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**MAINSTREAMING CLIMATE CHANGE IN ADB'S OPERATIONS**

**Pacific Regional Department**  
**CLIMATE CHANGE IMPLEMENTATION PLAN**  
**Pacific Islands Region**  
**[2009 – 2015]**

**Part 2: Appendices**

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## Appendix 1: Projected Climate Change, the Impacts and Response Strategies<sup>1</sup>

Many parts of the world are now recognizing the significance of both current and anticipated changes in climate. Island countries in the Pacific are already reporting the serious socio-economic, environmental, physical and cultural consequences of current and recent climate change. In the absence of prompt and substantial reductions in GHG emissions these and new impacts will undoubtedly become even more serious in the future. As a result, international assistance is being mobilized for the Pacific, to support adaptation, mitigation and cross-cutting needs such as capacity building and technology transfer.

The climate of the Pacific Islands Region shows considerable spatial and temporal variability. These patterns are influenced by many contributing factors, including the seasonally varying convergence zones (e.g. the South Pacific Convergence Zone) and ENSO. The latter is the dominant mode of year to year variability. Numerous studies suggest that global warming is likely to accentuate the spatial and temporal variations, including the differences from normal that result from ENSO events. Thus it is anticipated that rainfall amounts will change from by between -2.7% to +25.8% in the northern Pacific and by between -14% to +14.6% in the southern Pacific. Some countries will experience more floods and other countries will have more droughts. Generally, the countries with higher rainfalls will become wetter, while drier countries will experience more droughts. Increases in high sea-level events (e.g. storm surges), rainfall, extreme weather and climate events, air and sea temperatures, water shortages and erosion will cause increasingly significant economic and related problems for all sectors of the island economies and societies.

Climate scientists are projecting that the Pacific region will experience the following changes in the climate:

- Sea-level rise of 0.19 - 0.58 m by 2100, resulting in accelerated coastal erosion and saline intrusion into freshwater sources;
- Surface air temperature increases of 1.0 - 4.17°C in the northern Pacific and 0.99 - 3.11°C in the southern Pacific by 2070, leading to increases in sea surface temperature of 1.0 - 3.0°C;
- Acidification of the ocean through increased absorption of CO<sub>2</sub>, causing pH to drop by an estimated 0.3 - 0.4 units by 2100 and impacting adversely on coral growth rates;
- Rainfall increases or decreases from -2.7% to +25.8% in the northern Pacific, and -14% to +14.6% in the southern Pacific, causing worse floods or droughts; whilst there are relatively large uncertainties in rainfall projections for the Pacific region, much of the systematic change is likely to be associated with increased El Niño-like conditions; the consequences of such changes are more predictable for local areas as they can be based on previous responses to El Niño-like conditions; and
- Tropical cyclones becoming more intense, with increased peak wind speeds and higher mean and peak rainfall.

**Consequences of Sea-Level Rise.** The Intergovernmental Panel on Climate Change (IPCC) has recently highlighted that the survival of PDMCs is at extreme risk from sea-level rise. In the Pacific islands region more than 50% of the population live within 1.5 km of the shore. Moreover, many of the PDMCs are less than a few meters above sea level. Thus an increase of as little as half a meter, along with

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<sup>1</sup> Sources of information are listed at the end of this appendix.

increased storm surges, would completely inundate many critical areas and threaten their populations.

While the rate of sea-level rise will vary from country to country, and even within countries, the uncertainties are generally too large to suggest that responses be based on any value other than the regional projection given above. The one exception is where tectonic movement results in locally emergent or submergent coasts. In general the impacts of sea-level rise differ between low (e.g. atoll) and high (e.g. volcanic) islands. This is especially the case for salt water contamination of both ground water and soils, generally making low islands much more vulnerable. However, in many other respects both low and high islands are equally vulnerable to sea-level rise, due to the concentration of human activity in coastal areas and the difficulty to relocate to the interior of high islands.

Population relocations sparked by high sea levels are already a reality and, with land in limited, and reducing, supply, the issue could quickly reach critical proportions in many countries. The possibility of rising sea levels has already caused many people to consider migrating, either to properties on higher ground, or to other islands or countries. As a result, low-lying nations are at serious risk of spawning an entirely new class of displaced persons, namely 'environmental refugees'. Faced with the foreseeable loss of their habitable areas, many island societies may well struggle to redefine their sense of community and nationhood. This in turn may compound existing political and social stresses already prevalent in the Pacific region.

**Extreme Weather Events.** Recently there have been several well-documented events that show the increase of extreme weather events such as tropical storms/cyclones, droughts, floods and heat waves. These are described and reflected in the risk profiles referenced below. In 2004 Cyclone Heta caused storm waves to rise over the 30 meter cliffs in Niue, leaving one person dead and many others homeless, and causing US\$150 million (2004 figures) in damage. In another example, the Cook Islands experienced five cyclones within a one month period in early 2005, three of which were classified as Category Five. In the decades prior, the Cook Islands could expect a storm of this magnitude approximately every 20 years.

Many of these extreme weather events can be linked to the ENSO pattern. Since the mid 1970s there has been a tendency for more frequent El Niño episodes, without significant intervening La Niña events. Recent modeling studies indicate more El Niño-like conditions as a result of global warming - that is, central and eastern equatorial Pacific sea surface temperatures are projected to warm more than the western equatorial Pacific, with a corresponding mean eastward shift of precipitation as well as in the area of tropic cyclone formation. Anomalously wet areas are likely to become even wetter, while unusually dry areas could become even drier.

**Mean Rainfall.** Changes in rainfall can have wide-ranging and significant impacts, including effects on water supply, agriculture and erosion. The range of projections for precipitation is still large, and in some parts of the region even the direction of change is unclear. Rainfall may become significantly higher or lower in the Pacific region, along with increased frequency, duration and intensity of droughts and floods. During summer, more rainfall is projected, as are more frequent heavier rainfall events. Drought conditions can significantly reduce the soil's ability to cope with a sudden intense rainfall, exacerbating flooding and erosion.

**Impacts to Reefs.** Coral reef ecosystems are vital to all PDMCs, the reason why 2008 was declared the Pacific Year of the Reef. Reefs provide at least one quarter

of the fish catch in most developing countries, and feed over 1 billion people. In the Pacific, their possible destruction or degradation poses a threat to every country. Coral reefs provide one of the biggest attractions to tourists in the Pacific.

Increasing sea surface temperatures and rising sea-level, damage from tropical cyclones, and decreases in growth rates due to the effects of higher carbon dioxide concentrations, are very likely to affect the health of coral reefs and other marine ecosystems which sustain island fisheries. The impacts will be exacerbated by increased turbidity, nutrient loading and chemical pollution as a result of poor management practices in catchments and coastal areas,

**Threats to Human Settlements and Infrastructure.** With the exception of PNG, the majority of human settlements and critical infrastructure in PDMCs are located in coastal areas. Villages, towns, cities, and key infrastructure are mostly located in coastal areas. This includes hospitals, schools, churches, power plants and distribution systems, fuel depots, telecommunication systems, disaster coordination centres, hotels and other tourist infrastructure, airports, wharves and business structures. It is estimated that coastal flooding will potentially affect between 60,000 and 90,000 Pacific Island people by 2050. Therefore, any factors that impact coastal areas, such as extreme weather events, coastal erosion, sea-level rise) would exact a very high human and economic toll.

**Consequences for Human Health.** Diseases that are sensitive to climate change are among the largest global killers. These include water-borne and vector-borne diseases such as cholera, typhoid, malaria and dengue. As the climate changes in the Pacific region, occurrences of all of these diseases are likely to increase, with resultant higher mortality. Rising temperatures and increased humidity create perfect conditions for pathogens to grow and spread, resulting in increased incidence and prevalence of infectious diseases. Food and waterborne diseases will also become more common.

Urban areas can expect more heat waves, the risks from water-borne diseases will rise due to increased flooding, and the areas susceptible to malaria, dengue fever, and other communicable diseases are expected to widen as are injuries and other health impacts from extreme weather events. All of these trends will require adaptation measures.

**Fisheries.** Many climate change issues will affect the productivity and economic viability of fisheries, both in-shore and deep water. Alterations in ocean temperatures and currents due to increased ENSO-like conditions will result in changes to the distribution and abundance of tuna, a significant fishery in the Pacific region. For example, the 1997-98 El Niño event saw a significant westward shift of major tuna stocks. As already noted, a decline in the health of reef ecosystems, damage to coastal infrastructure, erosion, chemical run-off and increased turbidity will also have a detrimental effect on in-shore fisheries. There are likely to be increased costs for fishing at sea, due to safety considerations and loss of days at sea due to increased incidence of bad weather. Aquaculture, a developing industry in the Pacific region, is also likely to face difficulties due to the effects of changing patterns of rainfall - e.g. increased sediment and rainwater flooding of some ponds, and drought affecting others.

**Agriculture and Food/Water Supply.** Extreme weather events, irregular rainfall (and resulting floods/droughts), and saltwater intrusion will all have significant impacts on agriculture and the production of food. This will have follow-on effects on diet (with more reliance on imported, often less healthy, foods) and income for

families relying on agriculture for their livelihoods. Already some farmers have been forced to grow their crops (e.g. taro) in raised tin containers, and some of the smaller islands have lost coconut palms to saline intrusion. These changes also affect the secure supply of potable water. The combination of changes in rainfall patterns and saline intrusion has a large impact in fresh water supplies. Climate change models indicate that these effects will be more significant in the future. For example, a possible 10% reduction in average rainfall by 2050 for Kiribati would lead to a 20% reduction in the size of the freshwater lens on Tarawa Atoll.

**Infrastructure and Human Settlements.** Building codes and other design standards for commercial and residential structures as well as many other infrastructure investments will need to consider climate change impacts, such as increased average temperatures and more frequent and severe storm events. The assumed weather and climate conditions in many project designs will need to be adjusted to take better account of projected changes. For example, some roads along coastal areas will require greater clearance from the shore to take account of sea-level rise and storm surges.

The above summary shows that PDMCs are extremely vulnerable to the consequences of climate change. In addition, PDMCs tend to have a lower capacity to address these consequences. Governments and NGOs are becoming more aware that the effects of climate change are much more than threats to the environment alone. These consequences of climate change are likely to threaten some of the most fundamental needs of society: a safe place to live, access to water, health care (e.g. disease and nutrition), food supplies, and the ability to earn a living. When these needs are threatened, whole economies and societies are at risk.

PIC's priorities and needs in the area of climate change are reflected in international documents such as the Mauritius Strategy. They are also reflected in national communications, the outcomes of the UNFCCC Conferences of the Parties and the outcomes of related international meetings. At the regional level, their priorities and needs have been reiterated for over a decade in relevant documents such as Forum Leaders Communiqués, regional policy frameworks and related action plans together with the strategic plans of the regional intergovernmental and non-governmental organizations. At the national level, PICs are also highlight the necessary action to address climate change in their national sustainable development strategies, which are in turn linked to national budgetary and planning processes. PICs recognize their commitment to sustainable development, including addressing the challenges of climate change, is a national responsibility but realize that this cannot be achieved without development partner support.

The *Pacific Islands Framework for Action on Climate Change 2006-2015* states that for PICs adaptation is the key priority for responding to climate change. Importantly, the emphasis on adaptation acknowledges that adaptation measures undertaken now will greatly increase national and regional capacity to better adapt to future climate change impacts. Adaptation measures based on the principles of risk management are preferred. Where this is not possible the "no regrets" and precautionary approaches focusing on improving the livelihoods of people, including their safety and security, are preferred.

Overall, there is a recognized need to improve climate change governance and institutions in the region, to establish practical working alliances and partnerships with improved coordination and harmonization, and to strengthen the climate change knowledge base in the region. PICs have also highlighted the importance of

developing scientific capacity in the region along with the need to communicate climate change science to stakeholders and climate change officials.

Effective understanding of and responses to climate change at community level can only be fruitfully and effectively realized if stakeholders are adequately educated to understand the values underpinning sustainable development. Importantly, public education and awareness are prerequisites for behavioral change and for gaining support among the general public for actions to implement climate change action for sustainable development. PICs have identified several areas where assistance is required, including development and maintenance of regional expertise for research and development focused on climate change, climate variability and sea-level rise and developing a directory of regional and national organizations and individuals, with a view to building active networks in the implementation of climate change activities, and increase the capacity of regional educational and research institutions;

Table 1 provides examples of specific country-level needs related to mitigation, adaptation and synergies.

**Table 1: Examples of Specific Country-level Needs for Mitigation and Adaptation, including Synergies<sup>2</sup>**

| Country                        | Mitigation  | Adaptation  | Synergies <sup>3</sup>  |
|--------------------------------|---|---|---|
| Cook Islands                   | Reduced greenhouse gas emissions through improved energy efficiency and conservation  | Strengthened resilience of coastal communities and infrastructure; increased capacity to respond  | Strengthened approaches to integrated environmental quality monitoring and assessment   |
| Fiji Islands                   | Improved efficiency of energy consumption in the transport sector; improved awareness of the government and civil society of the benefits of energy efficient transport systems | Increased long-term sustainability of tourism development, including reduced vulnerability of the tourism sector to climate change  | Preservation of island biodiversity   |
| Kiribati                       | Reduced green house gas emissions through use of clean renewable energy   | Upgrading/improvements to causeways and coastal protection  | Encouraging and promoting planting of atoll food crops, including indigenous and introduced food crops and vegetables                                       |
| Marshall Islands               | Promote a coordinated approach to RE financing by donors and financiers   | Increased resiliency and preparedness to natural disasters in an effort to reduce the potential for large-scale economic costs to local communities and the RMI as a whole. | Build capacity for land management and land use schemes for the development of agroforestry.  |
| Federated States of Micronesia | Enhanced carbon sequestering through improved capacities for sustainable forest management, sustainable agriculture and reduced deforestation.                                  | Increased resiliency of basic infrastructure to natural disasters and other climate change related trends.  | Strengthen information management systems on integrated land-use planning and sustainable land management, to support decision making at national and state |

<sup>2</sup> Sources: Preparatory Reports for GEF Pacific Alliance for Sustainability, National Communications, National Adaptation Programs of Action and other sources listed in Appendix 2.

<sup>3</sup> The synergies listed here are actions that deliver both adaptation and mitigation outcomes. They do not necessarily involve the same activities and outcomes as listed separately under adaptation and mitigation.

| Country          | Mitigation   | Adaptation   | Synergies <sup>3</sup>   |
|------------------|--|--|--|
| Nauru            | Reducing emissions from power generation; defining the baseline for mitigation projects; introduction and use of solar thermal energy for water heating and solar photovoltaic energy for lighting | Revision of the Rehabilitation Master Land-use Plan and the National Environmental Action Plan to take account of the possible effects of climate and sea-level change on the proposed activities, and how these might need to be modified to accommodate adaptation       | Reduce amount of waste going to landfills; this will help decrease impacts on natural ecosystems levels.   |
| Papua New Guinea | Widespread application of biomass-based energy systems   | Protect public coastal assets and infrastructure   | Development of an effective enabling environment for mainstreaming environment issues into forest use decision making processes  |
| Palau            | Improved local expertise, experiences, and skills to monitor and analyze RE resources measurements and data; plan, design, monitor and maintain renewable energy installations.                    | Inventory of existing resources to assess vulnerability/resistance and develop mitigation/evacuation strategies for the most vulnerable and protection for the most resilient areas; strengthen capacity of institutions for disaster management preparedness and response | Strengthened institutional mechanisms and capacity for equitable and integrated land use planning and sustainable land management to improve harmonization and implementation at the national, state and local levels. |
| Samoa            | Development of biofuel as alternative to fossil fuel developed; improved design and construction for buildings, to reduce energy use   | Enhanced food security; strengthened resilience of coastal communities; protect coastal wetlands   | Sustainable development of forest resources among rural communities; improved support for rural livelihoods from forest products   |
| Solomon Islands  | Increased reforestation and use of biomass energy  | Construction of engineered and climate proofed wharves to cope with a 60-year storm; integrated coastal management; improved resilience of intra and inter-island transportation   | Better understanding of the state of the environment; sustainable use of natural resources; more informed local communities  |
| Timor-Leste      | Combating land degradation through integrated policies and development of alternative energy sources and improved agricultural practices for forest-reliant poor                                   | Draft climate change related policy and legislation based on outcomes of NAPA  | Build capacity to formulate integrated national legislation on environmental management; capacity building on soil data collection and risk assessment methodology   |
| Tonga            | Improved energy efficiency of existing buildings energy efficiency compliance of new buildings.  | Integrated coastal zone management plan; enhanced coastal protection systems; strengthened legislation to regulate onshore and offshore sand mining  | Economic valuation of Tonga's biodiversity and the associated ecosystem services   |
| Tuvalu           | Solar photovoltaic systems for seven outer   | Increasing resilience of coastal areas and   | Strengthened environmental   |

| Country | Mitigation  | Adaptation  | Synergies <sup>3</sup>  |
|---------|---|---|---|
|         | islands to improve livelihoods of outer island communities and reduce greenhouse gas emissions  | settlements to climate change.  | governance and improved land use planning and resource management, to safeguarding the long-term sustainability of the natural resource base and improve social and economic opportunities for these communities. |
| Vanuatu | Improved energy efficiency through use of renewable sources;; improved energy efficiency of motorized transport; higher levels of non-motorized transport; improved understanding of ethanol as a biofuel | Enhanced early warning systems; improved management of climate health relationships; improved food security; better resilience of coastal communities | Coherent institutional framework and national institutions capable of coordinating response to national and global environmental concerns   |

Many of the consequences of climate change are closely linked. As a result, failing to prevent adverse impacts on a given economic sector can have adverse repercussions for other sectors, and for society at large. For example, water supplies can be affected by both saline intrusion and changes in rainfall patterns, while coastal erosion will be exacerbated by rising sea levels, increased storm surges and persistent changes in wind regimes. Moreover, most changes in climate affect more than one significant economic sector or aspect of human life. For example, changes in rainfall can affect agriculture/food supplies, water supplies, health, biodiversity and erosion. As a result of these interactions, most initiatives to reduce the adverse impacts of climate change have the potential to benefit multiple sectors and many aspects of society.

Through their Initial National Communications to the UNFCCC and other reports, PDMCs have identified common areas of vulnerability: coastal hazards, sea-level rise, coral bleaching, food and water supplies, health and climate-related natural disasters. Some areas of vulnerability were less common: tourism (Cook Islands), cash crops (Fiji - sugar cane), biodiversity (Cook Islands, Samoa, Fiji, PNG), air temperature (Marshall Islands, PNG) and fisheries (PNG, Solomon Islands, Vanuatu). This shows that, while some impacts of climate change will be generally consistent across the Pacific, other consequences will vary from country to country, as well as within country.

In most PDMCs the development outcomes have been less than those hoped for by governments, the people and development partners, underperforming targets set in development plans. Unless concerted efforts are made to reduce its adverse impacts, it is highly likely that climate change will exacerbate this situation. The smallest, most resource-poor PICs, and outer-island groups within many of these countries, have limited development options and marginal viability in the absence of significant external assistance. Regional environmental and socio-economic characteristics already make a substantial contribution to the less than desired rate of development. These factors in turn combine with societal norms that place a high priority on communal sharing of resources because of the safety net this provides. The apparent end result is to substantially reduce incentives for individual entrepreneurship, labor, and wealth accumulation. In addition, the Pacific generally faces a significant shortfall in the capacity required to deal with an increasing diversity and complexity of emerging social, environmental and economic challenges.

PICs have also recognized that because of their limited human, technical and financial resources, they cannot achieve their development goals without the assistance of development partners.

On the other hand, PICs have significant development opportunities. However, many of these are also threatened by climate change. The Pacific's natural endowments include extensive oceanic resources, such as fisheries and untapped seabed minerals; fertile land and favorable climates for agricultural production; attractive sites for tourism development; and some natural resources (such as gold in Fiji and forests in the Solomon Islands). While PICs are often referred to as "small island developing states," they could also be considered as "large ocean developing states." Importantly, widespread subsistence production and the strong social support systems have helped prevent the occurrence of absolute poverty in PICs. The region has acknowledged that integrated natural resource and environment management which promotes sustainable use and management requires policies, strategies and actions that are underpinned by rigorous interdisciplinary analysis together with traditional knowledge. Given the significant effect climate change will have on so many vital sectors of Pacific economies and societies, this integrated management approach must include mainstreaming climate change considerations in national sustainable development policies and planning processes.

