip of relatively flat land that runs between the shore and the steep slopes of Sokehs Mountain.

The resident population of 776 occupies 144 dwellings. In addition, there are 15 unoccupied dwellings, seven commercial buildings (two are unoccupied), four combined residential and commercial buildings, four community buildings and four nahs. No government buildings are located in the study area. Collectively all structures have an estimated replacement value of $15,063,000.

At present, many structures are flooded regularly, as a result of either heavy rainfall events and/or high sea levels.

Based on the topography of the study area, and given the lack of strong channelization of flow, an assumption was made that sheet flow occurs down the full length of the slope. The study area was divided into five subcatchments based around two "gullies." The subcatchments with gullies were allocated a greater catchment area as a reflection of the channelization that occurs with these gullies. A simple "conceptual model" was developed, using first principles (including the Rational Method) to estimate flood depths for different segments of the study area. The estimates were based on 1-hour rainfall intensities for given return periods. The model was validated using observed flooding depths associated with a storm in October 2003.

The spatial distributions and depths of flooding for individual and ensemble rainfall events were estimated for the current climate and for scenarios of future climate. Under current conditions, the 25-year hourly rainfall (210 mm) results in flooding up to a depth of between 0.4 and 0.6 m for most of the area. A small area is flooded to less than 0.2 m. By 2050, the 25-year hourly rainfall is projected to increase to 393 mm. This results in a substantial increase in flood risk: maximum flood depths will be greater than 1 m, with all areas being flooded to at least 0.2 m.

Calculations show that over the next 50 years damage costs without and with climate change will be $10 million and $16 million, respectively, after applying a discount rate of 3 percent. Comparable values to 2100 are $8.9 million and $15.8 million, respectively. While the area is already experiencing high damage costs as a result of extreme rainfall events, it is apparent that these will worsen dramatically because of climate change, even in the next few decades. Measures to reduce the flood risks need to be considered, and especially their effectiveness at reducing the risks in a financially sound manner.

Consultations with stakeholders, notably community leaders and residents of the study area, resulted in the identification of a number of adaptation measures as potential ways to reduce the flood risk to acceptable levels. Their preference was for “no regrets” options. The flood modeling confirmed that runoff from the steep slopes above the community is a major contributor to flood risk. Accordingly, the effectiveness of drainage works that would divert this runoff away from the built-up areas was explored. The effectiveness of changes to building practices, and to land use planning and EIA regulations, was also investigated. This included requirements that new construction or the substantial renovation of existing buildings be carried out in such a way that the flood risk is reduced.

For the selected scenarios, both the diversion works and the regulatory measures qualify as “no regrets” interventions, including being cost effective. It is instructive to consider the incremental costs of the adaptation measures. Over the next 50 years, runoff works capable of diverting 50% of the runoff from the 25-year storm would bring incremental benefits (i.e., reducing the additional damage costs attributable to climate change) of $5 million, at an incremental cost of $0.75 million. While climate change will impose significant additional costs on the community, the incremental benefits coming from adaptation interventions are larger by at least a factor of four.

The study area is also subject to coastal flooding resulting from high tides. Rarely do these relate to the consequences of a tropical cyclone (typhoon). Instead, the high ocean levels are usually associated with king tides, strong onshore winds and the La Niña phase of the El Niño Southern Oscillation (ENSO). The damage costs arising within the area modeled as a result of the ensemble of high sea-level events projected to occur over a future time period were calculated, using methods analogous to those used to determine the damage costs from flooding associated with heavy rainfall events occurring over a defined period into the future.

Over the next 50 years, damage costs without climate change will be US$6 million, after applying a discount rate of 3%. Climate change will increase the costs by a relatively insignificant amount: a comparable value for the period to 2100 is US$7 million. High sea levels (including high tides) present a significant risk to structures, infrastructure, and other assets in the study area, and also to the people who reside and/or work there. Again, several realistic regulatory and voluntary measures were identified, some of which residents of Sapwohn Village are already implementing on a voluntary basis. These measures are capable of reducing damage costs by between 11% and 35% over the next 50 years. Due to the high damage costs without climate change, all measures qualify as "no regrets" adaptation initiatives, including being cost effective.