At the national level, governmental institutions, private entities and NGOs will need to consider strengthening the integration of climate change into their planning and budgeting at all levels of decision making, as well as coordinating the resulting actions. Addressing climate change in the context of sustainable development necessitates a holistic approach that aims to ensure an improved quality of life over a long-term time frame, rather than focusing on achieving short-term gains. Successful response measures thus require long-term thinking and explicit consideration of climate-related risks at the regional (cross-national), national, sub-national and local levels. They also assume there is capacity for both short- and long-term planning of response strategies need to address both long-term climate change impacts as well as those arising from shorter-term climate variability and extreme events.

Successful responses to climate change at the national level are also reliant on a set of enabling conditions and elements such as: (i) adequate institutional arrangements, including systematic planning capacity in a cooperative institutional setting, with consistent policies and regulatory frameworks; (ii) strong coordination of ongoing activities on a sub-national level, including activities that are driven by NGOs, research institutions, the private sector and by local governments; (iii) scientific and technical capacities to understand the climate problem and its effects at national and sub-national levels, model long-term impacts, and elaborate responses and adaptive strategies to the level of implementation; (iv) enhanced program and project preparation and screening capacities; and (v) citizen awareness and participation activities that prioritize and sustain climate change actions.

Ensuring adequate, predictable and sustainable financial resources for mitigation, adaptation and related capacity building and technology cooperation in the Pacific region is another major challenge. The exact amount of future investment and financial flows that will be needed is as yet unknown, due to uncertainties in characterizing impacts and hence identifying the most appropriate response options. However, it is certain that addressing climate change in the Pacific region will require significant shifts and an overall net increase in regional investment and financial flows. Additional effort will be required to ensure the success of climate change related investments in WPCs in the Pacific. These countries have weak governance, ineffective public administration and rule of law, and civil unrest. Such countries need

encouragement and resources that will enable them to commit to improved governance, ongoing dialogue, use of sound (yet simple) planning tools, and enhanced stakeholder participation. At the same time, their development assistance partners need to pay increased attention to ensuring an effective partnership approach and national ownership, to aid harmonization and alignment, use of an appropriate mix of aid instruments, avoiding activities that undermine national institutional building, the need for longer duration of in-country design missions and interventions, and the importance of building the government apparatus, including good governance.

### **Sources of Information**

#### First National Communications to the UNFCCC

| Country          | Date  |
|------------------|---|
| Cook Islands     | 30 October 1999                               |
| Fiji Islands     | 18 May 2006                                   |
| Kiribati         | 30 October 1999                               |
| Marshall Islands | 24 November 2000                              |
| FSM              | 4 December 1997 + addendum on 30 October 1999 |
| Nauru            | 30 October 1999                               |
| PNG              | 27 February 2002                              |
| Palau            | 18 June 2003                                  |
| Samoa            | 30 October 1999                               |
| Solomon Islands  | 29 September 2004                             |
| Tonga            | 21 July 2005                                  |
| Tuvalu           | 30 October 1999                               |
| Vanuatu          | 30 October 1999                               |

#### National Adaptation Programs of Action

|          |              |
|----------|--------------|
| Kiribati | January 2007 |
| Samoa    | January 2005 |
| Tuvalu   | May 2007     |
| Vanuatu  | July 2007    |

Mimura, N., L. Nurse, R.F. McLean, J. Agard, L. Briguglio, P. Lefale, R. Payet and G. Sem, 2007: Small islands. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 687-716.

Nurse, L., McLean, R.F. and A. Suarex. 1998. Small Island States. In *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. R. Watson, M. Zinyowera and R.H. Moss (eds). Special Report of IPCC Working Group II, Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge. pp 331-354.

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Climate Risk Profiles for Cook Islands, Fiji, FSM, Kiribati, RMI, Samoa, Tuvalu, Palau, Tonga and Vanuatu, prepared by ADB.

Country Risk Profiles for Cook Islands, Fiji, PNG, Samoa, Tonga, Tuvalu and Vanuatu, prepared by the World Bank and SOPAC.

Summary of Pacific Statements to Security Council Debate on Climate Change, 17 April 2007

Input final draft to Pacific paper for the Security Council Debate on Climate Change.

SPREP Factsheet: Pacific Climate Change, Factsheet PF003 (2005, rev 2008).

Secretariat of the Pacific Community, 38th meeting of the committee of representatives of governments and administrators, Noumea 13-16/10/08. Agenda Item 2.3 – Climate Change: Contributions from SPC to Regional and National Adaptation Initiatives

Climate Change Ministerial Briefing Paper. Prepared for the 19th Meeting of the Secretariat of the Pacific Regional Environment Program (SPREP), September 4-12, 2008, Pohnpei, Federated States of Micronesia

## Appendix 2: Glossary<sup>4,5</sup>

### **Acclimatization**

The physiological *adaptation* to climatic variations.

### **Adaptability**

See *adaptive capacity*.

### **Adaptation**

Adjustment in natural or *human systems* in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:

**Anticipatory adaptation** – Adaptation that takes place before impacts of *climate change* are observed. Also referred to as proactive adaptation.

**Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or *welfare* changes in *human systems*. Also referred to as spontaneous adaptation.

**Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

### **Adaptation assessment**

The practice of identifying options to adapt to *climate change* and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency and feasibility.

### **Adaptation benefits**

The avoided damage costs or the accrued benefits following the adoption and implementation of *adaptation* measures.

### **Adaptation costs**

Costs of planning, preparing for, facilitating, and implementing *adaptation* measures, including transition costs.

### **Adaptive capacity (in relation to climate change impacts)**

The ability of a system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

### **Afforestation**

Direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources. See also *reforestation* and *deforestation*. For a discussion of the term *forest* and related terms such as *afforestation*, *reforestation* and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000).

### **Aggregate impacts**

Total *impacts* integrated across sectors and/or regions. The aggregation of impacts requires knowledge of (or assumptions about) the relative importance of impacts in different sectors and regions. Measures of aggregate impacts include, for example, the total number of people affected, or the total economic costs.

### **Albedo**

The fraction of solar radiation reflected by a surface or object, often expressed as a percentage.

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<sup>4</sup> Words in italic indicate that the term is also contained in this glossary.

<sup>5</sup> Based on Parry M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., 2007, Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 1000pp.

**Anthropogenic**

Resulting from or produced by human beings.

**AOGCM**

See *climate model*.

**Aquaculture**

The managed cultivation of aquatic plants or animals such as salmon or shellfish held in captivity for the purpose of harvesting.

**Aquifer**

A stratum of permeable rock that bears water. An unconfined aquifer is recharged directly by local rainfall, rivers and lakes, and the rate of recharge will be influenced by the permeability of the overlying rocks and soils.

**Arid region**

A land region of low rainfall, where 'low' is widely accepted to be <250 mm precipitation per year.

**Atmosphere**

The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen and oxygen, together with trace gases including *carbon dioxide* and *ozone*.

**Attribution**

See *Detection and attribution*

**Baseline/reference**

The baseline (or reference) is the state against which change is measured. It might be a 'current baseline', in which case it represents observable, present-day conditions. It might also be a 'future baseline', which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.

**Biodiversity**

The total diversity of all organisms and *ecosystems* at various spatial scales (from genes to entire *biomes*).

**Biofuel**

A fuel produced from organic matter or combustible oils produced by plants. Examples of biofuel include alcohol, black liquor from the paper-manufacturing process, wood, and soybean oil.

**Biomass**

The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass. The quantity of biomass is expressed as a dry weight or as the energy, carbon or nitrogen content.

**Biome**

Major and distinct regional element of the *biosphere*, typically consisting of several *ecosystems* (e.g., forests, rivers, ponds, swamps) within a region of similar *climate*. Biomes are characterized by typical communities of plants and animals.

**Biosphere**

The part of the Earth system comprising all *ecosystems* and living organisms in the *atmosphere*, on land (terrestrial biosphere), or in the oceans (marine biosphere), including derived dead organic matter, such as litter, soil organic matter, and oceanic detritus.

**Biota**

All living organisms of an area; the flora and fauna considered as a unit.

**Breakwater**

A hard engineering structure built in the sea which, by breaking waves, protects a harbor, anchorage, beach or shore area. A breakwater can be attached to the coast or lie offshore.

**C3 plants**

Plants that produce a three-carbon compound during *photosynthesis*, including most trees and agricultural crops such as rice, wheat, soybeans, potatoes and vegetables.

**C4 plants**

Plants, mainly of tropical origin, that produce a four-carbon compound during *photosynthesis*, including many grasses and the agriculturally important crops maize, sugar cane, millet and sorghum.

**Calcareous organisms**

A large and diverse group of organisms, many marine, that use *calcite* or *aragonite* to form shells or skeletons. See *calcite*, *aragonite* and *ocean acidification*.

**Calcite**

A calcium carbonate (limestone) mineral, used by shell- or skeleton-forming, calcifying organisms such as foraminifera, some macroalgae, lobsters, crabs, sea urchins and starfish. Calcite is less sensitive to *ocean acidification* than *aragonite*, also used by many marine organisms. See also *aragonite* and *ocean acidification*.

**Capacity building**

In the context of *climate change*, capacity building is developing the technical skills and institutional capabilities in developing countries and economies in transition to enable their participation in all aspects of *adaptation* to, *mitigation* of, and research on *climate change*, and in the implementation of the Kyoto Mechanisms, etc.

**Carbon cycle**

The term used to describe the flow of carbon (in various forms, e.g., *carbon dioxide*) through the *atmosphere*, ocean, terrestrial *biosphere* and *lithosphere*.

**Carbon dioxide (CO<sub>2</sub>)**

A naturally occurring gas fixed by *photosynthesis* into organic matter. A by-product of fossil fuel combustion and *biomass* burning, it is also emitted from land-use changes and other industrial processes. It is the principal *anthropogenic greenhouse gas* that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured, thus having a Global Warming Potential of 1.

**Carbon dioxide fertilization**

The stimulation of plant *photosynthesis* due to elevated CO<sub>2</sub> concentrations, leading to either enhanced productivity and/or efficiency of *primary production*. In general, C3 plants show a larger response to elevated CO<sub>2</sub> than C4 plants.

**Carbon sequestration**

The process of increasing the carbon content of a *reservoir/pool* other than the *atmosphere*.

**Catchment**

An area that collects and drains rainwater.

**CDM (Clean Development Mechanism)**

The CDM allows *greenhouse gas* emission reduction projects to take place in countries that have no emission targets under the *United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol*, yet are signatories.

**Climate**

Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the *climate system*. The classical period of time is 30 years, as defined by the World Meteorological Organization (WMO).

**Climate change**

Climate change refers to any change in *climate* over time, whether due to natural variability or as a result of human activity. This usage differs from that in the *United Nations Framework Convention on Climate Change (UNFCCC)*, which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global *atmosphere* and which is in addition to natural climate variability observed over comparable time periods'. See also *climate variability*.

**Climate change commitment**

Due to the thermal inertia of the ocean and slow processes in the *biosphere*, the *cryosphere* and land surfaces, the climate would continue to change even if the atmospheric composition was held fixed at today's values. Past change in atmospheric composition leads to a 'committed' *climate change* which continues for as long as a radiative imbalance persists and until all components of the *climate system* have adjusted to a new state. The further change in temperature after the composition of the *atmosphere* is held constant is referred to as the committed warming or warming commitment. Climate change commitment includes other future changes, for example in the hydrological cycle, in *extreme weather events*, and in *sea-level rise*.

**Climate model**

A numerical representation of the *climate system* based on the physical, chemical, and biological properties of its components, their interactions and *feedback* processes, and accounting for all or some of its known properties. The climate system can be represented by models of varying complexity. Climate models are applied, as a research tool, to study and simulate the climate, but also for operational purposes, including monthly, seasonal, and interannual *climate predictions*.

**Climate prediction**

A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, e.g., at seasonal, interannual or long-term time scales. See also *climate projection* and *climate (change) scenario*.

**Climate projection**

The calculated response of the *climate system* to *emissions* or concentration scenarios of *greenhouse gases* and *aerosols*, or *radiative forcing* scenarios, often based on simulations by *climate models*. Climate projections are distinguished from *climate predictions*, in that the former critically depend on the emissions/concentration/radiative forcing scenario used, and therefore on highly uncertain assumptions of future socio-economic and technological development.

**Climate (change) scenario**

A plausible and often simplified representation of the future *climate*, based on an internally consistent set of climatological relationships and assumptions of *radiative forcing*, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate *scenario* and the current climate.

**Climate sensitivity**

The equilibrium temperature rise that would occur for a doubling of CO<sub>2</sub> concentration above *pre-industrial* levels.

**Climate system**

The climate system is defined by the dynamics and interactions of five major components: *atmosphere*, *hydrosphere*, *cryosphere*, *land surface*, and *biosphere*. Climate system dynamics are driven by both internal and external forcing, such as volcanic eruptions, solar variations, or human-induced modifications to the planetary radiative balance, for instance via *anthropogenic* emissions of *greenhouse gases* and/or land-use changes.

**Climate threshold**

The point at which external forcing of the *climate system*, such as the increasing atmospheric concentration of *greenhouse gases*, triggers a significant climatic or environmental event which is considered unalterable, or recoverable only on very long time-scales, such as widespread bleaching of *corals* or a collapse of oceanic circulation systems.

**Climate variability**

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the *climate* on all temporal and

spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (internal variability), or to variations in natural or *anthropogenic* external forcing (external variability). See also *climate change*.

**CO<sub>2</sub> fertilization**

See *carbon dioxide fertilization*.

**Coastal squeeze**

The squeeze of coastal ecosystems (e.g., salt marshes, mangroves and mud and sand flats) between rising sea levels and naturally or artificially fixed shorelines, including hard engineering defenses.

**Coccolithophores**

Single-celled microscopic *phytoplankton* algae which construct shell-like structures from *calcite* (a form of calcium carbonate). See also *calcite* and *ocean acidification*.

**Committed to extinction**

This term describes a species with dwindling population that is in the process of inescapably becoming extinct in the absence of human intervention. See also *extinction*.

**Control run**

A model run carried out to provide a '*baseline*' for comparison with climate-change experiments. The control run uses constant values for the *radiative forcing* due to *greenhouse gases* and *anthropogenic aerosols* appropriate to *pre-industrial* conditions.

**Coral**

The term 'coral' has several meanings, but is usually the common name for the Order *Scleractinia*, all members of which have hard limestone skeletons, and which are divided into reef-building and non-reef-building, or cold- and warm-water corals.

**Coral bleaching**

The paling in colour which results if a *coral* loses its symbiotic, energy-providing, organisms.

**Coral reefs**

Rock-like limestone (calcium carbonate) structures built by *corals* along ocean coasts (fringing reefs) or on top of shallow, submerged banks or shelves (barrier reefs, atolls), most conspicuous in tropical and sub-tropical oceans.

**Deforestation**

Natural or *anthropogenic* process that converts forest land to non-forest. See *afforestation* and *reforestation*.

**Dengue fever**

An *infectious* viral *disease* spread by mosquitoes, often called breakbone fever because it is characterized by severe pain in the joints and back. Subsequent infections of the virus may lead to dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), which may be fatal.

**Desert**

A region of very low rainfall, where 'very low' is widely accepted to be <100 mm per year.

**Desertification**

Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities.

**Detection and attribution**

Detection of change in a system (natural or human) is the process of demonstrating that the system has changed in some defined statistical sense, without providing a reason for that change.

*Attribution* of such an observed change in a system to *anthropogenic climate change* is usually a two-stage process. First, the observed change in the system must be demonstrated to be associated with an observed regional climate change with a specified degree of *confidence*. Second, a measurable portion of the observed

regional climate change, or the associated observed change in the system, must be attributed to *anthropogenic* climate forcing with a similar degree of confidence. Confidence in such *joint attribution* statements must be lower than the confidence in either of the individual attribution steps alone due to the combination of two separate statistical assessments.

**Discount rate**

The degree to which consumption now is preferred to consumption one year hence, with prices held constant, but average incomes rising in line with *GDP* per capita.

**Disturbance regime**

Frequency, intensity, and types of disturbances, such as fires, insect or pest outbreaks, floods and *droughts*.

**Downscaling**

A method that derives local- to regional-scale (10 to 100 km) information from larger-scale models or data analyses.

**Drought**

The phenomenon that exists when precipitation is significantly below normal recorded levels, causing serious hydrological imbalances that often adversely affect land resources and production systems.

**Dyke**

A human-made wall or embankment along a shore to prevent flooding of low-lying land.

**Ecological community**

A community of plants and animals characterized by a typical assemblage of species and their abundances. See also *ecosystem*.

**Ecological corridor**

A thin strip of vegetation used by wildlife, potentially allowing movement of biotic factors between two areas.

**Ecosystem**

The interactive system formed from all living organisms and their abiotic (physical and chemical) environment within a given area. Ecosystems cover a hierarchy of spatial scales and can comprise the entire globe, *biomes* at the continental scale or small, well-circumscribed systems such as a small pond.

**Ecosystem approach**

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many *ecosystems*. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Priority targets are conservation of *biodiversity* and of the ecosystem structure and functioning, in order to maintain ecosystem services. **Ecosystem services**

Ecological processes or functions having monetary or non-monetary value to individuals or society at large. There are (i) supporting services such as productivity or *biodiversity*

maintenance, (ii) provisioning services such as food, fiber, or fish, (iii) regulating services such as climate regulation or *carbon sequestration*, and (iv) cultural services such as tourism or spiritual and aesthetic appreciation.

**Ecotone**

Transition area between adjacent *ecological communities* (e.g., between forests and grasslands).

**El Niño-Southern Oscillation (ENSO)**

El Niño, in its original sense, is a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. This oceanic event is associated with a fluctuation of the inter-tropical surface pressure pattern and circulation in the Indian and Pacific Oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation. During an El Niño event, the prevailing trade winds weaken and the equatorial countercurrent strengthens, causing warm surface waters in the Indonesian area to flow eastward to overlie the cold waters of the Peru current. This event has great impact on the wind, sea surface temperature, and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world.

The opposite of an El Niño event is called *La Niña*.

**Emissions scenario**

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., *greenhouse gases*, *aerosols*), based on a coherent and internally consistent set of assumptions about driving forces (such as demographic

and socio-economic development, technological change) and their key relationships. In 1992, the IPCC presented a set of emissions scenarios that were used as a basis for the *climate projections* in the Second Assessment Report. These emissions scenarios are referred to as the IS92 scenarios. In the IPCC Special Report on Emissions Scenarios (SRES) (Nakićenović et al., 2000), new emissions scenarios – the so-called SRES scenarios – were published.

**Endemic**

Restricted or peculiar to a locality or region. With regard to human health, endemic can refer to a disease or agent present or usually prevalent in a population or geographical area at all times.

**Ensemble**

A group of parallel model simulations used for *climate projections*. Variation of the results across the ensemble members gives an estimate of *uncertainty*. Ensembles made with the same model but different initial conditions only characterize the uncertainty associated with internal *climate variability*, whereas multi-model ensembles including simulations by several models also include the impact of model differences.

**Erosion**

The process of removal and transport of soil and rock by weathering, mass wasting, and the action of streams, *glaciers*, waves, winds and underground water.

**Eustatic sea-level rise**

See *sea-level rise*.

**Eutrophication**

The process by which a body of water (often shallow) becomes (either naturally or by pollution) rich in dissolved nutrients, with a seasonal deficiency in dissolved oxygen.

**Evaporation**

The transition process from liquid to gaseous state.

**Evapotranspiration**

The combined process of water *evaporation* from the Earth's surface and *transpiration* from vegetation.

**Externalities**

Occur when a change in the production or consumption of one individual or firm affects indirectly the well-being of another individual or firm. Externalities can be positive or negative. The impacts of pollution on *ecosystems*, water courses or air quality represent classic cases of negative externality.

**Extinction**

The global disappearance of an entire species.

**Extirpation**

The disappearance of a species from part of its range; local *extinction*.