H. Climate Proofing the Infrastructure, Human Health Care, and Environment Components of the Federated States of Micronesia National Strategic Development Plan

In early 2003, the FSM began preparing a Strategic Development Plan (SDP) that outlines the county's broad economic strategy and sector development policies. In addition to being the primary national economic planning mechanism of the country, the SDP is also a requirement under the Amended Compact of Free Association with the United States. An Infrastructure Development Plan (IDP) is also a requirement under the Amended Compact. The IDP is the

FSM's long-term planning document for public investment in infrastructure. Together the SDP and IDP provide a comprehensive economic strategy for the FSM at a critical time in its development as an increasingly self-reliant nation. ADB provided technical assistance to the FSM for the preparation of both the SDP and the IDP.

A critical step in the preparation of the SDP and IDP was the convening of the third FSM Economic Summit from March 28 to April 2, 2004. For the Summit nine sector committees were established.

Climate proofing at the national policy level is one of the major ways to mainstream adaptation. It helps to strengthen the enabling environment for adaptation while also integrating adaptation planning and implementation into existing and new development policies, plans, and actions. Climate proofing both the SDP and the IDP was assisted by the preparation of Adaptation Mainstreaming Guidelines for the FSM. The Project Liaison Committee and other stakeholders advised focusing on sectors known to face risks related to climate variability and change, including extreme events. As a result, the climate proofing activities focused on three sectors: health care, environment, and infrastructure.

In addition to the detailed findings of the case studies, climate proofing the SDP and IDP drew on the results of additional studies showing the impact of climate change on human health and on infrastructure. The task of climate proofing was a cooperative effort involving relevant government officials, the ADB consultants, and other key players who drafted the SDP's infrastructure, health care, and environment sectors.

Following are some examples of the way in which the SDP and IDP provide an enabling environment that fosters climate-proofed development and links with sustainable development:

- Include risk exposure of infrastructure development projects as a criterion to rank projects nationally across sectors and states.
- Require that risk assessments be conducted for new infrastructure projects, including the influence of climate change on risk levels as part of the assessment;
- Strengthen and adapt new building and other relevant regulations and codes of good practice to take climate change into account and ensure that infrastructure is located, built, and maintained in line with codes and practices that ensure full functionality for the projected lifetime.

- Conduct assessments of climate-related health risks, including vector-borne and water-borne diseases, and initiate relevant early warning and public education programs.
- Strengthen surveillance and monitoring functions of the environmental health program (water, hygiene, sanitation, and food safety), including risks related to climate variability and change.
- Document public health risks related to climate variability and change and include these findings in relevant healthcare, education, and public awareness programs.
- Mainstream environmental considerations, including climate change, in economic development.
- Create strategies and plans that address unacceptable risks to the natural environment and built assets, including those arising from natural hazards such as weather and climate extremes, variability, and change.
- Develop and implement integrated environmental and resource management objectives that enhance resilience of coastal and other ecosystems to natural hazards such as those associated with extreme weather events, climate change, high tides, and sea-level rise.
- In all FSM communities, develop and implement risk reduction strategies to address natural hazards such as those related to current weather and climate extremes and variability, while at the same time preparing for anticipated impacts of climate change.
- Identify structures, infrastructure, and ecosystems at risk and explore opportunities to protect critical assets.
- Integrate considerations of climate change and sea-level rise in strategic and operational (e.g., land use) planning for future development, including that related to structures, infrastructure, and social and other services;
- Document low-lying agricultural areas at risk from the effects of natural hazards, including sea-level rise, and implement appropriate land-use planning and other measures.
- Determine impacts of climate change on the tuna industry as a result of such effects as changed migration patterns of Pacific tuna stocks, and implement strategies to minimize impacts on this important industry.

At the Third FSM Economic Summit, held between 28 March and 2 April 2004, the climate-proofed SDP was endorsed by participants. The SDP was subsequently approved by the National Congress. It has now become the primary national economic planning mechanism of the FSM. Implementation of the climate proofing called for in the SDP will be guided by the National Guidelines for Mainstreaming Adaptation to Climate Change (NGMACCs). These Guidelines were approved at the final Tripartite Review Meeting held in the FSM in June 2004.