**Extreme weather event**

An event that is rare within its statistical reference distribution at a particular place. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10<sup>th</sup> or 90th percentile. By definition, the characteristics of what is called 'extreme weather' may vary from place to place. Extreme weather events may typically include floods and *droughts*.

**Feedback**

An interaction mechanism between processes is called a feedback. When the result of an initial process triggers changes in a second process and that in turn influences the initial one. A positive feedback intensifies the original process, and a negative feedback reduces it.

**Food chain**

The chain of *trophic relationships* formed if several species feed on each other. See *food web* and *trophic level*.

**Food security**

A situation that exists when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life. Food insecurity may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level.

**Food web**

The network of *trophic relationships* within an *ecological community* involving several interconnected *food chains*.

**Forecast**

See *climate prediction* and *climate projection*.

**Forest limit/line**

The upper elevational or latitudinal limit beyond which natural tree regeneration cannot develop into a closed forest stand. It is typically at a lower elevation or more distant from the poles than the *tree line*.

**Freshwater lens**

A lenticular fresh groundwater body that underlies an oceanic island. It is underlain by saline water.

**Functional extinction**

This term defines a species which has lost its capacity to persist and to recover because its populations have declined to below a minimum size. See *committed to extinction*.

**General Circulation Model (GCM)**

See *climate model*.

**Generalist**

A species that can tolerate a wide range of environmental conditions.

**Globalization**

The growing integration and interdependence of countries worldwide through the increasing volume and variety of cross border transactions in goods and services, free international capital flows, and the more rapid and widespread diffusion of technology, information and culture.

**Greenhouse effect**

The process in which the absorption of infrared radiation by the *atmosphere* warms the Earth. In common parlance, the term 'greenhouse effect' may be used to refer either to the natural greenhouse effect, due to naturally occurring *greenhouse gases*, or to the enhanced (*anthropogenic*) greenhouse effect, which results from gases emitted as a result of human activities.

**Greenhouse gas**

Greenhouse gases are those gaseous constituents of the *atmosphere*, both natural and *anthropogenic*, that absorb and emit radiation at specific wavelengths within the

spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the *greenhouse effect*. Water vapor (H<sub>2</sub>O), *carbon dioxide* (CO<sub>2</sub>), *nitrous oxide* (N<sub>2</sub>O), *methane* (CH<sub>4</sub>) and *ozone* (O<sub>3</sub>) are the primary greenhouse gases in the Earth's atmosphere. As well as CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub>, the *Kyoto Protocol* deals with the greenhouse gases *sulfur hexafluoride* (SF<sub>6</sub>), *hydrofluorocarbons* (HFCs) and *perfluorocarbons* (PFCs).

**Gross Domestic Product**

Gross Domestic Product (GDP) is the monetary value of all goods and services produced within a nation.

**Gross National Product**

Gross National Product (GNP) is the monetary value of all goods and services produced in a nation's economy, including income generated abroad by domestic residents, but without income generated by foreigners.

**Gross primary production**

The total carbon fixed by plant through *photosynthesis*.

**Groundwater recharge**

The process by which external water is added to the zone of saturation of an *aquifer*, either directly into a formation or indirectly by way of another formation.

**Groyne**

A low, narrow jetty, usually extending roughly perpendicular to the shoreline, designed to protect the shore from *erosion* by currents, tides or waves, by trapping sand for the purpose of replenishing or making a beach.

**Habitat**

The locality or natural home in which a particular plant, animal, or group of closely associated organisms lives.

**Heat island**

An urban area characterized by ambient temperatures higher than those of the surrounding non-urban area. The cause is a higher absorption of solar energy by materials of the urban fabric such as asphalt.

**Human system**

Any system in which human organizations play a major role. Often, but not always, the term is synonymous with 'society' or 'social system' e.g., agricultural system, political system, technological system, economic system; effectively all are human systems.

**Hydrographic events**

Events that alter the state or current of waters in oceans, rivers or lakes.

**Hydrological systems**

The systems involved in movement, distribution, and quality of water throughout the Earth, including both the hydrologic cycle and water resources.

**(climate change) Impact assessment**

The practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of *climate change* on natural and *human systems*.

**(climate change) Impacts**

The effects of *climate change* on natural and *human systems*. Depending on the consideration of *adaptation*, one can distinguish between potential impacts and residual impacts:

**Potential impacts:** all impacts that may occur given a projected change in climate, without considering adaptation.

**Residual impacts:** the impacts of climate change that would occur after adaptation. See also *aggregate impacts*, *market impacts*, and *non-market impacts*.

**Indigenous peoples**

No internationally accepted definition of indigenous peoples exists. Common characteristics often applied under international law, and by United Nations agencies to distinguish indigenous peoples include: residence within or attachment to geographically distinct traditional *habitats*, ancestral territories, and their natural

resources; maintenance of cultural and social identities, and social, economic, cultural and political institutions separate from mainstream or dominant societies and cultures; descent from population groups present in a given area, most frequently before modern states or territories were created and current borders defined; and self-identification as being part of a distinct indigenous cultural group, and the desire to preserve that cultural identity.

**Industrial revolution**

A period of rapid industrial growth with far-reaching social and economic consequences, beginning in England during the second half of the 18th century and spreading to Europe and later to other countries including the USA. The industrial revolution marks the beginning of a strong increase in combustion of fossil fuels and related emissions of *carbon dioxide*. The term '*pre-industrial*' often refers, somewhat arbitrarily, to the period before 1750.

**Infectious disease**

Any disease caused by microbial agents that can be transmitted from one person to another or from animals to people. This may occur by direct physical contact, by handling of an object that has picked up infective organisms, through a disease carrier, via contaminated water, or by the spread of infected droplets coughed or exhaled into the air.

**Infrastructure**

The basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organization, city or nation.

**Integrated assessment**

An interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines so that all relevant aspects of a complex societal issue can be evaluated and considered for the benefit of decision-making.

**Integrated water resources management (IWRM)**

The prevailing concept for water management which, however, has not been defined unambiguously. IWRM is based on four principles that were formulated by the International Conference on Water and the Environment in Dublin, 1992: (1) fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment; (2) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) women play a central part in the provision, management and safeguarding of water; (4) water has an economic value in all its competing uses and should be recognized as an economic good.

**Invasive species and invasive alien species (IAS)**

A species aggressively expanding its range and population density into a region in which it is not native, often through out competing or otherwise dominating native species.

**Irrigation water-use efficiency**

Irrigation *water-use efficiency* is the amount of *biomass* or seed yield produced per unit irrigation water applied, typically about 1 tonne of dry matter per 100 mm water applied.

**Isohyet**

A line on a map connecting locations that receive the same amount of rainfall.

**Joint attribution**

Involves both *attribution* of observed changes to regional *climate change* and attribution of a measurable portion of either regional climate change or the associated observed changes in the system to *anthropogenic* causes, beyond natural variability. This process involves statistically linking climate-change simulations from *climate models* with the observed responses in the natural or managed system. *Confidence* in joint attribution statements must be lower than the confidence in either of the individual attribution steps alone due to the combination of two separate statistical assessments.

**Keystone species**

A species that has a central servicing role affecting many other organisms and whose demise is likely to result in the loss of a number of species and lead to major changes in ecosystem function.

**Kyoto Protocol**

The Kyoto Protocol was adopted at the Third Session of the Conference of the Parties (COP) to the *UN Framework Convention on Climate Change (UNFCCC)* in 1997 in Kyoto, Japan. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most member countries of the Organisation for Economic Cooperation and Development (OECD) and those with economies in transition) agreed to reduce their *anthropogenic greenhouse gas* emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs, and SF<sub>6</sub>) by at least 5% below 1990 levels in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on 16 February 2005.

**La Niña**

See *El Niño-Southern Oscillation (ENSO)*.

**Landslide**

A mass of material that has slipped downhill by gravity, often assisted by water when the material is saturated; the rapid movement of a mass of soil, rock or debris down a slope.

**Large-scale singularities**

Abrupt and dramatic changes in the state of given systems, in response to gradual changes in driving forces. For example, a gradual increase in atmospheric *greenhouse gas* concentrations may lead to such large-scale singularities as slowdown or collapse

of the *thermohaline circulation* or collapse of the West Antarctic ice sheet. The occurrence, magnitude, and timing of large-scale singularities are difficult to predict.

**Last Glacial Maximum**

The Last Glacial Maximum refers to the time of maximum extent of the ice sheets during the last glaciation, approximately 21,000 years ago.

**Leaching**

The removal of soil elements or applied chemicals by water movement through the soil.

**Littoral zone**

A coastal region; the zone between high and low watermarks.

**Maladaptation**

*Adaptation* that is (or has become) more harmful than helpful.

**Malaria**

*Endemic* or *epidemic* parasitic disease caused by species of the genus *Plasmodium* (Protozoa) and transmitted by mosquitoes of the genus *Anopheles*; produces bouts of high fever and systemic disorders, affects about 300 million and kills approximately 2 million people worldwide every year.

**Market impacts**

*Impacts* that can be quantified in monetary terms, and directly affect *Gross Domestic Product* – e.g., changes in the price of agricultural inputs and/or goods. See also *non-market impacts*.

**Meningitis**

Inflammation of the meninges (part of the covering of the brain), usually caused by bacteria, viruses or fungi.

**Meridional overturning circulation (MOC)**

See *thermohaline circulation (THC)*.

**Microclimate**

Local climate at or near the Earth's surface. See also *climate*.

**Millennium Development Goals (MDGs)**

A list of ten goals, including eradicating extreme poverty and hunger, improving maternal health, and ensuring environmental sustainability, adopted in 2000 by the UN General Assembly, i.e., 191 States, to be reached by 2015. The MDGs commit the international community to an expanded vision of development, and have been commonly accepted as a framework for measuring development progress.

**Mires**

*Peat-accumulating wetlands.* See *bog*.

**Mitigation**

An *anthropogenic* intervention to reduce the anthropogenic forcing of the *climate system*; it includes strategies to reduce *greenhouse gas sources* and emissions and enhancing *greenhouse gas sinks*.

**Mixed layer**

The upper region of the ocean, well mixed by interaction with the overlying *atmosphere*.

**Monsoon**

A monsoon is a tropical and sub-tropical seasonal reversal in both the surface winds and associated precipitation.

**Montane**

The biogeographic zone made up of relatively moist, cool upland slopes below the *sub-alpine* zone that is characterized by the presence of mixed deciduous at lower and coniferous evergreen forests at higher elevations.

**Morbidity**

Rate of occurrence of disease or other health disorders within a population, taking account of the age-specific morbidity rates. Morbidity indicators include chronic disease incidence/prevalence, rates of hospitalization, primary care consultations, disability-days (i.e., days of absence from work), and prevalence of symptoms.

**Morphology**

The form and structure of an organism or land-form, or any of its parts.

**Mortality**

Rate of occurrence of death within a population; calculation of mortality takes account of age-specific death rates, and can thus yield measures of life expectancy and the extent of premature death.

**Net primary production (NPP)**

Net primary production is the *gross primary production* minus autotrophic *respiration*, i.e., the sum of metabolic processes for plant growth and maintenance, over the same area.

**Nitrogen oxides (NO<sub>x</sub>)**

Any of several oxides of nitrogen.

**No regrets policy**

A policy that would generate net social and/or economic benefits irrespective of whether or not *anthropogenic climate change* occurs.

**Non-linearity**

A process is called 'non-linear' when there is no simple proportional relation between cause and effect.

**Non-market impacts**

*Impacts* that affect ecosystems or human *welfare*, but that are not easily expressed in monetary terms, e.g., an increased risk of premature death, or increases in the number of people at risk of hunger. See also *market impacts*.

**Ocean acidification**

Increased concentrations of CO<sub>2</sub> in sea water causing a measurable increase in acidity (i.e., a reduction in ocean pH). This may lead to reduced calcification rates of calcifying organisms such as *corals*, *mollusks*, *algae* and *crustacea*.

**Opportunity costs**

The cost of an economic activity forgone through the choice of another activity.

**Ozone**

The triatomic form of oxygen (O<sub>3</sub>), a gaseous atmospheric constituent. In the *troposphere*, it is created both naturally and by photochemical reactions involving gases resulting from human activities (*photochemical smog*). In high concentrations, tropospheric ozone can be harmful to many living organisms. Tropospheric ozone acts as a *greenhouse gas*. In the *stratosphere*, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O<sub>2</sub>). Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by *climate change*, results in an increased ground-level flux of ultraviolet (UV) B radiation.

**Particulates**

Very small solid exhaust particles emitted during the combustion of fossil and biomass fuels. Particulates may consist of a wide variety of substances. Of greatest concern for health are particulates of less than or equal to 10 nm in diameter, usually designated as PM10.

**Peat**

Peat is formed from dead plants, typically *Sphagnum* mosses, which are only partially decomposed due to the permanent submergence in water and the presence of conserving substances such as humic acids.

**Peatland**

Typically a *wetland* such as a *mire* slowly accumulating *peat*.

**Pelagic community**

The community of organisms living in the open waters of a river, a lake or an ocean (in contrast to *benthic communities* living on or near the bottom of a water body).

**Photochemical smog**

A mix of photochemical oxidant air pollutants produced by the reaction of sunlight with primary air pollutants, especially hydrocarbons.

**Photosynthesis**

The synthesis by plants, *algae* and some bacteria of sugar from sunlight, *carbon dioxide* and water, with oxygen as the waste product. See also *carbon dioxide fertilisation*, *C3 plants* and *C4 plants*.

**Physiographic**

Of, relating to, or employing a description of nature or natural phenomena.

**Phytoplankton**

The plant forms of *plankton*. Phytoplankton are the dominant plants in the sea, and are the basis of the entire marine *food web*. These single-celled organisms are the principal agents of photosynthetic carbon fixation in the ocean. See also *zooplankton*.

**Plankton**

Microscopic aquatic organisms that drift or swim weakly. See also *phytoplankton* and *zooplankton*.

**Population system**

An ecological system (not *ecosystem*) determined by the dynamics of a particular *vigil* species that typically cuts across several *ecological communities* and even entire *biomes*. An example is migratory birds that seasonally inhabit forests as well as grasslands and visit *wetlands* on their migratory routes.

**Potential production**

Estimated crop productivity under non-limiting soil, nutrient and water conditions.

**Pre-industrial**

See *industrial revolution*.

**Primary production**

All forms of production accomplished by plants, also called primary producers. See *GPP*, *NPP*, *NEP* and *NBP*.

**Projection**

The potential evolution of a quality or set of quantities, often computed with the aid of a model. Projections are distinguished from predictions in order to emphasize that projections involve assumptions – concerning, for example, future socio-economic and technological developments, that may or may not be realized – and are therefore subject to substantial *uncertainty*. See also *climate projection* and *climate prediction*.

**Pure rate of time preference**

The degree to which consumption now is preferred to consumption one year later, with prices and incomes held constant, which is one component of the *discount rate*.

**Radiative forcing**

Radiative forcing is the change in the net vertical irradiance (expressed in Watts per square metre; Wm<sup>-2</sup>) at the tropopause due to an internal or external change in the forcing of the *climate system*, such as a change in the concentration of CO<sub>2</sub> or the output of the Sun.

**Rangeland**

Unmanaged grasslands, shrublands, savannas and *tundra*.

**Recalcitrant**

Recalcitrant organic material or recalcitrant carbon stocks resist decomposition.

**Reference scenario**

See *baseline/reference*.

**Reforestation**

Planting of forests on lands that have previously contained forests but that have been converted to some other use. For a discussion of the term *forest* and related terms such as *afforestation*, *reforestation* and *deforestation*, see the IPCC Special Report on Land Use, Land-Use Change, and Forestry (IPCC, 2000).

**Reinsurance**

The transfer of a portion of primary insurance risks to a secondary tier of insurers (reinsurers); essentially 'insurance for insurers'.

**Relative sea-level rise**

See *sea-level rise*.

**Reservoir**

A component of the *climate system*, other than the *atmosphere*, that has the capacity to store, accumulate or release a substance of concern (e.g., carbon or a *greenhouse gas*). Oceans, soils, and forests are examples of carbon reservoirs. The term also means an artificial or natural storage place for water, such as a lake, pond or *aquifer*, from which the water may be withdrawn for such purposes as irrigation or water supply.

**Resilience**

The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.

**Respiration**

The process whereby living organisms convert organic matter to *carbon dioxide*, releasing energy and consuming oxygen.

**Riparian**

Relating to or living or located on the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater.

**River discharge**

Water flow within a river channel, for example expressed in m<sup>3</sup>/s. A synonym for *streamflow*.

**Runoff**

That part of precipitation that does not evaporate and is not *transpired*.

**Salinisation**

The accumulation of salts in soils or groundwater.

**Salt-water intrusion / encroachment**

Displacement of fresh surface water or groundwater by the advance of salt water due to its greater density. This usually occurs in coastal and estuarine areas due to reducing land-based influence (e.g., either from reduced *runoff* and associated *groundwater recharge*, or from excessive water withdrawals from *aquifers*) or increasing marine influence (e.g., *relative sea-level rise*).

**Savanna**

Tropical or sub-tropical grassland or woodland *biomes* with scattered shrubs, individual trees or a very open canopy of trees, all characterized by a dry (arid, semi-arid or semi-humid) *climate*.

**Scenario**

A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from *projections*, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'. See also *climate (change) scenario*, *emissions scenario* and *SRES*.

**Sea-level rise**

An increase in the mean level of the ocean. *Eustatic sea-level rise* is a change in global average sea level brought about by an increase in the volume of the world ocean. *Relative sea-level rise* occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence. In areas subject to rapid land-level uplift, relative sea level can fall.

**Sea wall**

A human-made wall or embankment along a shore to prevent wave *erosion*.

**Semi-arid regions**

Regions of moderately low rainfall, which are not highly productive and are usually classified as *rangelands*. 'Moderately low' is widely accepted as between 100 and 250 mm precipitation per year. See also *arid region*.

**Sensitivity**

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by *climate variability* or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to *sea-level rise*).

**Sequestration**

See *carbon sequestration*.

**Silviculture**

Cultivation, development and care of forests.

**Sink**

Any process, activity, or mechanism that removes a *greenhouse gas*, an *aerosol*, or a precursor of a *greenhouse gas* or *aerosol* from the *atmosphere*.

**Social cost of carbon**

The value of the *climate change impacts* from 1 tonne of carbon emitted today as CO<sub>2</sub>, aggregated over time and discounted back to the present day; sometimes also expressed as value per tonne of *carbon dioxide*.

**Socio-economic scenarios**

Scenarios concerning future conditions in terms of population, *Gross Domestic Product* and other socio-economic factors relevant to understanding the implications of *climate change*. See *SRES*.

**SRES**

The storylines and associated population, *GDP* and *emissions scenarios* associated with the Special Report on Emissions Scenarios (SRES) (Nakićenović et al., 2000), and the resulting *climate change* and *sea-level rise scenarios*. Four families of *socio-economic scenario* (A1, A2, B1 and B2) represent different world futures in two

distinct dimensions: a focus on economic versus environmental concerns, and global versus regional development patterns.

**Stakeholder**

A person or an organization that has a legitimate interest in a project or entity, or would be affected by a particular action or policy.

**Stock**

See *reservoir*.

**Stratosphere**

Highly stratified region of *atmosphere* above the *troposphere* extending from about 10 km (ranging from 9 km in high latitudes to 16 km in the tropics) to about 50 km.

**Streamflow**

Water flow within a river channel, for example, expressed in m<sup>3</sup>/s. A synonym for *river discharge*.

**Sub-alpine**

The biogeographic zone below the *tree line* and above the *montane* zone that is characterised by the presence of coniferous forest and trees.

**Succulent**

Succulent plants, e.g., cactuses, possessing organs that store water, thus facilitating survival during *drought* conditions.

**Surface runoff**

The water that travels over the land surface to the nearest surface stream; *runoff* of a *drainage basin* that has not passed beneath the surface since precipitation.

**Sustainable development**

Development that meets the cultural, social, political and economic needs of the present generation without compromising the ability of future generations to meet their own needs.

**Thermal expansion**

In connection with *sea-level rise*, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level.

**Thermocline**

The region in the world's ocean, typically at a depth of 1 km, where temperature decreases rapidly with depth and which marks the boundary between the surface and the ocean.