I. Climate Proofing the Cook Islands National Development Strategy

In late 2003, the Cook Islands began preparing a National Development Strategy (NDS) that would outline the county's broad economic strategy and sector development policies. The first major public consultation to set the stage for formulation of the NDS was the First National Development Forum, held in November 2003. As part of preparations for the Forum, the National Planning Task Force established five interim focus groups, which had oversight of preparing the NDS. The focus groups provided a stocktaking of developments over the past 20 years and identified issues to be addressed in the areas of economic development, education, health care, infrastructure, and law and governance. Environment was seen as a cross-cutting theme to be considered by all focus groups.

Subsequent to the Forum the National Planning Task Force built on the results of the National Development Forum and prepared a draft matrix of seven strategic priority issues:

- good governance and law and order;
- macroeconomic stability and economic development;
- improved quality of education;
- improved quality of healthcare services;
- improved standards of infrastructure and the provision of utilities, including transport services;
- increased agricultural productivity and self-sufficiency and food security; and
- improved development and management of marine resources.

For each strategic priority the matrix included key challenges, key policy objectives, and key actions required.

In subsequent discussions the Task Force acknowledged the need to add environmental quality as a strategic priority objective. With this addition, the draft matrix developed by the Task Force served as the foundation for climate proofing the NDS.

Climate proofing at the national policy level is one of the major ways to mainstream adaptation. It helps to strengthen the enabling environment for adaptation while also integrating adaptation planning and implementation into existing and new development policies, plans, and actions.

Climate proofing at the national policy level was assisted by the preparation of Adaptation Mainstreaming Guidelines for the Cook Islands. In addition to the detailed findings of the case studies, climate proofing the NDS drew on the results of additional studies showing the impact of climate change on human health and infrastructure. The task of climate proofing the NDS was a cooperative effort involving, in the main, members of the Project Liaison Committee and participants in a National Climate Dialogue. The process of climate proofing was organized around the eight strategic priorities listed above. Initial discussions were aided by the use of questions designed to focus the interactions on the climate proofing dimensions of each strategic priority. The initial responses to the questions were used as a basis for preparing a series of key challenges, objectives, and actions that would help enhance the enabling environment and facilitate the climate proofing of future development in the Cook Islands. This draft material was shared with members of the Project Liaison Committee for their review and feedback. The revised material was subsequently presented at a National Climate Dialogue. After discussion and some revisions, the dialogue participants agreed that the key challenges, objectives, and actions should be communicated to the Government, as a practical and tangible contribution to assist with the climate proofing of the NDS.

Examples of the key challenges, objectives and actions prepared as described above are as follows:

- Promote and provide policy advice with respect to adaptation priorities and practices:
  - ➢ institutionalize the Climate Change Country Team (CCCT), and

   - Establish a Technical Working Group reporting to the CCCT.
- Strengthen the maritime surveillance and agriculture ministries.
- Ensure that the Disaster Management Unit is fully operational.
- Strengthen weather observation and information gathering.
- Comply with international agreements and submit a Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC).
- Recognizing the vulnerability of the economy's key economic drivers, including the challenges that climate variability will pose;
   - introduce and strengthen legislation and regulations that facilitate adaptation;
   - improve compliance monitoring and enforcement capabilities of relevant regulatory agencies;
   - enhance agricultural pest control;
   - enhance water resources management on all islands;
   - develop strategies to deal with land erosion, especially on Outer Islands; and
   - promote the integration of polices and plans directed at reducing climate related risks.
- Mainstream climate change issues within the formal and informal education and vocational training curricula;
   - Identify of those responsible for awareness raising, and
   - Ensure that formal education curricula include climate change issues.
- Address the impacts of climate variability and change (including extreme events) on the health and welfare of Cook Islanders:
   - improve the effectiveness of the *tutaka* (annual inspection of local properties by health officials);
   - use technical and scientific tools to map and predict disease outbreaks; and
   - strengthen border control.
- Conduct assessments of climate-related health risks.
- Take steps to ensure that risks to infrastructure are not increased due to climate variability and change:
   - establish computer models and technical expertise to make informed decisions (e.g., use of geographic information systems);

  - revise EIA, regulations, and codes to reflect new information and practices; and
  - provide guidance on how to make current land-use practices (buildings, etc.) more resilient and more sustainable.
- Minimize risks to the sustainability of living marine resources and ecosystems as a result of environmental and related changes, including climate variability and change:
  - establish research programs to improve information sharing;
  - strengthen the monitoring of migratory fish species; and
  - implement policies and plans that reduce adverse impacts and exploit beneficial relationships (e.g., adaptive management of the tuna fishery in light of the impact of ENSO on migratory fish species).
- Minimize the adverse consequences of climate change on the economy, society, and environment:
  - develop simple and easy-to-follow procedures;
  - improve technical expertise and decision-making processes; and
  - Strengthen national institutional arrangements for the effective implementation of climate change policies and plans.
- Reduce the vulnerability of the tourism sector to climate variability and change, including extreme events:
  - identify and prioritize the climate-related risks facing the tourism industry;
  - strengthen disaster management;
  - develop in-house risk management strategies;
  - establish stringent performance standards for tourism; and
  - recognize the adverse impacts of over-water resorts and their high vulnerability to extreme weather and climate events.
- Harmonize responses to climate change with other sustainable development initiatives.
- Formulate a National Energy Sector Policy.
- Decrease the use of imported petroleum fuels through use of conservation, efficiency, renewable energy, and other measures.

Participants in the National Climate Dialogue also endorsed the NGMACCs that had previously been developed in partnership with, and approved by, the Project Liaison Committee. Both the Guidelines and the proposals for climate proofing the NDS were subsequently presented to the Cook Islands Cabinet for its approval and adoption. The Acting Prime Minister had attended the National Climate Dialogue in her capacity as Minister for the Environment.

The Cabinet

- approved adoption and implementation of the NGMACCs, and
- approved the recommendations for climate proofing the National Sustainable Development Strategy that is currently in preparation.

J. Lessons Learned

Many key lessons have been learned and demonstrated. Climate change will manifest itself most often as changes in the frequency and consequences of extreme events and interannual and similar variations, rather than as long-term trends in average conditions. While uncertainties are prevalent in projections of greenhouse gas emissions and of the response of the global climate, as estimated by models, confidence in estimates of future changes in climate-related risks is increasing. This is due to the consistency in model-based projections of changes in the likelihood of extreme events and climate variability, as well as between these projections and the observed changes in these likelihoods over recent decades.

While inconsistent with international conventions, at a practical level adaptation should thus focus on reducing both present and future risks related to climate variability and extremes. In many instances, current levels of climate risk are already high, due to increases in risk over the past few decades. Moreover, adapting to current climate extremes and variability prevents precious financial and other resources from being squandered on disaster recovery and rehabilitation and is an essential step to being able to withstand the pending changes in climate.

A risk-based approach to adaptation is both desirable and practicable. It combines both the likelihood and consequence components of climate-related impacts and can assess risks for both current and anticipated conditions, with the option of examining either specific events or an integration of those events over time. Furthermore, risk assessment and management are common to many sectors, e.g., health, financial, transport, agriculture, energy, and water resources; the familiarity of planners and decision makers with risk management facilitates the mainstreaming of risk-based adaptation. A risk-based approach also facilitates an objective and more quantitative approach, including cost-benefit analyses that result in evaluation of the incremental costs and benefits of adaptation and assist in prioritizing adaptation options. Many players are usually involved in the risk- and cost-benefit-based assessments, but the approach provides a framework that facilitates coordination and cooperation, including the sharing of information that might otherwise be retained by information “gate keepers”.

The risk-based approach can be linked to sustainable development by identifying those risks to future generations that present generations would find unacceptable. The case studies have highlighted the need to ensure that future development does not exacerbate climate-related risks.

Adaptation has many dimensions and must also be viewed as a process. This means a framework and associated methodology are essential. CCAIRR provides an operational framework, as well as relevant methodologies. The success of adaptation is enhanced by CCAIRR’s integrated bottom-up and top-down approach: top-down activities should focus on creating a favorable enabling environment, such as by climate proofing policies, plans, and regulations; bottom-up activities should be founded on meaningful consultation and widespread empowerment of key players. This is a prerequisite to successful adaptation and should be the major emphasis and benefit of adaptation mainstreaming. Decision support tools, such as SimClim, that facilitate comparison of adaptation measures are fundamental to ensuring the effectiveness of adaptation.