**Thermohaline circulation (THC)**

Large-scale, density-driven circulation in the ocean, caused by differences in temperature and salinity. In the North Atlantic, the thermohaline circulation consists of warm surface water flowing northward and cold deepwater flowing southward, resulting in a net poleward transport of heat. The surface water sinks in highly restricted regions located in high latitudes. Also called *meridional overturning circulation (MOC)*.

**Threshold**

The level of magnitude of a system process at which sudden or rapid change occurs. A point or level at which new properties emerge in an ecological, economic or other system, invalidating predictions based on mathematical relationships that apply at lower levels.

**Transpiration**

The evaporation of water vapor from the surfaces of leaves through stomata.

**Tree line**

The upper limit of tree growth in mountains or high latitudes. It is more elevated or more poleward than the *forest line*.

**Trophic level**

The position that an organism occupies in a *food chain*.

**Trophic relationship**

The ecological relationship which results when one species feeds on another.

**Troposphere**

The lowest part of the *atmosphere* from the surface to about 10 km in altitude in mid-latitudes (ranging from 9 km in high latitudes to 16 km in the tropics on average) where clouds and 'weather' phenomena occur. In the troposphere, temperatures generally decrease with height.

**Tsunami**

A large wave produced by a submarine earthquake, *landslide* or volcanic eruption.

**Uncertainty**

An expression of the degree to which a value (e.g., the future state of the *climate system*) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain *projections* of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a range of values calculated by various models) or by qualitative statements (e.g., reflecting the judgement of a team of experts). See also *confidence* and *likelihood*.

**Undernutrition**

The temporary or chronic state resulting from intake of lower than recommended daily dietary energy and/or protein requirements, through either insufficient food intake, poor absorption, and/or poor biological use of nutrients consumed.

**Ungulate**

Ahoofed, typically herbivorous, quadruped mammal (including ruminants, swine, camel, hippopotamus, horse, rhinoceros and elephant).

**United Nations Framework Convention on Climate Change (UNFCCC)**

The Convention was adopted on 9 May 1992, in New York, and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the 'stabilization of *greenhouse gas* concentrations in the *atmosphere* at a level that would prevent dangerous *anthropogenic* interference with the *climate system*'. It contains commitments for all Parties. Under the Convention, Parties included in Annex I aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The Convention entered in force in March 1994. See also *Kyoto Protocol*.

**Upwelling region**

A region of an ocean where cold, typically nutrient-rich waters from the bottom of the ocean surface.

**Urbanization**

The conversion of land from a natural state or managed natural state (such as agriculture) to cities; a process driven by net rural to urban migration through which an increasing percentage of the population in any nation or region come to live in settlements that are defined as 'urban centers'.

**Vagile**

Able to migrate.

**Vascular plants**

Higher plants with vascular, i.e., sap-transporting, tissues.

**Vector**

A blood-sucking organism, such as an insect, that transmits a pathogen from one host to another. See also *vector-borne diseases*.

**Vector-borne diseases**

Disease that are transmitted between hosts by a *vector* organism (such as a mosquito or tick); e.g., *malaria*, *dengue fever* and *leishmaniasis*.

**Vernalisation**

The biological requirements of certain crops, such as winter cereals, which need periods of extreme cold temperatures before emergence and/or during early vegetative stages, in order to flower and produce seeds. By extension, the act or process of hastening the flowering and fruiting of plants by treating seeds, bulbs or

seedlings with cold temperatures, so as to induce a shortening of the vegetative period.

**Vulnerability**

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its adaptive capacity.

**Water consumption**

Amount of extracted water irretrievably lost during its use (by evaporation and goods production). Water consumption is equal to water withdrawal minus return flow.

**Water productivity**

The ratio of crop seed produced per unit water applied. In the case of irrigation, see *irrigation water-use efficiency*. For rainfed crops, water productivity is typically 1 t/100 mm.

**Water stress**

A country is water-stressed if the available freshwater supply relative to water withdrawals acts as an important constraint on development. Withdrawals exceeding 20% of renewable water supply have been used as an indicator of water stress. A crop is water-stressed if soil-available water, and thus actual *evapotranspiration*, is less than potential evapotranspiration demands.

**Water-use efficiency**

Carbon gain in *photosynthesis* per unit water lost in *evapotranspiration*. It can be expressed on a short-term basis as the ratio of photosynthetic carbon gain per unit transpirational water loss, or on a seasonal basis as the ratio of *net primary production* or agricultural yield to the amount of available water.

**Welfare**

An economic term used to describe the state of well-being of humans on an individual or collective basis. The constituents of well-being are commonly considered to include materials to satisfy basic needs, freedom and choice, health, good social relations, and security.

**Wetland**

A transitional, regularly waterlogged area of poorly drained soils, often between an aquatic and a terrestrial *ecosystem*, fed from rain, surface water or groundwater. Wetlands are characterized by a prevalence of vegetation adapted for life in saturated soil conditions.

**Zoonoses**

Diseases and infections which are naturally transmitted between vertebrate animals and people.

**Zooplankton**

The animal forms of *plankton*. They consume *phytoplankton* or other zooplankton.

**Appendix 3:**  
**Current Portfolio of PARD/ADB Adaptation and Mitigation Projects**

**A. Adaptation**

| Project Title  | Country   | Description/Objectives  | Begin & End Date                              | Budget                                     |
|--|---|---|---|--|
| Infrastructure Development Project (Phase 1 &2) Project Number: 40287 Avatiu Port Development  | Cook Islands  | The Project will rehabilitate and expand the capacity of Avatiu port and harbor. The project comprises: (i) widening of the harbor entrance, dredging, reconstruction wharf deck; and (ii) technical assistance for improving the delivery of infrastructure services. The Project will climate proof the wharf by replacing the existing structure, designed the wharf such that it can be raised along with the container yard at some future date. Sheet piling will be used at a depth of 12m, sufficient withstand the wave energy during storm events. The harbour is to be protected by a breakwater, currently being constructed under the Cyclone Emergency Assistance Loan project. It redesign the breakwater from 4m high to 1.5m with the crest width increased to 20m based on the following considerations: (i) to avoid prolonging the retention of water behind the wall during severe storms, (ii) to minimize impedance to receding water during storms, (iii) to reduce the possibility that the higher structure would cause wave build up to the west of the breakwater and give rise to coastal erosion. | 2009-2012                                     | Phase II 2009 US\$15million                |
| TA 6064 Climate Change Adaptation Project for the Pacific                                      | Cook Islands and FSM  | The objective of the TA was to assist Pacific developing member countries (PDMCs) to adapt to climate change and variability. The purpose was to mainstream climate change adaptation through integrated risk reduction, in development planning and management in selected PDMCs and ADB operations. The scope of the TA included (i) a review of completed and ongoing programs on climate variability and risk management, and climate change vulnerability and adaptation; (ii) mainstreaming climate change adaptation into ADB project operations; and (iii) at the country level, undertake mainstreaming of Climate Change Adaptation through Integrated Risk Reduction in two selected PDMCs, FSM and Cook Islands, at national development planning, sector, and project levels.  | 2003-2005                                     | US\$800000                                 |
| Alternative Livelihoods Development Project 2158   | Fiji  | The Project include promoting agricultural diversification and services, and developing effective public-private sector partnerships in commercial agriculture; encouraging people to engage in off-farm livelihoods; and strengthening rural financial services.   | 2005-2008 (the project was cancelled in 2008) | US\$25,000,000 (only US\$505,344 was used) |
| TA4456 - KIR - Outer Island Growth Centres   | Kiribati  | The TA will identify necessary infrastructure and supporting systems for sustainable use of natural resources in Kiribati Island and employment generation. The output of the TA will be a recommendations of priority projects for selected outer island growth centers, and a long-term strategic development plan for Kiribati Island that considers land use planning and zoning for residential, business, and protected areas, tourism, transportation, expanded water/sewer systems and protection of fresh-water lenses, solid waste management, and necessary supporting infrastructure. The ensuing investment project was cancelled  | 2/12/2004 approved                            | US\$800000                                 |
| TA4977 - PAL - Babeldaob Water Supply Project: Palau   | Palau   | The Project Preparatory TA will prepare water supply sector development plan for Babeldaob and Koror State; and preparation of feasibility studies to improve the security of supply of treated water to communities in Babeldaob and Koror, and to enable the expansion of the Koror-Airai water supply network to Aimeliik. The ensuing project will consider climate change adaptation related to sustained availability of raw water.   | 2007-2008                                     | US\$700000                                 |
| Strengthening Disaster Recovery Planning & coordination Solomon Islands                        | Solomon Islands   | The objectives of the TA was to strengthen disaster management, infrastructure planning, and capacity to ensure that infrastructure designs incorporate adaptation and mitigation strategies and are less vulnerable to climate change and potential future disasters. The outcomes will (i) strengthen disaster and emergency management by establishing an effective coordination process across relevant ministries to administer the current and future recovery response operations, and (ii) improve assessment, analysis, and subproject preparation in the affected areas that incorporate climate change adaptation, thereby helping Government develop an effective approach to mitigating the country's vulnerability to adverse weather conditions. [This TA is piggy-backed to Emergency Assistance Project]   | 2007-2009                                     | US\$800000 (Total US\$950,000)             |
| Emergency Assistance Project Solomon Islands   | Solomon Islands   | The goal of the Project is to restore economic and social activities and accessibility in affected areas to pre-disaster levels. The purpose is to assist the Government in rehabilitating damaged infrastructure and make it less vulnerable to climate change and natural hazards. The rehabilitation of damaged infrastructure is expected to restore accessibility in rural areas, allow a resumption of economic activities and social services, and safeguard public health.  | 2007-2009                                     | ADB: US\$ 4,950,000 (Total US\$9,750,000)  |
| Stengthening Coastal and Marine Resources in the Coral Triangle of the Pacific                 | PNG, Solomon Islands, Timor Leste, Vanuatu, Fiji  | It consist of 3 components: (i) Marine Protected/Managed Areas: Policies and institutions, sustainable financing, review of formal and informal marine protected areas networks, pilot activities to demonstrate best practices or fill gaps in existing management systems; (ii) Ridge to Reef Management to Protect Coastal and Marine Ecosystems: Assessment and action to identify and respond to threats from land-based pollution and other causes of stress for coastal and marine resources; (iii) Climate Change Adaptation: Increasing the resilience of fisheries, coastal and marine resource systems and marine protected areas.   | 2009  | ADB: US\$550,000 (Total US\$1,125,000)     |
| REG 41187-01 Regional Partnerships for Climate Change Adaptation and Disaster Preparedness     | Cook Islands, Fiji Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu (final list will depend on country approval of participation) | The TA will strengthen financial resilience of participating Pacific islands to the effects of natural disasters, including those exacerbated by human-induced climate change. The outcome of this TA will be an improved geophysical-information-environment which supports greater resilience to climate impacts/shocks through both government and development partner decision-making regarding hazard exposure and risk minimization, and supportive of the assessment of the feasibility of a regional pooled catastrophe insurance scheme and its subsequent development.  | 2009-2010                                     | ADB: \$1,000,000 (Total: \$1,120,000)      |
| TA6204 - REG - Mainstreaming Environmental Considerations in Economic and Development Planning | FSM, Kiribati, Palau (replacing Cook Islands),PNG, RMI, Samoa, Solomon Islands, and Vanuatu   | The TA have prepared Country Environment Analysis (CEA) that will provide inputs to CSP and CSP updates (presently called Country Partnership Strategy/CPS) for selected PDMCs and countries' medium term development strategy, particularly in addressing eight key environmental challenges, including climate change. The TA's main objective is to mainstream key environmental concerns into economic and development planning processes and to help reduce poverty in PDMCs. The TA will (i) identify priority areas in policy, institutional and legislative mechanisms, and programs/projects that will help to mainstream environmental concerns into economic development planning; and (ii) strengthen the understanding among policymaking, economic planning, and environmental authorities about key environmental and natural resource management issues and their link with macroeconomic and national development goals. The TA has also prepared Climate Risk Profile for selected countries.   | 2005-2008 (Status: Completed)                 | US\$520000                                 |

|  |     |   |             |  |
|--|-----|---|-------------|--|
| Sanitation and Drainage Project, Phase II                | SAM | The TA will prepare project that will improve and rehabilitate existing drainage and rivers to reduce flooding upgrading sanitation through a combination of: a pressure sewerage scheme to service key urban areas, and improved on-site sanitation and sanitation management for other areas of the capital, particularly low-lying flood prone land building capacity within the implementing Agencies.  | 2009-2010   | \$20m ADF Loan                                       |
| Port Vila Urban Development                              | VAN | Road repairs will be carried out in Port Vila and Luganville under the project. Other project components include: structural repairs to the capital's main wharf; development of Luganville's water supply and drainage facilities; improvement of the Erakor causeway bridge and protection of lagoon environment. The specific objectives of the project are to: (i) improve living conditions and public health of people in two main urban centers of Vanuatu; (ii) mitigate adverse effects of urban growth on the environment; and (iii) promote economic growth by enhancing conditions conducive to tourism and trade. Climate change adaptation will be considered in infrastructure development.  | 2010        | \$10.5m ADF Loan                                     |
| Developing a Rural Urban Transport Linkage Road Map      | VAN | Project will identify investment opportunities in rural feeder and provincial roads to complete gaps in network, particularly in areas with tourism and agricultural production potential. No mention of climate proofing the roads in VAN COBP (2009-2011).  | 2011        | \$0.8 Million ADB PPTA                               |
| Support for Decentralization and Deconcentration         | TIM | The overall objective of the Integrated Urban Development Sector Project (IUDSP) is to improve rundown urban infrastructure assets (roads and water/sanitation) identified during the IUDSP consultation process. Seven core subprojects have been selected. All of the subprojects involve minor civil works and are located in urban areas surrounding Nuku'alofa.  | 2011        |  |
| Integrated Urban Development Sector Project Phase II     | TON | The Project will provide an efficient and well-maintained primary road network, all-weather roads to low-income and low-lying residential areas, well-maintained and functional drainage systems, effective trunk drainage systems, and groundwater quality monitoring wells to assess the impacts of septic tanks on Nuku'alofa's aquifers. It will facilitate improved urban planning and management capacity as well as infrastructure maintenance programs. This project will consider climate change adaptation during its construction.   | 2008-2013   | ADB: \$11.3 million (Total: US\$14.20 million)       |
| Regional Advisory Service for Infrastructure Regulation  | REG | The project will undertake: 1. An assessment of the relationship between skills development and economic development, labor market demand and outward migration within the sample countries; 2. Policy options for skill development that governments of the Pacific developing member countries may wish to consider based on an in-depth analysis of issues and alternatives; 3. An integrated, prioritized, and initially costed project design for regional skills development, based on output 4; 4. National-level project proposals encompassing pre-employment training, skills upgrading, adult retraining, and income generation.   | 2009        | \$1 million ADB RETA                                 |
| Road Maintenance & Upgrading (Sector) Project 1709       | PNG | The proposed Investment Program will establish a sustainable road system in the Highlands region that will enable maximum use of its natural, mineral and human resources for the development of the Highlands region and the country. This will contribute to export driven economic growth, fostering rural development and reducing poverty, good governance, and promotion of agriculture, forestry, fisheries and tourism on a sustainable basis. The Investment Program will result in improved accessibility to ports, markets, and livelihood opportunities, and travel time savings. Improved road network will reduce transport costs in the Highlands region. [The Project will incorporate adaptation measures into planning.]  | 2000-2010   | ADB: \$63 million (Total: \$115 million)             |
| Highlands Region Improvement II                          | PNG | The Investment Program will result in improved accessibility to ports, markets, and livelihood opportunities, and travel time savings. Improved transportation infrastructure and services, which would provide reliable access to domestic and international markets for rural produce and commodities, are critical to (i) restarting and building rural economies through access to domestic and international markets, (ii) fostering private sector development and rural income opportunities, (iii) reducing migration of people in search of employment, and (iv) restoring basic social services in rural areas to increase health and educational achievement. [Road drainage design shall consider high rainfall due to climate change (draft RRP 2008). Climate change adaptation will be considered, particularly due to possible higher rainfall that need adaptation of roadside drainage. | 2010-2018   | \$750 million (\$400 ADB, \$200 Gov't; \$150 Others) |
| Rural Transport Infrastructure Project                   | SOL | The project is expected to invest in rural feeder roads and provincial roads to complete gaps in the network, particularly in areas of high agricultural production potential. A piggy-backed TA will be included for Supporting Transport Infrastructure Development, to consolidate the Government's asset management and community contracting reforms. Project will help integrate the rural transport network and improve access for the high proportion of the population that lacks road transport. The Project will consider incorporation of adaptation measures into project design.  | 2009 (PPTA) | ADB Grant US\$14.73 (Total: US\$19.73 million)       |
| Strengthening Road Sector Performance (FRUP IV) 37184-01 | FIJ | The TA will prepare a detailed feasibility study for the proposed sector investment program for FRUP IV for possible ADB funding. The program is intended to upgrade sections of priority national and rural roads totaling approximately 100 km and rehabilitate a similar length of roads on the islands of Viti Levu, Vanua Levu, and Taveuni. The expected results of the investment program will be an improved and expanded, sustainably funded road transport network, managed within an appropriate policy, regulatory and institutional framework, designed to meet the present and future development needs of the Fiji Islands.  | 2009        | \$0.65 million ADB TA                                |