K. Barriers to Successful Application of the Risk-based Approach to Adaptation

Most barriers to the successful application of a risk-based approach to adaptation relate to the existence of, and access to, information. The barriers relating to information are somewhat intractable, though again experience in preparing the current case studies provides some grounds for optimism.

Before generalized findings and lessons can be drawn from case studies prepared using a risk-based approach to adaptation, many more examples will need to be developed. It is desirable to have internationally consistent assessment methodologies. International agencies, such as the Intergovernmental Panel on Climate change (IPCC), play major roles in establishing best practices. They would need to formally endorse and encourage a risk-based approach to adaptation before widespread uptake will occur. At present, best practice favors the more traditional assessments of vulnerability and of adaptation options. These have many limitations compared to a risk-based approach.

Until a risk-based approach to adaptation is formally endorsed and encouraged, documentation and training opportunities will also be lacking. While a risk-based approach requires no greater skills and experience than are called for in the traditional assessments, a cadre of in-country expertise will need to be built. While parallel frameworks and methodologies are being advocated, confusion and arguments for maintaining the status quo will occur.

Additional barriers include the need for formal specification of risk-based targets that define future levels of acceptable risk; this requires consultation with, and consensus among, key stakeholders; specification of relationships between magnitude and consequence of risk events of relevance; "rules" that specify future social, economic, and wider environmental changes; and appropriate discount rates to be applied to future costs and benefits (in SimClim, the discount rate is set by the user and can be adjusted without needing to rerun the simulation).

For the current case studies, all these barriers were overcome. Future efforts to develop additional case studies, as well as to support the practical application of adaptation measures, can build on both the methodologies and experience gained in preparing the current case studies. Thus the barriers are unlikely to be as imposing as for the initial work.

L. Implications for Governments

Governments are urged to note and act on the finding that the likelihoods of adverse weather and climate conditions are already high and are projected to increase in the future. Similarly, the consequences of these weather and climate events are also already very severe and are likely to increase markedly as a result of climate change. Most climate-related risks can be reduced in a cost-effective manner. Care should be exercised to ensure that future development does not exacerbate climate-related risks.

Governments should ensure that all regulations (e.g., building code, public health regulations) are also climate proofed as this will allow enforcement of policies and plans that should, themselves, be climate proofed. These actions can be facilitated by developing and implementing NGMACCs.

Governments should ensure that all proposed, new, and upgraded development projects are climate proofed at the design stage. This should be part of good professional practice, with national and state CRPs being used as the basis for climate proofing infrastructure, community, and other development projects. Compliance with this requirement should be assessed as part of enhanced EIA procedures. Governments should also undertake cost-benefit analyses of all major development projects, including determining the incremental costs and benefits. If it is a developing country and the incremental costs are large, the Government should request developed country aid providers and other relevant agencies to fund those incremental costs.

M. Implications for ADB Operations

Climate change poses a threat to poverty reduction, water and energy supply, waste management, wastewater treatment, food security, human health, natural resources, and protection against natural hazards. Development also impacts on climate change.

Linkages between climate change and development are increasingly recognized. Climate change is largely the result of human-induced greenhouse gas emissions that are driven by socioeconomic development patterns characterized by economic growth, technology, population, and governance. These socioeconomic development patterns, in turn, determine vulnerability to climate change and the human capacity for greenhouse gas mitigation and for adaptation to climate change. The impacts of climate change on human and natural systems in turn influence socioeconomic development patterns and, thereby, greenhouse gas emissions.

For ADB to incorporate adaptation to climate change in its operation, it would need that both its internal policies and procedures and the national implementation activities with which it is associated recognize the importance of

- enhancing the enabling environment at a national level consistent with the NGMACCs;
- maximizing the synergies between ADB's sustainable development initiatives (e.g., poverty reduction) and its climate change initiatives; and
- ensuring that all development projects with which it is associated comply with best professional practices, which include climate proofing consistent with the national CRP.

Experience in the Cook Islands and the FSM highlights the importance of the enabling environment for successful adaptation, across all its many dimensions. It also highlights the opportunities to exploit synergies between ADB's sustainable development initiatives and climate change adaptation initiatives. Examples include ADB's technical assistance in preparing national and sector strategic development plans and in strengthening the regulatory environment and environmental management in the Outer Islands of both countries.

Thus, ADB sees the benefits of the very strong and intentional complementarities between the adaptation mainstreaming initiatives being undertaken within ADB and those developed and demonstrated at the country level via the six case studies prepared under TA 6064-REG Climate Change Adaptation Program for the Pacific (Second Phase, Country Level Activities), 2003.

Considering the study findings, ADB is exploring to adjust its procedures in ways that ensure that the design and funding implications associated with climate proofing its infrastructure, community, and other development projects are addressed early in the project cycle. Such initiatives mean that climate proofing will become an integral part of best practice, rather than a later add-on. It would require that the ADB continue to develop methods to identify, early in the project cycle, the incremental costs of this climate proofing, so that these costs can be met from sources other than loans, etc., to the developing country. Such sources could include the GEF and other funding streams. Such moves would allow ADB to set and demonstrate a standard of good practice among development banks and other multilateral lending agencies, with the hope that others will follow.

The GEF has recently operationalized the strategic priority "Piloting an Operational Approach to Adaptation". This, plus three new climate change funds managed by the GEF and other bilateral and multilateral financing initiatives, means that opportunities are increasing for developing countries to access funding that will cover at least the incremental costs of adaptation initiatives.

Three principles were used to guide the specific suggestions as to how ADB might mainstream climate change adaptation in its policies and procedures:

- the additions must be consistent with and add value to existing policies and procedures;
- they must expedite project preparation and implementation rather than add further requirements and work demands on staff; and
- they must not only reflect best practice, but in fact lead it.

At a strategic level, the Climate Risk Profile (CRP) which may form part of the Country Environmental Analysis will help ensure adequate recognition to climate-related risks and that such risks are in turn reflected in the Country Strategy and Program (CSP). Climate risks would feature in the CSP in at least two ways: i) highlighting the need to climate proof projects and other initiatives in ways consistent with the CRP; and ii) identifying projects and other initiatives that could reduce the level of risk and at the same time contribute to sustainable development. The CSP Update would be an ideal instrument for ensuring that the inevitable further understandings regarding climate-related risks, and how they might best be addressed, could be reflected and acted upon without undue delay.

At the operational (i.e., project) level, the CRP would provide guidance to ADB staff who are preparing the Project Preparatory Technical Assistance (PPTA). Specifically, the CRP would be used to ensure that the terms of reference for the technical assistance require that climate risks be reflected in the pre-design work and in the actual project design. Under normal circumstances, best practice would automatically result in this occurring, but experience shows that many professionals are unaware of the need to take into account current, let alone future, climate-related risks. At best, they may be aware of the need, but lack the information and tools to meet such a standard. The CRP meets these needs, aided where necessary by a Project Adaptation Brief—in effect a CRP tailored to a specific project.

If the process works as intended, reflecting climate-related risks in project design will become a standard practice, and any lapses in the quality of the work will be detected in peer reviews of reports presenting the results of an Initial Environmental Assessment and/or an EIA.

Further quality control for the process will come via project performance reports on the effectiveness of the Environmental Management Plan, since this would include contingencies if the measures to address climate-related risks proved inadequate. Another, but similar, level of quality control would occur after project completion, via the Project Performance Audit.

At a higher level, these procedures would need to be recognized and formalized within the ADB's policies.

N. Recommendations

Several recommendations evolved from preparing the case studies, and from associated activities. Many were prepared, reviewed, and endorsed at the concluding Tripartite Review Meetings held in the FSM and Cook Islands.

1. Arising from the Final Cook Islands Tripartite Review Meeting

- Follow up and implement in a timely manner the four Cabinet decisions related to CLIMAP:

  - ➢ NGMACCs—implementation will strengthen the enabling environment for adaptation and integrate adaptation with other development initiatives.
  - ➢ Climate proofing the National Sustainable Development Strategy— implementation will enhance the sustainability of development initiatives, in a cost-effective manner.