## B. Mitigation

|  |  |  |                         |  |
|--|--|--|-------------------------|--|
| TA4764 - FIJ - Preparing the Renewable Power Sector Project  | FIJ  | The objective of the technical assistance (TA) is to assist the Government of Fiji in the development of a resource-efficient, cost-effective, and environmentally-sustainable power sector to promote broad-based economic growth. The TA will assist the Government and the Fiji Electricity Authority (FEA) in developing a least cost and diversified investment plan to meet electricity demand growth. The TA components and outputs would include support for the development of an optimized and prioritized least cost investment plan to meet forecast electricity demands. The investment plan will, in particular, take into account policies in promoting renewable resources, sustainable and cost-effective generation mix, and the country vulnerability to global macroeconomic shocks and international price fluctuations. The TA will also include explicit work on carbon credits. The project include installing flaring equipment. Biogas is currently being generated from the Kinoya sewage treatment plant. Approximate sludge production is 30-50 cubic meters per day. The methane captured in the existing anaerobic biodigester will be flared.                                | 2007-2008 (PPTA)        | US\$650,000  |
| Kinoya waste water biogas project  | FIJ  | The Project forms part of FEA's renewable investment plan to create a resource efficient, cost effective, and environmentally sustainable power sector through the development of indigenous and renewable energy sources and reduced dependence on diesel fuel imports. [This Project is part of FIJ - Preparing the Renewable Power Sector Project (to be managed separately), it includes installing flaring equipment. The methane captured in the existing anaerobic biodigester will be flared]  | 2009                    |  |
| Western and Central Network Reinforcement and Extension Project FIJ 39521-01                           | FIJ  | The Project forms part of FEA's renewable investment plan to create a resource efficient, cost effective, and environmentally sustainable power sector through the development of indigenous and renewable energy sources and reduced dependence on diesel fuel imports. The Project will strengthen FEA's transmission network to (i) meet growing demand from renewable and clean energy sources, (ii) improve system reliability and quality of supply, (iii) facilitate power transfers from renewable energy resources, (iv) reduce transmission losses, (v) optimize utilization of existing and planned power plants, and (vi) integrate IPP generation into the power system network.  | Suspended               | ADB: \$19.97 million (Total 32.8 million)                |
| ADTA4932 PNG: Power Sector Development Plan  | PNG  | The purpose is to assist the Government to examine issues and options to promote and facilitate the provision of reliable, safe and affordable access to an efficient electrical power supply for PNG. The outputs include identify ways of maximizing renewable energy production and energy efficiency to reduce the overall cost of providing power.  | 2007 - 2009 (20 months) | ADB: US\$500,000 (Total: US\$630,000)                    |
| Power Sector Expansion Project   | SAM  | The Project will improve the capacity of the sector to provide sustainable and reliable electricity services to all consumers at affordable prices. The Project will help EPC to improve the quality, reliability, and cost-effectiveness of power supply by (i) supporting EPC's investment plan to meet growing demand, (ii) improving the operational efficiency of EPC, (iii) improving the financial performance of EPC, (iv) establishing effective regulation of the power sector, (v) developing a demand-side management strategy to promote energy efficiency and conservation, and (vi) developing clean energy resources through the establishment of a clean energy fund (CEF), a clean development mechanism (CDM) subfund, and a designated national authority (DNA).   | 2008 - 2015             | ADB: \$42 million (Total \$100 million)                  |
| TA: Implementing the Samoa National Energy Policy (Piggy-backed to the Power Sector Expansion Project) | SAM  | The TA will: (i) promote development of clean energy resources through the establishment of a clean energy fund (CEF); (ii) enable Samoa to participate in carbon-market trading through the establishment of a designated national authority (DNA); (iii) develop effective regulation of the power sector and promote demand-side management and energy conservation; and (iv) help improve EPC's financial performance. Develop required policy, legal and institutional framework for EE projects to be funded by ADB, GEF & others  | 2008-2015               | ADB: \$1.85 million (Total: \$2.185 million)             |
| PPTA-7121 SAM: Preparing the Afulio Environmental Enhancement Project                                  | SAM  | The outcome of the TA is a project design scope that will enhance the sustainability of the existing Afulio Hydropower Project. The outcome will be achieved through a two-phase approach. The first phase will (i) examine and provide recommendations for addressing the existing environmental and social issues associated with the Afulio Hydropower Project; (ii) assess the safety of the dam structure, including a dam break analysis and registration with the International Committee on Large Dams (ICOLD); (iii) assess existing management practices and recommend options for optimizing hydropower output; and (iv) assess least cost options for augmentation of the capacity of the Afulio Hydropower Project. Following the findings of the first phase, the second phase will focus on due diligence for project processing and preparation for project implementation, including assessment of eligibility for clean development mechanism (CDM) and preparation of CDM project design documents.   | 2010 (PPTA)             | ADB: US\$1.2 million                                     |
| Promoting Energy Efficiency in the Pacific   | REG (Cook Islands, PNG, Samoa, Tonga, and Vanuatu) | The RETA aims to help improve energy security in the participating PICs (Cook Islands, PNG, Samoa, Tonga, and Vanuatu) and develop sound models of energy efficiency policy and project implementation that all the PICs can follow. It will provide direct assistance for the development of the required policy, legal, and institutional framework, and will build a pipeline of energy efficiency assistance projects for funding or co-financing by ADB, GEF, or other sources. Outputs: include (i) assessment of the energy efficiency policy and regulatory framework in the Pacific; (ii) recommended energy efficiency policy and regulatory frameworks with action plan; (iii) recommended best way of promoting and setting up a structured energy management system to sustain energy efficiency initiatives over the long run, including possible energy efficiency services companies; (iv) training needs analysis and training curricula for private and public sector key players in the five PDMCs; (v) pipeline of assistance projects for funding by ADB, GEF, or other relevant financing sources; (vi) a strategy for public awareness and education; and (vii) information exchange. | 2008-2009 (Phase 1)     | ADB: \$1.2 million (Total \$1.7 million)                 |
| Cluster Renewable Energy and Environmental Project in RMI (subproject 2)                               | RMI  | TA will provide assistance to the Government's reforms to improve the efficiency and capacity of infrastructure services and increase access to services in the sectors of power, water and sanitation, and telecommunications. Diagnostic tasks include assessing the potential for using renewable energy service companies [Includes regulatory assistance component for the power sector]  | 2011                    | US\$1.2M JSF   |
| ADTA 4850-FIJ: Improving Infrastructure Services   | FIJ  | TA objective is to promote good governance and a conducive environment for investments and competition in three infrastructure sectors: power, water and sanitation, and telecommunications. It will provide assistance to the Government's reforms to improve the efficiency and capacity of infrastructure services and increase access to services by all consumers. TA has two components. Component A covers the establishment of a multi-sector regulatory commission covering the three infrastructure sectors. Component B covers the development of a strategy for grid and off-grid rural electrification. This will include (i) an analysis of the progress and gaps in rural electrification in the Fiji Islands, and (ii) a capacitybuilding workshop to increase awareness of international best practice arrangements for rural electrification, and (iii) an assessment of options for institutional, financial, and implementation arrangements for rural electrification.  | 2009                    | \$1 million (ADB TA \$0.7 million, Gov't. \$0.3 million) |

## C. Adaptation and Mitigation

|  |  |             |   |
|--|--|-------------|---|
| SAM<br>Electric Power Corporation<br>(EPC) | Outcome: Government and development partners agreed on the recommended project scope. Outputs: include (i) assessment of the impacts of climate change on the dam capacity and safety, (ii) options for optimization and augmentation to increase energy output and capacity, and (iii) assessment of the eligibility of the project for ADB's CDM facility. | 2008 - 2010 | ADB: US\$1,200,000 (Total: US\$1,440,000) |
|--|--|-------------|---|

### Appendix 4: Key Regional and Integrated Multi-country Programs and Projects<sup>6</sup>

| Climate Change Generally, including Mitigation and Adaptation                   |  |                          |   |                      | Adaptation  |  |                       | Mitigation  |                   |
|---|--|--------------------------|---|----------------------|---|--|-----------------------|---|-------------------|
| Governance; Institutions; Main-streaming  | Scientific Information and Capacity; Communication; Coordination; Exchange | International Programmes | Education; Training Awareness                                   | Financial Assistance | National Adaptation Measures                      | Building Adaptive Capacity   | Early Warning Systems | Renewable Energy and Energy Efficiency                                    | Information Bases |
| Pacific Islands Climate Change Assistance Programme                             |  |                          | Training Programme for Meteorology                              |                      | Pacific Adaptation to Climate Change              |  |                       | Pacific Islands Renewable Energy Project                                  |                   |
| Mainstreaming Environmental Considerations in Economic and Development Planning | Pacific Islands Climate Prediction Project                                 |                          | Training Institute on Climate and Extreme Events in the Pacific |                      | Coral Triangle Initiative                         |  |                       | Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project |                   |
| Pacific Regional Meteorological Services  | South Pacific Sea Level and Climate Monitoring Project                     |                          |   |                      | Climate Change Adaptation Project for the Pacific | Capacity Building for the Development of Adaptation Measures in Pacific Island Countries |                       | Promoting Energy Efficiency in the Pacific                                |                   |

<sup>6</sup> The first part of this appendix lists the projects and programs according to the relevant priorities in the *Pacific Islands Framework for Action on Climate Change 2006-2015*. Details of these projects and programs are provided in the second part of the appendix.

| Climate Change Generally, including Mitigation and Adaptation |  |                          |                               |                      | Adaptation   |  |                       | Mitigation  |                   |
|---|--|--------------------------|-------------------------------|----------------------|--|--|-----------------------|---|-------------------|
| Governance; Institutions; Main-streaming                      | Scientific Information and Capacity; Communication; Coordination; Exchange     | International Programmes | Education; Training Awareness | Financial Assistance | National Adaptation Measures   | Building Adaptive Capacity   | Early Warning Systems | Renewable Energy and Energy Efficiency                      | Information Bases |
| Review of Pacific Regional Meteorological Services            | Climate Data Rescue in the Pacific   |                          |                               |                      | Vulnerability and Adaptation Initiative  | Regional Partnerships for Climate Change Adaptation and Disaster Preparedness  |                       | Regional Energy Programme for Poverty Reduction             |                   |
|   | Climate Change and the Southern Hemisphere Tropical Cyclones Project           |                          |                               |                      | Programme for Water Safety Plans in PDMCs  | Building Disaster Response and Preparedness of Caritas Partners in the Pacific |                       | Promotion of Environmentally Sustainable Transport in PDMCs |                   |
|   | Pacific Meteorological Services Needs Assessment Programme                     |                          |                               |                      | National Action Plan Implementation Facility   | The Pacific Community Focussed Integrated Disaster Risk Reduction Project      |                       | Sustainable Energy Financing Project                        |                   |
|   | Pacific RANET  |                          |                               |                      | Development of Sustainable Agriculture in the Pacific  | Impact Assessment Studies in PDMCs   |                       |   |                   |
|   | Resource Book for Policy and Decision Makers, Educators and other Stakeholders |                          |                               |                      | Strengthening Humanitarian Emergency Response Management for Children and Women in the Pacific | Sub-regional Community-based Disaster Management                               |                       |   |                   |
|   | Island Climate Update and Seasonal Cyclone Forecasting                         |                          |                               |                      | Integrated Water Resource Management   | Promoting Climate Change Adaptation in Asia and the                            |                       |   |                   |

| Climate Change Generally, including Mitigation and Adaptation |  |                          |                               |                      | Adaptation   |                            |                       | Mitigation                             |                   |
|---|--|--------------------------|-------------------------------|----------------------|--|----------------------------|-----------------------|--|-------------------|
| Governance; Institutions; Main-streaming                      | Scientific Information and Capacity; Communication; Coordination; Exchange | International Programmes | Education; Training Awareness | Financial Assistance | National Adaptation Measures   | Building Adaptive Capacity | Early Warning Systems | Renewable Energy and Energy Efficiency | Information Bases |
|   |  |                          |                               |                      | Pacific  |                            |                       |  |                   |
|   | Pacific Water Database and Quality Management                              |                          |                               |                      | Pacific Regional Natural Resources and Disaster Management Programme   |                            |                       |  |                   |
|   | Pacific Islands Disaster and Emergency Communications System               |                          |                               |                      | Cities, Seas and Storms: Managing Change in Pacific Island Economies   |                            |                       |  |                   |
|   | Pacific Island Global Climate Observing System                             |                          |                               |                      | Community Relocation as an Option for Adaptation to the Effects of Climate Change and Climate Variability in PDMCs |                            |                       |  |                   |
|   | Pacific Islands Global Ocean Observing System                              |                          |                               |                      | Assessment of Impacts and Adaptation to Climate Change   |                            |                       |  |                   |
|   | Pacific Hydrological Cycle Observing System                                |                          |                               |                      | United States Country Studies Programme  |                            |                       |  |                   |
|   | Historical Reconstruction and Mapping of Pacific Island Coasts             |                          |                               |                      | Ethnographic perspectives on resilience to climate variability in PDMCs  |                            |                       |  |                   |

## Adaptation Projects

1. Capacity Building for the Development of Adaptation Measures in Pacific Island Countries – funded by Canada and executed by SPREP between 2002 and 2005 in 16 communities in the Cook Islands, Fiji, Samoa and Vanuatu; the project was designed to (i) develop a community vulnerability and adaptation assessment and action approach to analyze actual adaptation processes so as to contribute to capacity building as the alternative to using the global and regional climate models; (ii) examine the conditions that give rise to vulnerability based on personal experiences and insights of local residents; and (iii) identify and implement adaptation measures through community participation;
2. Climate Change Adaptation Project for the Pacific (CLIMAP) – implemented by ADB at ADB-level and in Cook Islands and FSM; completed 2005; focused on demonstrating mainstreaming climate adaptation into development and planning in PDMCs and into ADB Pacific Department operations, on a pilot basis;
3. Mainstreaming Environmental Considerations in Economic and Development Planning – implemented since 2005 in FSM, Kiribati, Palau, PNG, RMI, Samoa, Solomon Islands, and Vanuatu; assesses environment-related constraints on, and opportunities for national sustainable development, including those relating to climate change;
4. Regional Partnerships for Climate Change Adaptation and Disaster Preparedness – planned to be implemented by ADB in Cook Islands, Fiji Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu; designed to improve availability of geophysical information that supports greater resilience to climate impacts and shocks through both government and development partner decision-making on hazard exposure and risk minimization; also includes an assessment of the feasibility of a regional pooled catastrophe insurance scheme and its subsequent development;
5. Pacific Islands Climate Prediction Project (PICPP) – funded by AusAID since 2005 and scheduled to close in 2009; implemented in PNG, Solomon Islands, Vanuatu, Kiribati, Tuvalu, Fiji, Tonga, Samoa, Niue, Cook Islands; designed to enhance the capacity of Pacific Island National Meteorological Services to understand and monitor climate variability and climate and generate useful seasonal predictions and disseminate these and other climate information to government and industry;
6. South Pacific Sea Level and Climate Monitoring Project – current phase runs to 2010; implemented in Cook Islands, FSM, Fiji, Kiribati, RMI, Nauru, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu, with funding from AusAID; designed to generate an accurate long-term record of sea level for the South Pacific and to establish methods to make these data readily available and usable by Pacific Island countries;
7. Vulnerability and Adaptation Initiative – funded by AusAID from 2004 through to 2009; implemented in Fiji, Solomon Islands, Samoa, Tonga, Tuvalu and Vanuatu; through small grants programs in Fiji, Solomon Islands, Samoa, Tonga and Vanuatu and a water and sanitation project in Tuvalu the project provides practical adaptation assistance such as increased water storage, improved food security through crop diversification, and coastal stabilisation through replanting of mangroves;
8. The AusAID-funded 'Programme for Water Safety Plans in PDMCs' is implemented by SOPAC and the World Health Organization and runs from 2008 to 2009; it promotes development and implementation of a 'catchment to consumer' risk-management approach to safe drinking water for both urban and rural Pacific communities;
9. National Action Plan Implementation Facility – implemented by SOPAC between 2008 and 2011, in the Cook Islands, Papua New Guinea, Samoa, Solomon Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Tonga and Tuvalu, with funding from AusAID; designed to enhance the sustainable development of Pacific countries through the implementation of measures identified in their National Action

Plans to reduce underlying risks to disasters caused by both natural and human-induced hazards, and to improve preparedness and response to disasters caused by such hazards;

10. CARITAS - Building Disaster Response and Preparedness of Caritas Partners in the Pacific – implemented by SOPAC from 2008 to 2011 in Fiji, Kiribati, Samoa, and Vanuatu, along with a regional component, with funding from AusAID; designed to build stronger organizational systems that incorporate international best practice into local disaster preparedness and response plans, increase technical capacity to enable effective implementation of disaster response and preparedness plans, and build/strengthen networks to ensure effective coordination between stakeholders;
11. Strengthening Humanitarian Emergency Response Management for Children and Women in the Pacific – implemented between 2008 and 2011 by UNICEF with funding from AusAID; designed to strengthen the pre-positioning, management and distribution of humanitarian response supplies (especially health) for children and women, and enhance national and sub-national capacity in emergency management planning, disaster assessment and response monitoring for children and women;
12. The Pacific Community Focused Integrated Disaster Risk Reduction Project – implemented in Fiji, Solomon Islands, Tonga and Vanuatu between 2008 and 2011 by the National Council of Churches in Australia, with funding from AusAID; designed to integrate community-focused disaster risk reduction programs with existing disaster risk reductions institutions and organized by faith-based networks;
13. Development of Sustainable Agriculture in the Pacific – implemented since 2003 in 16 PDMCs with EU funding; the project promotes and implements sustainable agriculture that will improve food production, thereby enhancing food security and income generation in the Pacific;
14. Integrated Water Resource Management – implemented by SOPAC in Cook Islands, FSM, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu, with EU funding; designed to improve the assessment and monitoring of water resources, reducing water pollution, improving access to technologies, strengthening institutional arrangements and leveraging additional financial resources in support of integrated water resources management;
15. Impact Assessment Studies in PDMCs – implemented by SPREP from 1992 to 1996, with funding from Japan; studies were undertaken in Fiji, Samoa, Tonga and Tuvalu; the project was designed to identify the vulnerability and resilience of the coastal natural and socio-economic systems of each country;
16. Sub-regional Community-based Disaster Management – this project is being formulated for Fiji, Tonga, Solomon Islands, and Vanuatu, with funding from Japan; it will support development/improvement of the preparedness for natural disasters (cyclone and flood) at a community level;
17. Promoting Climate Change Adaptation in Asia and the Pacific – with funding from Japan, technical assistance under this project is designed to strengthen adaptation responses in the Asia and Pacific region so that PDMCSs will be more resilient to climate change; the project commenced in 2007, with an expected duration of four years;
18. Pacific Regional Natural Resources and Disaster Management Programme – this project, funded by NZAID, will strengthen the capacity and capability of Pacific Island governments and communities to sustainably manage natural resources, prepare for and respond to natural disasters, and prepare for long term environmental changes; the project strategy was recently released for comment;
19. Support to GEF Pacific Small Grants Programme – funded by NZAID, this assistance includes climate change as a focal area;

20. Programme-level support – NZAID provided program level support to SOPAC, SPREP and SPC; activities include those related to climate change, disaster risk reduction and disaster management;
21. Water Quality Demand and Water Quality Management Initiatives – under this project NZAID provides project-level support to SOPAC for regional activities;
22. Emergency Management Support to the Pacific – NZAID provides funding through the NZ Ministry of Civil Defense and Emergency Management, the UN Office of the Coordination for Humanitarian Affairs and SOPAC;
23. Support to the UN Office of Coordination for Humanitarian Affairs (Pacific Office) – funding is provided by NZAID;
24. Cities, Seas and Storms: Managing Change in Pacific Island Economies – implemented by the World Bank between 1999 and 2000 in all PDMCSs, with a special focus on Fiji and Kiribati; the project was designed to quantifying the likely economic cost of doing nothing, by highlighting the exorbitant costs of protecting land, ecosystems, people and infrastructure under worst case scenarios, and by identifying the co-benefits and cost effectiveness of a proactive, “no regrets” approach to adaptation that favors only those measures for which benefits exceed costs, even in the absence of climate change;
25. Community Relocation as an Option for Adaptation to the Effects of Climate Change and Climate Variability in PDMCs - implemented between 2005 and 2006 in 14 PDMCs with funding from NZ and the United States via the Asia-Pacific Network for Global Change Research; the initiative was to support collaborative research between researcher in developed and developing countries;
26. Assessment of Impacts and Adaptation to Climate Change – implemented between 2004 and 2006 by UNEP and executed by START and TWAS, with funding from GEF and sub-projects in Fiji and the Cook Islands; the project was designed to: (i) enhance scientific understanding of climate change, physical and social vulnerabilities and adaptation options in developing countries; (ii) enhance the scientific capacity of developing countries to assess climate change vulnerability and adaptation; and (iii) generate and communicate information useful for adaptation planning and action.

### **Mitigation Projects**

27. Promoting Energy Efficiency in the Pacific – implemented by ADB, and designed to assist the Cook Islands, Samoa, Tonga and Vanuatu to develop the required policy, legal and institutional framework for energy efficiency projects to be funded by ADB, GEF and others;
28. Regional Energy Programme for Poverty Reduction – an almost completed three year project involving ten PDMCs and implemented by UNDP; ; includes interventions in three thematic areas of priority: improving access to energy services; promoting efficient use of energy; and increasing access to financing for sustainable energy;
29. Promotion of Environmentally Sustainable Transport in PDMCs (PESTRAN): To be implemented by UNDP in Fiji, Samoa, Vanuatu, but Project Information Form (PIF) prepared under a PDF A, and submitted under GEF-PAS, did not receive endorsement/commitment from two pilot countries;
30. Sustainable Energy Financing Project – a World Bank project implemented between 2007 and 2017 aims to significantly increase the adoption and use of renewable energy technologies in Fiji, Papua New Guinea, the Republic of the Marshall Islands, Solomon Islands and Vanuatu by trialing a package of incentives to encourage local financial institutions to participate in sustainable energy finance in support of equipment purchase;

## Other Projects

31. AusAID has an MoU with SOPAC covering the period 2006-08, to support three of SOPAC's technical programs: Ocean and Islands, Community Lifelines and Community Risk;
32. Similarly, AusAID has an MoU with SPREP covering the period 2006-08, to support SPREP's member endorsed strategic programs;
33. Climate Data Rescue in the Pacific – with AusAID funding, Kiribati, Vanuatu, Solomon Islands, Fiji, Papua-New Guinea are being assisted to develop an inventory of digitized and un-digitized climate records, to recommend action for the preservation of the records, and where appropriate, to enact immediate action to secure important paper climate records at risk of loss; since then similar activities have also been undertaken in the Cook Islands, Niue, Tonga and Tuvalu to also ensure that their climate data is secure, accessible, and in a form capable of being utilized in the mitigation of the adverse impacts of climate change and variability;
34. Climate Change and the Southern Hemisphere Tropical Cyclones Project – funded by Australian Department of Climate Change and implemented in all PDMCs during 2007 and 2008; project is designed to conduct further analysis of the climatology of tropical cyclone variability and to develop a tropical cyclone forecasting scheme, linking with activities in PI-CPP;
35. Pacific Meteorological Services Needs Assessment Programme – implemented in 2000 and 2001, with AusAID funding; the project was designed to identify the assistance required by the Meteorological Services of 20 PDMCs, including needs for capacity building to meet growing public demand for the provision of improved weather and climate services and products;
36. Pacific RANET – a multi-donor funded feasibility project for all PDMCs, conducted in 2004 and 2005; the planned project was to increase the accessibility of weather, climate and hydro-meteorological related information through the use of radio, including information to assist remote and resource poor populations for their day-to-day resource decisions and preparations related to natural hazards;
37. Resource Book for Policy and Decision Makers, Educators and other Stakeholders – the book "Climate Variability and Change and Sea- Level Rise in the Pacific Islands Region", co-authored by several Pacific and Japanese experts, was published in 2005 by SPREP, funded by Japan; the book was designed to provide knowledge regarding climate change and sea level rise, identify awareness gap among local people, clarify the needs for measures to overcome issues arising from climate change, and enhance international understanding and international cooperation to deal with climate change issues in PDMCs;
38. Training Programme for Meteorology – this course, funded by Japan, is designed for meteorology staff in Pacific Countries; around 10 participants are trained each year; in 2006 the course focused on Automatic Weather Station Network while in 2007 is focused on Operational Forecasting;
39. Island Climate Update and Seasonal Cyclone Forecasting – this project is funded by NZAID and implemented by NIWA and SOPAC;
40. Pacific Regional Meteorological Services – NZAID has committed funding for 2008-09;
41. Pacific Water Database and Quality Management – this project is funded by NZAID and implemented by the NZ Ministry of Health;
42. Pacific Islands Disaster and Emergency Communications System (PITA) – this project is funded by NZAID;
43. Pacific Island Global Climate Observing System (PI-GCOS) – project implemented by SPREP in 14 PDMCs, starting in 2004; designed to establish a robust and sustainable Pacific Islands climate observing system that meets long-term climate observation

needs in the region and the world, in line with the PI-GCOS Action Plan and the PI-GCOS Implementation Plan;

- 44. Pacific Islands Global Ocean Observing System (PI-GOOS); implemented from 1998 by SOPAC in 14 PDMCs; designed to assist development of an online catalogue of marine environmental datasets and to disseminate oceanographic and marine data as useful information in response to the needs of governments, scientific research institutions and the public, so as to address marine issues;
- 45. Pacific Hydrological Cycle Observing System (Pacific HYCOS) – coordinated through SOPAC, with the involvement of NIWA; funded by the EU; operations since 2006; coordinated through SOPAC Community lifeline program, with involvement of NIWA; the project is designed to collect, archive, and analyse information necessary for water resource management, with equipment and technical support and to build capacity for water resources assessment and monitoring through training;
- 46. Review of Pacific Regional Meteorological Services – NZAID funded the review in 2008-09;
- 47. United States Country Studies Programme – implemented in Fiji, FSM, Kiribati, Marshall Is and Samoa, by SPREP during 1992 to 1997, with funding from the United States; the studies were undertaken as part of United States' global initiative to contribute to the objectives of the UNFCCC by providing financial and technical assistance to assess the coastal vulnerability to sea-level rise and climate change in developing countries;
- 48. Training Institute on Climate and Extreme Events in the Pacific – implemented between 2003 and 2006 in 14 PDMCs with funding from the Asia-Pacific Network for Global Change Research; the training was designed to enhance the regional network of scientists, forecasters, disaster management officials and resource managers skilled in the development and use of climate information to increase the resilience of PDMCs in the face of climate-related extreme events;
- 49. Historical Reconstruction and Mapping of Pacific Island Coasts – implemented between 2008 and 2009 in 14 PDMCs with funding from Japan via the Asia-Pacific Network for Global Change Research; the initiative was to support collaborative research between researcher in developed and developing countries; and
- 50. Ethnographic perspectives on resilience to climate variability in PDMCs – implemented in 2001 in 14 PDMCs with funding from the Asia-Pacific Network for Global Change Research; the initiative was to support collaborative research between researcher in developed and developing countries.

### **Overview of Regional Climate and Related Initiatives in the Pacific**

The *Pacific Islands Framework for Action on Climate Change* (2006-2015) was endorsed by Pacific leaders at the 36<sup>th</sup> Pacific Islands Forum held in 2005. They recognized the importance of Pacific island countries and territories taking action to address climate change through their national development strategies, or their equivalent, which are linked to national budgetary and planning processes. The Framework builds on *The Pacific Islands Framework for Action on Climate Change, Climate Variability and Sea Level Rise 2000-2004*. The seriousness of the threat of climate change to sustainable development was agreed to generally by Small Island Developing States together with the international community in the *Mauritius Strategy for the Further Implementation of the Barbados Programme of Action for Sustainable Development of Small Island Developing States*. The 2006-2015 timeframe of the Framework is consistent with the timeframes of the *Millennium Declaration, the Johannesburg Plan of Implementation* and the subsequent work of the UN Commission on Sustainable Development.

In 2005 a Pacific Islands Climate Change Roundtable meeting was convened to review the Framework. One outcome was a proposal to develop an action plan for implementation of the Framework. The *Action Plan for the Implementation of the Framework for Action on Climate Change* was subsequently prepared. In the plan national activities are complemented by regional programming. The plan also provides an indicative menu of options for action on climate change. In order to ensure appropriate coordination of activities under the Framework, the PCCR was reconstituted, with SPREP being called upon to convene regular meetings of the PCCR inclusive of all regional and international organizations, as well as civil society organizations, with active programs on climate change in the Pacific region. This is a timely and appropriate development. It goes some way to addressing the identified need for improved donor coordination and harmonization of efforts.

The *Pacific Islands Disaster Risk Reduction and Disaster Management Framework for Action (2005 – 2015)* reflects the increased national and regional commitment to disaster risk reduction and disaster management on an 'all hazards' basis and in support of sustainable development. These commitments derive from the Pacific Forum Leaders decision in Madang 1995 and the Auckland Declaration in 2004. The Framework contributes to the implementation of the Mauritius Strategy and the global Hyogo Framework for Action on Disaster Risk Reduction and Disaster Management.

The two regional frameworks complement each other as well as several other regional frameworks and policies, including those related to energy, oceans, freshwater, HIV/AIDS and agriculture. A recent timely development is the increasing, though still inadequate, attention being given at policy and project levels to harmonizing and coordinating regional responses to climate change adaptation and disaster preparedness. Given the evidence that shows that global warming is, and will likely continue to increase the frequency and intensity of severe weather events, disaster risk reduction strategies must be fully integrated with adaptation to climate change. Both are at the heart of effective poverty reduction and development agendas. They cannot be dealt with in isolation and must be integrated into development and poverty reduction instruments across agriculture, energy, health, water resources, urban development, forestry and environment sectors.

In the Pacific the International Federation of Red Cross Red Crescent addresses the needs identified by the national societies operating and supported by a regional office. The needs can be categorized as vulnerabilities to shocks (disaster and health emergencies) and to chronic problems, most notably non-communicable diseases. The people most at risk are those with poor access to land and/or livelihood opportunities, usually living in or near risky environments; these people are the target beneficiaries of the national societies. The tool of choice for the Red Cross Red Crescent Movement in determining action is the vulnerability and capacity assessment tool. This is being increasingly used as a means to determine what are appropriate interventions with and for communities. The program of activities also reflects the knowledge gained during recent years about which programs or projects have made a difference to people's lives - what has worked and what has not. In disaster management, programs are therefore aimed at preparedness and response – with a particular focus on risk reduction – exacerbated due to climate change.

SOPAC hosts the Pacific Integrated Water Resources Management Center. It is now recognized as the Asia-Pacific Water Forum's water knowledge hub for the Pacific. Since 2002 ADB and SOPAC have worked together to implement the regional cooperation plan. ADB should continue this collaboration on water-related work, including preparing climate change projections for water resources, impact assessments and adaptation work.

The Council of Regional Organizations in the Pacific (CROP) Energy Working Group has developed the *Pacific Islands Energy Policy and Plan* (PIEPP) to help coordinate energy programs of regional organizations and development partners. PEPP provides value as a common framework for energy sector development in the region, but it is not intended to be a vehicle specifically for project identification and implementation. This is a significant gap that is addressed only in part by the recent and current regional renewable energy projects (see below).

The PIEPP recognizes that energy has a vital role in achieving sustainable development in the Pacific region. It is a fundamental input to most economic and social activity and a prerequisite for development in other sectors such as education, health, and communications. Responding to energy issues within the context of sustainable development involves many complex and interdependent factors addressed by this policy statement. Partnership-based, cooperative approaches are key to the successful implementation of all mitigation activities. For example, PDMCs often require access to new or improved technologies. Regional co-operation in energy policy and planning can help to overcome the disadvantages faced by the region, particularly in relation to its small size, dispersed communities, fragmented markets, environmental vulnerability, and limited institutional and human capacity. A regional co-operative approach to co-ordination allows countries to share expertise, take advantage of economies of scale, harmonize policies and regulations, and mobilize increased official development assistance from international sources. Such technology transfer and uptake will be facilitated by collaborative programs between developed countries and PICs, and including the involvement of such key players as the private sector, government, investors and donors. Internationally agreed emissions reduction mechanisms, such as the Clean Development Mechanism, are of relevance to Pacific Island Countries even though their emissions are small on a global basis. Such mechanisms are designed to support sustainable development as well as the specifics of mitigating climate change.

As the first regional project related to climate change, the Pacific Islands Climate Change Assistance Programme (PICCAP) (1997-2001), was designed to assist ten PICs to meet their national reporting requirements (e.g. national GHG emissions inventories) under the UNFCCC. It was funded by the GEF, implemented by UNDP and executed by SPREP. Important outputs of this project included: (i) preliminary GHG emissions baseline, (ii) policy recommendations for GHG mitigation, and (iii) identification of 16 follow-on projects, including three mitigation projects and 13 adaptation and environmental management projects. A new regional project, Pacific Adaptation to Climate Change (PACC), will soon be implemented by UNDP in 13 PICs, with execution by SPREP and \$13.125 million of adaptation funding from GEF, under its Pacific Alliance for Sustainability (see below). The project is designed to enhance the resilience of the key development sectors in the PICs, such as food production and food security, water resources management, coastal zone and infrastructure, with the implementation of long-term planned adaptation response measures, strategies and policies.

The Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP) is implemented by UNDP with funding from GEF. GEF also funded a preparatory initiative, the Pacific Islands Renewable Energy Project (PIREP). The PIREP was completed in 2006 and the implementation of the PIGGAREP commenced in 2007. The global environment and development goal of PIGGAREP is the reduction of the growth rate of GHG emissions from fossil fuel use in the PICs through the removal of the barriers to the widespread and cost effective use of feasible RE technologies. The specific objective of the project is the promotion of the productive use of RE to reduce GHG emission by removing

the major barriers to the widespread and cost-effective use of commercially viable RE technologies. Successful implementation of the PIGGAREP is estimated to reduce CO<sub>2</sub> emissions by at least 30% by 2015, as compared to a business as usual scenario.

Another related regional project is the Pacific Islands Energy Policies and Strategic Action Planning (PIEPSAP) Project, funded by the Danish Government which ran from 2004-2008. The aim of this project was to assist PDMCs to develop practical national energy policies and strategic action plans to implement these policies. Under the project clean energy technologies were promoted as well as increased access to investment for financing sustainable energy. A number of countries including Fiji, FSM, Samoa, Tonga, Tuvalu and PNG were assisted in developing policies on renewable energy as part of assistance with national energy policy development.

The Coral Triangle Initiative (TA 42703, approved in 2008) is a 2-stage program of TA and investments which builds on the experience of the CLIMAP TA noted above. Stage 1 will design a 4-year project to ensure conservation and sustainable management of coral reef ecosystems, and coastal and marine biological resources. The second stage investments will include adaptation measures for integrated watershed and coastal management, including marine protected areas.

ADB is providing technical assistance (TA 42078, approved in 2008) to Cook Islands, PNG, Samoa, Tonga, and Vanuatu in order to develop sound models of energy efficiency policy and project implementation that all the PDMCs can follow. The TA provides direct assistance for the development of the required policy, legal, and institutional framework, and builds a pipeline of energy efficiency assistance projects for funding or co-financing by ADB, GEF, or other sources. Outputs include: (i) assessment of the energy efficiency policy and regulatory framework in the Pacific; (ii) recommended energy efficiency policy and regulatory frameworks with action plan; (iii) recommended best way of promoting and setting up a structured energy management system to sustain energy efficiency initiatives over the long run, including possible energy efficiency services companies; (iv) training needs analysis and training curricula for private and public sector key players in the five PDMCs; (v) pipeline of assistance projects for funding by ADB, GEF, or other relevant financing sources; (vi) a strategy for public awareness and education; and (vii) information exchange.

**List of Projects included in Global Environment Facility Pacific Alliance for Sustainability (GPAS)**

| Project Title   | Participating Pacific Island Countries  |
|---|---|
| Pacific Adaptation to Climate Change Project (PACC)   | Cook Islands, FSM, Fiji, RMI, Nauru, Niue, Palau, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu                  |
| The Micronesia Challenge : Sustainable Finance Systems for Island Protected Area Management | FSM, Palau, RMI   |
| Coastal and Marine Resources Management in the Coral Triangle of the Pacific                | PNG, Solomon Islands, Fiji, Timor Leste, Vanuatu  |
| Prevention, Control and Management of Invasive Alien Species in the Pacific Islands         | Marshall Islands, Federate States of Micronesia, Papua New Guinea, Cook Islands, Kiribati, Samoa, Tonga, Vanuatu and Niue |
| Phoenix Islands Protected Area (PIPA)   | Kiribati  |
| Integrated Island and Community-based Biodiversity Conservation and Management              | Nauru, Tuvalu, Cook Islands, Tonga  |

| <b>Project Title</b>   | <b>Participating Pacific Island Countries</b>   |
|--|---|
| National Biodiversity Strategy, Action Plan, the First and Third National Report to CBD and Establishment of a Clearing House Mechanism            | Timor Leste   |
| Demonstrating and Scaling Up Sustainable Alternatives to DDT, and Strengthening National Vector Control Capabilities in Southeast Asia and Pacific | PNG, Solomon Islands and Vanuatu  |
| Climate Change Adaptation  | Vanuatu, Kiribati and Solomon Islands   |
| Increasing resilience of coastal areas and community settlement to climate change  | Tuvalu  |
| Integrated solid and hazardous waste and POPs management   | Cook Islands, FSM, Marshall Islands, PNG, Samoa, Tuvalu, Palau, Tonga (the latter two countries only if they ratify the Stockholm Convention) |
| Accelerating the Use of Renewable Energy Technologies  | Nauru, Niue and Tuvalu  |
| Promoting Energy Efficiency in the Pacific   | Cook Islands, Samoa, Tonga and Vanuatu  |
| Regional Renewable Energy  | PNG, Solomon Islands, Fiji, Vanuatu, and Kiribati, Niue, Tuvalu and Nauru   |
| Forest Management Project  | Fiji, Samoa, Niue and Papa New Guinea   |
| Implementing Sustainable Integrated Water Resource and Wastewater Management in the Pacific Island Countries                                       | Cook Islands, Fiji, Kiribati, RMI, FSM, Nauru, Niue, Samoa, Solomon Islands, Palau, PNG, Tonga, Tuvalu, Vanuatu                               |

Source: GEF/C.33/9, March 20, 2008

**Appendix 5:**  
**Country- and Sector-based Assessment of Adaptation Needs and Opportunities**

The following tables provide a country-by-country; sector-based assessment of adaptation needs as well as opportunities for interventions by ADB that align with its current priorities for assisting its PDMCs.

The tables are followed by more general information on adaptation in the Pacific Islands Region.

**A. Country-by-country, sector-based assessment of adaptation needs**

| Year 2050<br>Climate<br>Change | Cook Is<br>(Source: First National<br>Communications to<br>UNFCCC, 1999; rev.<br>2000)                                    | Fiji<br>(Source: First National<br>Communications to<br>UNFCCC, 2005)   | Kiribati<br>(Source: Kiribati National<br>Adaptation Plan of Action,<br>2005) | PNG<br>(Source: First National<br>Communications to<br>UNFCCC, 2000)   | FSM<br>(Source: ADB: CRP_FSM,<br>2005)  | Samoa<br>(Source: ADB:<br>CRP_Samoa, 2004)   | Timor Leste |
|--------------------------------|---|---|---|--|---|--|-------------|
| Air Temp                       | HADCM2 + 1.2 C<br>CSIRO9M2 + 0.8 C  | CSIRO9M2 +0.9 to + 1.3<br>DKRZ +0.9 to + 1.3  | (at Betio; Source: CRP_Fiji,<br>2006)<br><br>+ 1.0 C                          | HADCM2 + 1.2 C<br>CSIRO9M2 +1.3 C<br>-----<br>Dec to Feb: +0.8 to 1.6 C<br>Jun to Aug: +0.75 to<br>1.75C<br>(Source: UNDP Country<br>profile, ALM Project) | Low 0.4<br>Median 0.8<br>High 1.3<br><br>Scenarios of temperature<br>change (°C) defined by<br>the PICCAP Project.<br>(Source: <a href="http://www.sidsnet.org/docshare/climate/hays.doc">www.sidsnet.org/docshare/climate/hays.doc</a> ) | + 0.7 C.   |             |
| Rainfall<br>(mean<br>annual)   | HADCM2 + 10.3 %<br>CSIRO9M2 - 0.1%  | Best Guess<br>1750 mm (at Nadi;<br>Source: CRP_Fiji, 2006)<br>CSIRO9M2 +5.7 % to<br>+8.2%<br>DKRZ -5.7 % to -<br>8.2% | Based on values for the<br>year 2000<br>+7% mm (+2 to +17)                    | HADCM2 2.2%<br>CSIRO9M2 8.9%<br><br>Dec to Feb: -5 to +4%<br>Jun to Aug: -4 to +6%<br>(Source: UNDP Country<br>profile, ALM Project)                       | An extreme rainfall event<br>of 450 mm in the current<br>climate with a return<br>period of 118 will shorten<br>to 20 years by 2050 -<br>meaning more frequent<br>high intense rain episodes.   | 1.2%<br><br>An extreme six-hourly<br>rainfall of 200 mm,<br>currently a 30-year event,<br>will likely become a 20-<br>year event .   |             |
| Sea Level                      | Best Guess 20 cm<br><br>High Est. 40 cm   | 20 cm (at Nadi; Source:<br>CRP_Fiji, 2006)<br>+ 23cm to + 43 cm   | +14 cm (+6 to +26 cm)   | Best Guess 20 cm<br><br>High Est. 40 cm  | At Pohnpei and Kosrae:<br>High + 40 cm<br>Best: + 20 cm<br>Low: + 8 cm  | Best guess<br>36 cm,   |             |
| Weather<br>Extreme             | Rainfall might be<br>characterized by high<br>intensity events on the one<br>hand, and prolonged<br>droughts on the other | Wind gust >60 kts (at<br>Nadi; CRP_Fiji, 2006);<br>Increase in frequency<br>and /or magnitude of<br>tropical cyclones | More drought effects  | Droughts and floods<br>effects intensified   | More frequent high intense<br>rain episodes.  | - Extreme wind gusts by +<br>7%.<br>- A currently extreme wind<br>gust of 70 kt at Apia with<br>a return period of 75 years<br>will reduce to<br>approximately 40 years by<br>2050 |             |