   - Developing a plan for excavating gravel and other materials from stream beds in Rarotonga—implementation will reduce current and future risks of flooding from heavy rainfall events.
   - Securing funding and implementing the activities proposed in the Cook Islands National Sustainable Land Development and Resource Management Project—this is a vehicle for applying the risk-based approach to adaptation and extending it to the Outer Islands as well as to the remainder of Rarotonga.

- Assist the Government of the Cook Islands to secure financing to cover at least the incremental costs of climate proofing communities and other assets on the north coast of Rarotonga, and in other vulnerable areas;
- The Ministry of Works will continue to act as the focal point for facilitating implementation of the risk-based approach to adaptation.
- Ensure that the Disaster Management Unit is fully resourced and functional, and harmonize its work with adaptation initiatives in Rarotonga and the Outer Islands.
- Strengthen and institutionalize the Climate Change Country Team of key players and stakeholders and give it oversight of a programmatic approach to climate change responses in the Cook Islands, with emphasis on empowering and delegating responsibilities to communities.
- Ensure that the CLIMAP results are used in the Cook Islands Second National Communication to the UNFCCC.
- Promote the use of the risk-based approach regionally and internationally, in part by including sessions on the CLIMAP case studies in regional and international workshops that are being convened to address climate, development, and related issues.
- Ensure that existing information is accessible to those undertaking future assessments of climate risk and adaptation.
- Make the case study findings widely available, including using them in preparing materials for the media and in other awareness-raising initiatives.

- Coordinate and integrate follow-up to the case studies with initiatives undertaken as part of the Comprehensive Hazard Assessment and Risk Management program [that program is "top down", while CCAIRR is both "bottom up" and "top down"].

- Assess roles and priorities in climate change work, awareness, and action, especially at the community level, including

  - ➢ developing and highlighting viable adaptive responses to climate change impacts— "action, not gloom and doom";
  - ➢ identifying ways for awareness of climate change to initiate action in multiple target groups, including grassroots;
  - ➢ using Cook Islands Maori in consultations and in preparation and delivery of materials, and in the gathering of anecdotal and other information on community examples; and
  - ➢ assessing the effectiveness of consultation, awareness raising, education, and related programs undertaken at the community level (possibly by a research student).
- Incorporate climate change into the NDS and discuss actions at the upcoming National Environment Forum, including assessments of climate-related risks.

- Encourage integration of science and social science at primary school, where appropriate, and promote climate change as a context for learning in science and social science.

- Support the World Wide Fund for Nature initiative in Environmental Education.

- Provide local resources (e.g., funding, teacher training) for the schools to promote climate change.

2. Arising from the Final Federated States of Micronesia Tripartite Review Meeting

- State governments to strengthen existing and pending regulations in ways that reflect projected increases in the climate-related risks.

- National and state governments to adopt the NGMACCs.
- National and state governments to climate proof relevant policies and plans in order to strengthen the enabling environment for adaptation, thereby ensuring that future infrastructure and other development projects are themselves climate proofed.
- ADB to facilitate the climate proofing of all future infrastructure and other development projects in the FSM; the first few projects to be climate proofed should be documented and disseminated as case studies.
- ADB to assist participating countries to secure external funding of the incremental costs of adaptation for the case study projects.
- Since the case studies were developed as part of a regional project, ADB to convene a special regional workshop, or add sessions to already scheduled workshops, to enhance the uptake of the case study findings and methods by other Pacific island countries.
- The final report on the CLIMAP case studies would highlight the management and administrative arrangements that contributed to the successful preparation of the case studies, specifically in the Federated States of Micronesia, and the lessons learned that would facilitate improved implementation of similar ADB activities in the future.

3. Based on the Lessons Learned and Demonstrated and Barriers to Successful Application

Given the results of the case studies, ADB may continue to demonstrate and advocate a risk-based approach to adaptation, both within the region and internationally, since it combines both the likelihood and consequence components of climate-related impacts, and assesses risks for both current and anticipated conditions, with the option of examining either specific events or an integration of those events over time.