|   |   |  |   |   |  |   |             |
|---|---|--|---|---|--|---|-------------|
| Climate Extreme                           | El Niño-Southern Oscillation (ENSO) phenomenon to dominate (more extreme events)  | More El Niño-like conditions: Increase in drought events   | More El Niño-like state   | Greater ENSO influence on extremes  | ENSO is the dominant influence on climate. In general, amore El-Niño-like mean state over the Pacific under climate change | No definite signal  |             |
| Sectoral Impacts                          | Cook Is<br>(Source: First National Communications to UNFCCC, 1999; rev. 2000)   | Fiji<br>(Source: First National Communications to UNFCCC, 2005)                                    | Kiribati<br>(Source: Kiribati National Adaptation Plan of Action, 2005)   | PNG<br>(Source: First National Communications to UNFCCC, 2000)  | FSM<br>(Source: First National Communications to UNFCCC, 1997)   | Samoa<br>(Source: Samoa National Adaptation Plan of Action, 2005)   | Timor Leste |
| Agricultural Production and food security | - Sea level rise and salt-water inundation into the underground fresh water lens will impede crop growth in low-lying northern group of atolls. Loss of land will reduce available land for agricultural production. Lack of rain and soil degradation thus reducing productivity. Increase forest fires. | Reductions in production of 30-40%   | - Reduction in agricultural productivity starting first with less resilient crops and ultimately coconut.<br>- Diminishing fish stocks (due to coastal erosion; increased and more intense sunlight; and sea level rise | Reduced agricultural production due to:<br>- Rapid post-harvest deterioration of crops;<br>- Greater rate of water loss through evaporation,<br>- Soil degradation<br>- Humid conditions will favor increased incubation of pests and diseases;<br>- Shorter time for crops to mature | Loss of land due to inundation   | Instability of food production levels to meet higher demands  |             |
| Tourism Industry                          | - Low agriculture outputs will reduce any exports and will further require the importation of fresh vegetables to meet the demands of the tourist industry.   | - Loss of tourists attractions<br>-- Coral Bleaching<br>-- Increase in shoreline and beach erosion | - Coastal land erosion becomes more extensive, intensive, and persistent.<br>- Erosion threatens existing roads and buildings,  |   |  | Loss of beaches, inundation and degradation of the coastal ecosystems, saline intrusion and damage to critical infrastructure and the loss of attractiveness of coral due to bleaching  |             |
| Water Sector                              | - Long dry periods will reduce water supplies to critical levels.<br>- Higher volcanic Southern islands as a result of sea level rise will experience salt-water inundation in ground/freshwater lens and the infrastructure surrounding the coastal areas of the islands will be at risk                 | Reduced water availability,  | Ground water lens turning more brackish; soil degradation;  | Loss of Freshwater due to saltwater intrusion   | Salinization of freshwater lenses  | Water quality and availability of water impact directly on the livelihoods of the communities. Sea level rise increases the possibilities of seawater intrusion into underground water aquifers as already experienced by many coastal communities. |             |
| Disaster risks                            | - Higher coastal erosion and flooding risks   | Flooding, inundation of low areas;<br>Increased storm surge  | Increase areas of inundation.<br>Under-washing of sea wall  | Flooding is likely to cause a loss of coastal and industrial infra, (e.g. roads   | Increased risks of coastal erosion and flooding due to wave and storm surge.   | Drought is the most obvious and hard felt impact. There is no   |             |

|                               |  |  |  |   |   |  |                           |
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|                               |  | risks  | due to stronger waves  | and marine installations and settlements,) particularly in low-lying areas.   |   | strategy for adapting to the adverse effects of flooding.  |                           |
| Human health and safety       | <ul style="list-style-type: none"> <li>- Temperature variations and extreme events strongly influence epidemic potential.</li> <li>- Cyclones and flooding leads to loss of life, injury</li> <li>- Increases in water borne diseases or ailments in periods</li> </ul>  | <p>Increases in the risk of dengue-fever epidemic; Dengue becoming endemic;</p> <p>Diarrheal disease may become more common</p> <p>Nutrition-related; illnesses are most likely;</p>   |  | <ul style="list-style-type: none"> <li>-Storms can damage and destroy health centers and related infra, thereby disrupting essential health services</li> <li>- Nutritional related disease arising from malnutrition and food shortages</li> <li>- Increases in the incidence of vector borne and other diseases</li> </ul>  |   | <p>Infrastructure assets will be the most vulnerable sector given the costs for construction and maintenance.</p>  |                           |
| Potential Sectoral Adaptation | <p><b>Cook Is</b><br/>(Source: Carruthers, 2003)</p>   | <p><b>Fiji</b><br/>(Source: First National Communications to UNFCCC, 2005)</p>   | <p><b>Kiribati</b><br/>(Source: Kiribati National Adaptation Plan of Action, 2005)</p>   | <p><b>PNG</b><br/>(Source: First National Communications to UNFCCC, 2000)</p>   | <p><b>FSM</b><br/>(Source: First National Communications to UNFCCC, 1997)</p>   | <p><b>Samoa</b><br/>(Source: Samoa National Adaptation Plan of Action, 2005)</p>   | <p><b>Timor Leste</b></p> |
|                               | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Integrated management plans implementation through policy and through the National Implementation Strategy</li> <li>- Incorporate climate change adaptation and mitigation concepts into national infrastructure Development (Preventative infrastructure master plan)</li> <li>- Climate proof infrastructure dev't in the water, sanitation, energy, telecommunications and transport sectors</li> <li>- Enhance systematic implementation of climate proofing measures to strengthen resilience and adaptation to climate change</li> <li>- Public Education and</li> </ul> | <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Coastal protection options, both community-based and engineering schemes;</li> <li>• Land-use policies encouraging settlement away from low-lying coastal areas, consistent with cultural practices and land tenure systems;</li> <li>• Mangrove and reef protection and rehabilitation, including education, public awareness and legislative measures.</li> <li>• Water-catchments management and soil-conservation measures to reduce erosion and sedimentation.</li> </ul> <p><b>Water Resources</b></p> <p>Adaptation options for</p> | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Integration of climate change adaptation into national planning and institutional capacity</li> <li>- Use of external financial and technical assistance</li> <li>- Population and resettlement</li> <li>- (Improvement /Enhancement of ) Governance and services</li> <li>- Survivability and self-reliance (Capacity Building)</li> </ul> <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Management of Freshwater resources and supply systems</li> </ul> <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>-Management of coastal structures, land uses and agricultural practices</li> <li>- Marine resources management</li> </ul> | <p><b>Water and Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Integrated Coastal and Water Management, (strategic) Policy and Planning</li> <li>- Community based monitoring and management</li> <li>- Integrated research, with stronger regional collaboration</li> <li>- Micro credit and small business expansion</li> <li>- Hard (e.g. sea walls) and soft measures (e.g. shoreline revegetation)</li> <li>- Develop alternative water sources such as rainfall catchments devices as well as saltwater and brackish water</li> </ul> <p><b>Capacity Building</b></p> <ul style="list-style-type: none"> <li>- Building capacity in provincial and national</li> </ul> | <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Identify and construct appropriate additional locations, deep wells (bores), and suitable water system infra.</li> <li>- Improve community water systems on atolls and in other insular coastal and rural areas by identifying and constructing additional sources of potable freshwater (e.g. small-scale, low technology, low maintenance, inexpensive, solar desalination systems: roof rainwater catchments)</li> </ul> <p><b>Agriculture/ agroforestry</b></p> <ul style="list-style-type: none"> <li>-Encourage farmers to improve farming practices to suit changing climate.</li> <li>-Ensure and facilitate an appropriate upland</li> </ul> | <p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>- Marketing and trading</li> <li>- Alternative crop research</li> <li>- Early warning systems</li> <li>-Traditional Planting scheduling</li> </ul> <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Water purification programs</li> <li>- Alternative water supply and storage programs</li> <li>- Watershed management plans</li> </ul> <p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>- Climate-adaptive health programs</li> <li>- Awareness activities and training</li> <li>- Early warning system and emergency measures</li> <li>- Climate-health cooperation program</li> </ul> <p><b>Coastal Sector / Tourism</b></p> |                           |

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| <p>Awareness</p> <p><b><u>Disaster Risk Reduction</u></b></p> <ul style="list-style-type: none"> <li>- Risk Management</li> <li>- Policies and legislations in disaster risk management, building standards, land use and management, water resources, transport, energy, agriculture, marine resources and fisheries, public health and infrastructure development.</li> <li>-Disaster preparedness and enhancing resilience to changing climatic conditions through plans, policies and legislation</li> <li>- Climate Risk Profiling (preliminary scoping of projects)</li> <li>- Acceptable level of risk and least cost design and implementation</li> </ul> <p><b><u>Capacity Building</u></b></p> <ul style="list-style-type: none"> <li>- Develop guidelines to integrate climate change into sectoral and sustainable development plans</li> <li>- Access to national &amp; international technical expertise &amp; appropriate technology transfer</li> <li>- Continue to address major gaps in planning and policy, regulations and legislation</li> <li>- Continued lobbying for mitigation and adaptation assistance</li> </ul> | <p>water resources fall into three broad categories.</p> <ul style="list-style-type: none"> <li>• Flood-control measures to cope with extreme high-rainfall events include such measures as diversion channels; the building of weirs, cut-off channels, retarding basins and dams; and river-improvement activities such as channel widening, dyke construction or river-bed excavation.</li> <li>• Drought-alleviation measures include management of water resources</li> <li>• Catchment management including reforestation, land-use controls, protection of wetlands and soil conservation.</li> </ul> <p><b><u>Agriculture</u></b></p> <ul style="list-style-type: none"> <li>• Research into more-flexible farming systems that are tolerant to climatic variability</li> <li>• Development of sustainable production systems such as Agricultural Diversification Scheme</li> </ul> <p><b><u>Health</u></b></p> <ul style="list-style-type: none"> <li>• Improve disease-control programme;</li> <li>• Encourage preventative exposure measures;</li> <li>• Improve quarantine measures;</li> <li>• Implement epidemic preparedness and response; and</li> <li>• Implement proper</li> </ul> |  | <p>government agencies (to implement laws and plans)</p> <ul style="list-style-type: none"> <li>- Maintain gene pools through a system of connected protected areas</li> <li>- Improve resources information and monitoring</li> <li>-Establish marine protected areas that provide for the customary harvesting of reef resources by Micronesians using traditional collection methods.</li> </ul> <p><b><u>Health Sector</u></b></p> <ul style="list-style-type: none"> <li>- Preventative health care through disease control and public awareness programmes</li> <li>- Improve medical and quarantine services</li> </ul> | <p>watershed protection program component is integrated into any nationwide community-based coral reef protection program and coastal zone management.</p> <ul style="list-style-type: none"> <li>-Establish marine protected areas that provide for the customary harvesting of reef resources by Micronesians using traditional collection methods.</li> </ul> | <p><b><u>Industry</u></b></p> <ul style="list-style-type: none"> <li>- Training for operator and tourism management</li> <li>• Sustainable tourism – developing a Tourism Environmental Policy (TEP)</li> <li>- Emergency management plans</li> </ul> |  |
|--|---|--|--|--|---|--|

|  |  |   |  |  |  |  |  |
|--|--|---|--|--|--|--|--|
|  |  | development policies.<br>• Improved provision of, and access to, primary health care. |  |  |  |  |  |
|--|--|---|--|--|--|--|--|

| Year 2050 Climate Change | Marshall Islands<br>(Source: Climate Risk Profile for RMI-ADB,2004)  | Nauru<br>(Source: First National Communications to UNFCCC, 1999) | Solomon Islands<br>(Source: First National Communications to UNFCCC, 2001)        | Tonga<br>(Source: Climate Risk Profile for Tonga -ADB, 2008)  | Tuvalu<br>(Source: Tuvalu's NAPA, 2007)   | Vanuatu<br>(Source: Climate Risk Profile for Vanuatu, ADB -2008)   | Palau:<br>(Source: Climate Risk Profile for Palau, ADB -2008)   |
|--------------------------|--|--|---|---|---|--|---|
| Air Temp                 | <u>CSIRO9M2</u><br>Mid - 0.9C<br>High -1.4C<br><br><u>HADCM2</u><br>Mid - 1.3C<br>High - 2.1C<br>Initial Nat. Com to the UNFCCC, 2000) | <u>CSIRO9M2</u> : + 0.9 C<br><br><u>HADCM2</u> : + 1.5 C         | <u>BMRC</u> : 0.7 C<br><br><u>CSIRO9M2</u> : 0.8 C<br><br><u>ECHAM3TR</u> : 1.1 C | Max air temp: 1.2 °C<br>Max water temp: 0.2 °C<br><br>For Nuku'alofa, current return period:<br>Of max air temp > 32.5 C is 400 years. By 2050, 36 years<br>Of max water temp > 32C is 400 years. By 2050, 50 years | <u>Best estimates</u><br><br>BMRC: 0.7C<br>UKHI: 0.5C<br>CSIRO9M2 0.9C<br>HADCM2 1.4C | Max air temp: 0.2 °C<br>Max water temp: 0.19 °C<br><br>- Increased occurrences of extreme high sea levels, air/water temperatures and and (ii) | Dec-Feb + 0.80 to +1.60 °C<br>Jun-Aug + 0.75 to +1.75 °C<br><br>(Source: UNDP Country profile, ALM Project) |
| Annual Rainfall, %       |  | CSIRO9M2: +10.9 %<br><br>HADCM2: + 2.4%                          | BMRC (-0.4 to+1.0)<br><br>CSIRO9M2 (+2.0 to +2.5)<br><br>ECHAM3TR (+3.7 to +4.5)  | HADCM2 -9.8<br>ECHAM4 +3.4<br>CSIRO2EO +4.8<br>GFDLTR +3.8<br>CGCM1-TR -3.8<br>(Best estimates, using MAGICC ScenGen}<br>Source: First National Communications to UNFCCC, 2005)                                     | <u>Best estimates</u> :<br><br>BMRC: -0.4<br>UKHI -27.9<br>CSIRO9M2 1.6<br>HADCM2 6.3 | <u>Best estimate</u> : +0.6%   |   |
| Rainfall Extremes        | <u>Canadian GCM</u> , with A2 emission scenarios<br>Increased frequency of   | Uncertain about future extremes. Current observations though,    |   | Both high and low rainfall projections, higher  | By analogy: ENSO events have  | There is less certainty regarding changes in the frequency of intense daily  | Dec-Feb -5 - +4 %<br>Jun-Aug -4 - +6%   |

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|   | months with extreme low rainfall and associated drought.   | suggest ENSO affects rainfall and sea level significantly.       |  | probabilities of dry periods.  | been experienced with greater frequency over the last two decades. In Tuvalu,  | precipitation events, but there are indications that the frequency of these events will increase in the future.  | (Source: UNDP Country profile, ALM Project)  |
| Drought                                   | Increase in severe droughts especially in the northern atolls.   |  |  | Decreased Rainfall -Periods of low rainfall are prolonged dry periods.   | <u>By analogy:</u><br>El Niño events bring warmer, wet conditions, whereas La Niña conditions are cooler and drier drought conditions;   |  | (In Koror) - Increased return period of extreme hourly /daily rainfall, An hourly rainfall of at least 120 mm is currently a 120-year event. By 2050 it is projected to be an 80-year event. A daily rainfall of at least 400 mm is currently a 155-year event. It will likely be a 100-year event by 2050 |
| Extreme Winds                             | A peak gust of about 35 knots, considered a rare event in the current climate, has a return period of 21 years; by 2050 the return period will be 1:11, or about twice as often. |  |  | Extreme wind gusts: 7%.<br><br>A current 100-year event of a maximum daily wind gust of 65 m/s is likely to be a one in 50-year event by 2050.   | <u>By analogy:</u><br>Tropical cyclones appear to have increased in frequency in Tuvalu. The most recent severe events was cyclone Percy (March, 2005) which had significant effects in Tuvalu | - Extreme wind gusts: 6.8%<br><br>- Increased occurrences of damaging winds are highly likely in the coming decades;   |  |
| Sea Level                                 | Mid - 19.9 cm<br>High - 39.7cm   | Mid - 20 cm<br>High - 40 cm                                      | Mid - 20 cm<br>High - 49 cm  | - Best estimate: 36 cm<br><br><u>At Nuku'alofa:</u><br>- Current observed long term trend in extreme high sea levels is 0.7 mm/year while for local mean sea level is 8.5 mm/year<br>- Current return period of hourly sea level > 2.2 m: is 580-year becomes 1.5-year | <u>By analogy:</u><br>Sea level is rising - a building foundation for the church mission school in 1904 is currently submerged by inundated seawater;  | - Best estimate: 20 cm.<br>An hourly sea level of at least <u>At Port Vila</u> - 1.9 m above mean sea level is a relatively rare event for, with a return period of approximately 136 years. This will become 3.6 years by 2050.<br>- Increased occurrences of extreme high sea levels | A sea level of at least 2.8 meters currently observed with a return period of 26.7 years is projected to occur at least once in every 2.3 years by 2050.   |
| Sectoral Impacts                          | Marshall Islands<br>(Source: Initial Nat. Com to the UNFCCC, 2000)   | Nauru<br>(Source: First National Communications to UNFCCC, 1999) | Solomon Islands<br>(Source: First National Communications to UNFCCC, 2001)                                 | Tonga<br>(Source: First National Communications to UNFCCC, 2005)   | Tuvalu<br>(Source: Tuvalu's NAPA, 2007)  | Vanuatu<br>(Source: First National Communications to UNFCCC,1999)  | Palau:<br>(Source: Climate Risk Profile for Palau, ADB -2008 and Palau BTOR & Road Map Final ARM550N_20080708_142032.pdf)  |
| Agricultural Production and food security | Reduced productivity due to:<br>- Land loss due to inundation  |  | Lower crop yields due to:<br>- Increase in frequency or intensity of extremes<br>-Loss of land through sea | - Reduction of crop yield<br>- Threat to food security (e.g. increasing soil salinity)   | - Decreasing agricultural yields due to increasing salinity of groundwater,  | - Changes may be detrimental to agricultural production and hence national food security.  | - Substantial agricultural losses (50%) due to extreme climate events.   |