Other reasons for advocating a risk-based approach include the familiarity of planners and decision makers with risk management, since risk assessment and management are common to many sectors, including health care, finance, transport, agriculture, energy, and water resources, thus facilitating the mainstreaming of risk-based adaptation. The approach also facilitates an objective and more quantitative approach, including cost-benefit analyses that result in evaluation of the incremental costs and benefits of adaptation and assist in prioritizing adaptation options. The risk-based approach involves many players, but also provides a framework that facilitates coordination and cooperation, including the sharing of information that might otherwise be retained by information "gate keepers."

Significantly, a risk-based approach can be linked to sustainable development by identifying those risks to future generations that present generations would find unacceptable.

Advocacy of the risk-based approach to adaptation could extend to encouraging international agencies, such as the IPCC, to formally endorse and encourage a risk-based approach to adaptation, including provision of documentation and training opportunities to build the needed cadre of in-country expertise.

ADB will also give consideration to developing and disseminating additional case studies, especially in countries that are part of continental land masses, but also for atolls and raised coralline islands in the Pacific Ocean and elsewhere. The preparation of generalized findings and lessons is needed based on new as well as existing case studies that demonstrate a risk-based approach to adaptation.

ADB will ensure that CRPs are prepared when undertaking Country Environmental Analysis for its developing member countries has the opportunity to show leadership with respect to adaptation to climate change by

- helping to enhance enabling environments at the national level, consistent with the NGMACCs;
- maximizing the synergies between ADB's sustainable development initiatives (e.g., poverty reduction) and its climate change initiatives; and
- ensuring that all development projects with which it is associated comply with best professional practices, including climate proofing, in order to reduce to acceptable levels the risks that should be described in national CRPs.

ADB will ensure that CRPs are prepared when undertaking Country Environmental Analysis for its developing member countries, using as examples those already prepared for the Cook Islands and the FSM.

ADB will identify, maximize, and take advantage of the many synergies between its sustainable development initiatives and climate change adaptation initiatives. Examples include ADB's technical assistance in preparing national and sector strategic development plans and in strengthening the regulatory environment and environmental management in the Outer Islands of both the Cook Islands and the FSM.

ADB will consider

- adjusting its procedures to ensure that the design and funding implications associated with climate proofing its infrastructure, community and other development projects are addressed early in the project cycle;
- undertaking further work to develop methods to identify, early in the project cycle, the incremental costs of this climate proofing, allowing these costs to be met from sources other than loans, etc., to the developing country;
- strengthening the Country Environmental Analysis so that it gives adequate recognition to climate-related risks and in turn, having such risks reflected in the CSP Update;
- using the CSP Update as a mechanism to ensure that new understandings regarding climate-related risks, and how they might best be addressed, are reflected and acted upon without undue delay;
- using national CRPs to provide guidance to ADB staff preparing the Project Preparatory Technical Assistance and, thus, ensuring that the terms of reference for the technical assistance include the requirement that climate risks be reflected in both pre-design work and the actual project design; and

The results of the present case studies should be used to highlight the following conclusions:

- It is possible to enhance the sustainability (e.g., lifetime) of projects at risk to climate change by climate proofing such projects at the design stage, noting that this will normally require an investment that is small relative to the additional maintenance and repair costs incurred over the lifetime of the project.

- Many adaptation options qualify as "no regrets" adaptation initiatives, including being cost effective.
- Retroactive climate proofing is likely to be considerably more expensive than that undertaken at the design stage of a project.
- Governments should reflect these findings by ensuring that all projects are climate proofed at the design stage, making this part of good professional practice.
- Governments of developing countries should determine the incremental costs and benefits of all major development projects and request that developed country aid providers and other agencies fund these incremental costs.
- National- and subnational-level regulations should be climate proofed, as this will allow enforcement of policies and plans that should themselves be climate proofed in accordance with NGMACCs.

If a risk-based approach to adaptation is to gain full acceptance, further attention needs to be given to methods that support

- formal specification of risk-based targets that define future levels of acceptable risk;
- determination of the damage costs from flooding due to heavy rainfall and sea surges, in combination;
- specification of relationships between the likelihood and consequence of risk events of relevance, and especially the refinement of stage-damage curves;
- quantifying the social, environmental, and wider economic costs of climate variability and change, including extreme events;
- creation of "rules" that specify future social, economic, and wider environmental changes; and
- selection of appropriate discount rates to be applied to future costs and benefits.