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|                            | - Prolonged periods of drought  |   | level rise<br>- Reduced quality of land through erosion   |  |   |   |   |
| Coastal Resources /Tourism | <ul style="list-style-type: none"> <li>- Inundation and flooding of low-lying areas</li> <li>- Coastal erosion</li> <li>- Possible increase in cyclone related effects</li> <li>- Changes in sediment production due to changes in coral reef systems</li> <li>- Coral bleaching and coral degradation.</li> <li>- Changes in mangrove health and distribution</li> <li>- Degradation of sea grass meadows</li> </ul> | <ul style="list-style-type: none"> <li>- Coastal erosion, decline in health of the reef system and other ecosystems (e.g., sea grasses and mangroves)</li> <li>- Increased flooding and overtopping during storms.</li> <li>- Salinization and decrease recharge ground water.</li> </ul> | <ul style="list-style-type: none"> <li>- Increase coastal flooding and inundation</li> <li>- Enhance coastal erosion</li> <li>- Sea level rise are likely to impact coastal ecosystems negatively.</li> </ul>   | <ul style="list-style-type: none"> <li>- Destruction of habitats of some marine species</li> <li>- Reduction in diversity of marine species in coral reefs</li> <li>- Threat to the survival of ecotourism and fisheries sectors</li> <li>- Land loss due to greater exposure of the shoreline to wave action</li> </ul> |   | <ul style="list-style-type: none"> <li>- Flooding and inundation may have negative economic impacts as national investments in infrastructure and agriculture are primarily in low lying coastal areas around the perimeter of the major islands.</li> <li>- Decrease suitability of conditions for corals, mangroves and other coastal ecosystems survival.</li> </ul>         | <ul style="list-style-type: none"> <li>- Coral bleaching</li> <li>- Threat to coral reef system and to the human population depending on them.</li> <li>(By analogy: During the 1998 El Nino, a massive coral bleaching killed one third of Palau's coral reef, causing annual tourism revenues to drop by 9% and the local economy to lose an estimated \$91million. (Source:www.micsem.org/)</li> <li>-Ocean acidity increase the risks of coral degradation</li> </ul> |
| Water Sector               | <ul style="list-style-type: none"> <li>- Changes in freshwater lenses and other groundwater resources</li> <li>- Salt intrusion of groundwater resources</li> <li>- Changes in surface water resources</li> <li>- Changes in surface runoff, flooding and erosion</li> </ul>  |   |   | <ul style="list-style-type: none"> <li>- Prolonged dry periods will decrease water supply for uses in rural areas and outer islands</li> <li>- Reduction in recharge to groundwater means reduction in potable water supply for uses in rural areas and outer islands.</li> </ul>  | <ul style="list-style-type: none"> <li>- Increasing frequency of drought and longer period of low rainfall increases salinity of groundwater.</li> <li>- Challenges with respect to impacts of climate change and sea level rise is the quality and availability of potable water.</li> </ul> | <ul style="list-style-type: none"> <li>- Possible reduction in the rate of ground water recharge and surface water flows.</li> <li>- More pronounced periods of water shortages</li> <li>- Increase turbidity in surface waters can cause decrease suitability for domestic uses.</li> <li>-Salt-water intrusion into the shallow groundwater lens in coastal areas.</li> </ul> | <ul style="list-style-type: none"> <li>- Salt water intrusion into groundwater</li> <li>- Intense droughts and storm lead to land degradation in the watershed.</li> </ul>  |
| Disaster risks             | In creased disaster risks due to extreme high sea conditions as the intensity and frequency of extreme events (storms and storm surge) are expected to increase.  | Increased intense rainfall events will add to the erosion and flooding risks.   | Increase risks of cyclones and flooding leading to loss of life and injury  | <ul style="list-style-type: none"> <li>- Extreme events can cause injuries and death, although the timing is highly uncertain.</li> </ul>  | <ul style="list-style-type: none"> <li>- Increasing risks of tropical cyclones to environment and socio-economic conditions</li> </ul>  | <ul style="list-style-type: none"> <li>- Increased disaster risks may lead to increase damages to public infrastructure and fixed assets</li> </ul>   | <ul style="list-style-type: none"> <li>- Extreme sea levels are associated with flooding, accelerated coastal erosion</li> <li>- Increased risks in cyclone and storm frequencies; extreme rainfall causing landslides</li> <li>(Source: <a href="http://portal.unesco.org/files/Palau.pdf">http://portal.unesco.org/files/Palau.pdf</a>)</li> </ul>  |
| Human health and safety    | <ul style="list-style-type: none"> <li>- Public health and nutrition problems may arise from the intrusion of salt water and the general reduction in the quality of the ground water resources of the more highly populated atolls.</li> </ul>   | <ul style="list-style-type: none"> <li>- Continuation and possible worsening of the existing health problems.</li> <li>- Prevalence of vector-borne disease in the region, may become an additional public health</li> </ul>  | <ul style="list-style-type: none"> <li>- Extreme weather events have public health impacts.</li> <li>- Similarly, deteriorated water quality and quantity conditions may result in an increase in water borne disease.</li> <li>- Any decrease in average future rainfall or increase in</li> </ul> | <ul style="list-style-type: none"> <li>- Exacerbate problems of sanitation and hygiene</li> <li>- Increase incidence of air, water and food borne diseases: malnutrition</li> <li>- Increase incidence of asthma &amp; other diseases due to drier atmospheric conditions</li> </ul>                                     | <ul style="list-style-type: none"> <li>- Increase in dengue fever risks and water borne diseases</li> <li>- Increase in human stress in modern houses</li> </ul>  | <ul style="list-style-type: none"> <li>- Increase incidence of vector and water borne diseases.</li> <li>- General increase human discomfort that can lead to increased morbidity</li> </ul>  |   |

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|                               | <ul style="list-style-type: none"> <li>- Fatalities, injuries and other aspects of ill health are often recorded as a consequence of extreme climatic events.</li> </ul>   | risk   | <p>drought frequency or length would adversely affect water supply.</p> <p>-Sea level change may result in salt-water intrusion of the important fresh water lenses of the low-lying islands and atolls.</p>   |   |   |   |   |
| Potential Sectoral Adaptation | <b>Marshall Islands</b><br>(Source: Initial Nat. Com to the UNFCCC, 2000)  | <b>Nauru</b><br>(Source: First National Communications to UNFCCC, 1999)  | <b>Solomon Islands</b><br>(Source: First National Communications to UNFCCC, 2001)  | <b>Tonga</b><br>(Source: First National Communications to UNFCCC, 2005)   | <b>Tuvalu</b><br>(Source: First National Communications to UNFCCC, 2005)  | <b>Vanuatu</b><br>(Source: First National Communications to UNFCCC, 1999)   | <b>PALAU</b><br>(Source: Climate Risk Profile for Palau, ADB -2008 and Palau BTOR & Road Map Final ARM550N_20080708_142032.pdf)   |
|                               | <p><b>General strategy</b></p> <ul style="list-style-type: none"> <li>- Limited retreat to less inhabited atolls.</li> <li>- Strengthen environmental and natural resources policies, legislation and regulations</li> <li>- CC mainstream into sectoral planning and management (water, coastal, agricultural, marine and human health)</li> </ul> <p><b>Infrastructure</b></p> <ul style="list-style-type: none"> <li>- Building design / materials/ traditional building styles</li> <li>- Optimize sanitation infrastructure design</li> </ul> <p><b>Disaster Risk Reduction</b></p> <ul style="list-style-type: none"> <li>- Disaster preparedness</li> <li>- Natural Hazard Management</li> <li>- Land Use Planning</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Comprehensive human health policies, disease and pest controls.</li> </ul> | <p><b>General strategy</b></p> <ul style="list-style-type: none"> <li>- Land rehabilitation and protection</li> <li>- Strengthening environmental education</li> <li>- Strengthening environmental institutions and legislation</li> <li>- Control of population and urban growth</li> <li>- Appropriate infrastructural development</li> </ul> <p><b>Coastal / marine tourism sectors</b></p> <ul style="list-style-type: none"> <li>-Conservation of biodiversity</li> <li>- Promotion of the sustainable use of marine resources</li> <li>- Pollution and waste management</li> </ul> | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Development of a national policy framework (landuse management, coastal zone management, fisheries, etc.)</li> <li>-Capacity building and institutional strengthening</li> <li>-Public awareness and education</li> </ul> <p><b>Agriculture Sector</b></p> <ul style="list-style-type: none"> <li>- Improved agricultural practices (e.g. diversification, soil and water conservation) and use of technology.</li> <li>- Protection of mangrove and coral reefs system</li> <li>- Improved water management, supply, distribution and storage.</li> </ul> <p><b>Disaster Risk Reduction</b></p> <ul style="list-style-type: none"> <li>- Selective flood protection infra such as plantation and other important areas.</li> <li>- Selective resettlement options.</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Improved medical and health services, both preventive and curative.</li> </ul> | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>-Transfer of technology and knowledge; and research.</li> <li>- Long-term monitoring and research climate systems and impacts</li> <li>- Integrated management policy frameworks (coastal, water mgt)</li> <li>- Public awareness and promotion</li> <li>- Development of innovative approaches</li> </ul> <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Foreshore protection infrastructure against rising sea level and extreme events</li> <li>- Land use planning and management: in particular, reclamation against rising sea level</li> <li>-Coastal replantation and revegetation</li> <li>-Integrated coral management plan</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>-Development of a standardized health impact assessment procedures, tools</li> </ul> | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Strengthen Tuvalu Trust Fund capital base</li> <li>- Public education and awareness</li> <li>- Research and capacity building on the use of technology</li> <li>- Research on the Islands carrying capacities, monitoring and observation.</li> <li>- Development of innovative approaches</li> </ul> <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Improved practices in agriculture, water conservation and coastal protections, among others.</li> </ul> <p><b>Disaster Risk Reduction</b></p> <ul style="list-style-type: none"> <li>- Relocation of infrastructure to areas of low vulnerability.</li> </ul> | <p><b>Agriculture Sector</b></p> <ul style="list-style-type: none"> <li>- Expansion of the range of agricultural products;</li> <li>-Selection of plant varieties better suited to predicted future climates;</li> <li>- Capacity building (particularly on the science-based knowledge) and public awareness.</li> </ul> <p><b>Coastal Sector/Tourism</b></p> <ul style="list-style-type: none"> <li>- Identification of opportunities to reduce reliance on coastal marine resources:</li> </ul> <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Sustainable land use within watersheds; riparian buffer zones to protect watersheds from development and sedimentation</li> <li>-Land use restrictions for primary protection zones surrounding stream banks; holistic land use management plan</li> <li>-Drought mitigation planning and implementation.</li> </ul> | <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Increased knowledge and scientific basis of current and future changes in climate, sea level and their impacts.</li> <li>- Identify mechanisms that allow development policies &amp; plans to incorporate climate change considerations to minimize risks.</li> </ul> |

## B. Opportunities for adaptation interventions by ADB that align with its current priorities for assisting its PDMCs

| 1. COOK ISLANDS  |  |  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)   | ADB Current Adaptation Related Priorities (Source: CPS-COO-20008-2012.pdf)   | Adaptation Opportunities for ADB   |
| <b>General Strategy</b><br><br>- Integrated management plans implementation through policy and through the National Implementation Strategy<br><br>----<br>- Public Education and Awareness  | <u>Sustainable use and management of natural resources and the environment</u><br><br>- TA4234: Strengthening Economic and Development Planning Capacity<br>----<br>- TA2165: Institutional Strengthening of the Ministry of Education<br><br>- Ln1317: Education Development  | - Mainstreaming CC into Economic and Development Capacity, Environmental Management, Natural Resources Mgt., etc.<br><br>----<br>- Strengthening of the Educational Curricula at all levels (to include disaster risk reduction and climate change adaptation) |
| <b>Capacity Building</b><br><br>- Guidelines to integrate climate change into sectoral and sustainable development plans<br>- Enhance systematic implementation of climate proofing measures to strengthen resilience and adaptation to climate change   | <u>Sustainable use and management of natural resources and the environment</u><br><br>- TA2322 : Outer Islands Marine Resource Management Training<br>- TA2144: Lagoon Ecology Monitoring and Management<br>- TA4273: Legal and Institutional Strengthening of Environmental Management<br>- Cluster TA for Implementation of reforms of agencies responsible for water and sanitation.<br>- RETA for incorporating climate proofing in the design of projects | Tourism Master Plan Study<br><br>Sustainable tourism – developing a Tourism Environmental Policy and Disaster Risks  |
| <b>General Strategy</b><br><br>- Incorporate climate change adaptation and mitigation concepts into national infrastructure Development (Preventative infra-structure master plan)<br>- Climate proofing infrastructure dev't in the water, sanitation, energy, telecommunications and transport sectors   | <u>Strengthened and affordable basic infrastructure, transport and utilities to support national development</u><br><br>PPTA for Infrastructure Development Project and infrastructure governance framework.   | Infrastructure Development Project to implement priority projects in water sanitation, transport and energy, incorporating climate change. (Climate proofing)  |
| <b>Disaster Risks Reduction</b><br><br>- Risk Management<br>- Policies and legislations in disaster risk management, building standards, land use and management, water resources, transport, energy, agriculture, marine resources and fisheries, public health and infra-structure development.<br>- Disaster preparedness and enhancing resilience to changing climatic conditions through plans, policies and legislation<br>- Climate Risk Profiling (preliminary scoping of projects)<br>- Acceptable level of risk and least cost design and implementation | <u>Safe, secure, and resilient community</u><br><br>Strengthening Disaster Management and Mitigation (TA4605) (Component 1: Disaster Management Capacity).<br><br>Cyclone Emergency Assistance Project (Loan2174)<br><br>REG 41187-01 Regional Partnerships for Climate Change Adaptation and Disaster Preparedness  | Linking CC to Disaster Risk Management<br><br>Risk Transfer Mechanism for Climate  |
| <b>Capacity Building</b><br><br>- Access to national & international technical expertise & appropriate technology transfer   | <u>Innovative and well-managed private sector-led economy</u><br><br>PPTA for Infrastructure Development Project and infrastructure governance framework.<br><br>Management of the Cook Islands Development Bank and Business Ventures Development (TA2650)  | Management of the Cook Islands Development Bank and Business Ventures Development, with CC transfer of technology investment portfolio   |
| <b>Capacity Building</b><br><br>- Continue to address major gaps in planning and policy, regulations and legislation<br>-----  | <u>Capacity development and institutional improvement</u><br><br>- PPTA addressing institutional reforms and associated capacity building (e.g. National Strategic planning)<br>----   | Strategic climate-proofed investment planning.   |

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| <ul style="list-style-type: none"> <li>- Continued lobbying for mitigation and adaptation assistance</li> </ul>   |   | ----  |
| <b>2. FIJI</b>  |   |   |
| Adaptation<br>(Source: <i>Country Matrix PDMCs.doc</i> )  | ADB Current Adaptation Related Priorities<br>(Source: <i>CSPU-2006.pdf</i> , <i>CPS-PAC-2008.pdf</i> and <i>MultiDonorPipeline_Update 20112008.xls</i> )  | Adaptation Opportunities for ADB  |
| <p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>• Research into more-flexible farming systems that are tolerant to climatic variability</li> <li>• Development of sustainable production systems such as Agricultural Diversification Scheme</li> </ul> <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>• Coastal protection options, both community-based and engineering schemes;</li> <li>• Land-use policies encouraging settlement away from low-lying coastal areas, consistent with cultural practices and land tenure systems;</li> <li>• Mangrove and reef protection and rehabilitation, including education, public awareness and legislative measures.</li> <li>• Water-catchments management and soil-conservation measures to reduce erosion and sedimentation.</li> </ul> | <p><b><u>Generate private sector-led growth through sound macroeconomic policies, infrastructure development, and alternative livelihoods</u></b></p> <p>PPTA on Private Sector development in agriculture</p> <p>TA for the Commercialization of Agriculture Development</p> <p>TA3888-FIJ: Sugar Sector Restructuring<br/>TA4589-FIJ: Rural and Outer Islands Development</p> <p>Ln2158-FIJ: Alternative Livelihoods Project Rural and Outer Island Development Project Natural Resource-Based Sector Program</p> <p>Ln1902-FIJFiji Ports Development Project</p> | <p>Natural Resource-Based Sector Development Program for agriculture and non-agricultural rural economic development, such as sustainable forestry, fisheries, and tourism development, factoring in climate change concerns as it places unexpected pressure on natural resources</p> <p>Improved climate proofing of infrastructure</p> |
| <p><b>Water Resources</b></p> <ul style="list-style-type: none"> <li>• Flood-control measures to cope with extreme high-rainfall events include such measures as diversion channels; the building of weirs, cut-off channels, retarding basins and dams; and river-improvement activities such as channel widening, dyke construction or river-bed excavation.</li> <li>• Catchments management including reforestation, land-use controls, protection of wetlands and soil conservation.</li> </ul>  | <p><b><u>Deliver affordable basic social services through support for water and sanitation services, and improvements in local governance</u></b></p> <p>TA4270-FIJ: Capacity in Water and Sewerage Services</p> <p>Loan 2055-FIJ: Suva-Nausori Water and Supply</p>  | <ul style="list-style-type: none"> <li>- Enhanced infrastructure for development that include climate change adaptation consideration (e.g. changing flood return periods will affect design specs)</li> </ul>  |
| <p><b>Water Resources</b></p> <ul style="list-style-type: none"> <li>• Drought-alleviation measures include management of water resources</li> </ul> <p><b>Health</b></p> <ul style="list-style-type: none"> <li>• Improve disease- control programme;</li> <li>• Encourage preventative exposure measures;</li> <li>• Improve quarantine measures;</li> <li>• Implement epidemic preparedness and response; and</li> <li>• Implement proper development policies.</li> <li>• Improved provision of, and access to, primary health care.</li> </ul>   | <p><b><u>Building effective development Institutions and Good Governance</u></b></p> <p>REG 41187-01 Regional Partnerships for Climate Change Adaptation and Disaster Preparedness</p>  | <p>TA in support of environmental planning, social protection systems, and pro-poor development planning, with emphasis on strengthening government and civil society's adaptive capacity to respond to risks, including climate change.</p>  |

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| <b>3. KIRIBATI</b>  |  |   |
| Adaptation<br>(Source: <i>Country Matrix PDMCs.doc</i> )  | ADB Current Adaptation Related Priorities<br>( <i>CSP-KIR-2005.pdf</i> and <i>MultiDonorPipeline_Update 20112008.xls</i> )                                     | Adaptation Opportunities for ADB  |
| <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Integration of climate change adaptation into national planning and institutional capacity</li> <li>- Use of external financial and technical assistance</li> </ul> | <p><b><u>Improve the quality and accessibility of basic services</u></b></p> <p>Ln1648-KIR: Sanitation, Public Health, and Environment Improvement Project</p> | <ul style="list-style-type: none"> <li>- Capacity Building (skills development in consideration of possible migration)</li> <li>- Migration policy (possibly regional for standardized approach)</li> </ul> |

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| <ul style="list-style-type: none"> <li>- Population and resettlement</li> <li>- (Improvement /Enhancement of ) Governance and services</li> <li>- Survivability and self-reliance (Capacity Building)</li> </ul> <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>-Management of coastal structures, land uses and agricultural practices</li> <li>- Marine resources management</li> </ul> | <p>REG 41187-01 Regional Partnerships for Climate Change Adaptation and Disaster Preparedness</p> <p>TA4456 - KIR - Outer Island Growth Centres that identify necessary infrastructure and supporting systems for sustainable use of natural resources and employment generation</p> <p>TA 6064 Climate Change Adaptation Project for the Pacific</p> | <ul style="list-style-type: none"> <li>- Improved climate proofing of infrastructure.</li> </ul>                                    |
| <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Management of Freshwater resources and supply systems</li> </ul>   | <p><b>Promote good governance and sound management</b></p> <ul style="list-style-type: none"> <li>- RETA 6031: Water Management Policies</li> <li>- RETA 6123: Promotion of Effective Water Management Policies and Practices (Phase3)</li> <li>Programmed TA on Water Resources</li> </ul>   | <ul style="list-style-type: none"> <li>- Climate change vulnerability information included in sectoral project documents</li> </ul> |

| 4. PAPUA NEW GUINEA   |   |  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)  | ADB Current Adaptation Related Priorities<br>(csp-png-2006.pdf)   | Adaptation Opportunities for ADB   |
| <p><b>Water and Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Micro credit and small business expansion</li> </ul> <p><b>Capacity Building</b></p> <ul style="list-style-type: none"> <li>- Building capacity in provincial and national government agencies (to implement laws and plans)</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Improve medical and quarantine services</li> </ul>   | <p><b>Support an environment conducive to the private sector.</b></p> <ul style="list-style-type: none"> <li>- Microfinance and Employment (1768), co-financed by AusAID</li> <li>- Employment oriented skills development (1706), co-financed by AusAID</li> </ul>   | <ul style="list-style-type: none"> <li>- Include climate change vulnerability information in project documents</li> </ul>  |
| <p><b>Water and Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Integrated Coastal and Water Management, (strategic) Policy and Planning</li> <li>- Community based monitoring and management</li> <li>- Hard (e.g. sea walls) and soft measures (e.g. shoreline revegetation)</li> </ul> <p><b>Capacity Building</b></p> <ul style="list-style-type: none"> <li>- Building capacity in provincial and national government agencies (to implement laws and plans)</li> <li>- Comprehensive disaster management Programmes</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Preventative health care through disease control and public awareness programmes</li> </ul> | <p><b>Promote effective development processes</b></p> <ul style="list-style-type: none"> <li>- Coastal Fisheries management and development (1925)</li> <li>- Provincial Towns Water Supply and Sanitation (1812)</li> <li>- Ln1754-PNG: Rehabilitation of Maritime Navigation Aids Project</li> <li>- Agriculture and Rural Development Sector (4055)</li> <li>- REG 41187-01 Regional Partnerships for Climate Change Adaptation and Disaster Preparedness</li> </ul> | <ul style="list-style-type: none"> <li>- Climate proofing of infrastructure for development</li> <li>- Building capacity to include climate change adaptation in strategic planning and budgeting</li> <li>- Integration of climate change adaptation through risk reduction in the disaster (risk) management.</li> </ul> |
| <p><b>Water and Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Develop alternative water sources such as rainfall catchments devices as well as saltwater and brackish water</li> </ul> <p><b>Capacity Building</b></p> <ul style="list-style-type: none"> <li>- Maintain gene pools through a system of connected protected areas</li> <li>- Improve resources information and monitoring</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Improve medical and quarantine services</li> </ul>  | <p><b>Enhance the supply of and demand for quality basic social services (health, education, clean water, and sanitation).</b></p> <ul style="list-style-type: none"> <li>- Low cost sanitation, community awareness and Health Education (9002), grant, financed by Japan Fund for Poverty Reduction.</li> </ul>   | Enhanced Health Sector Support with emphasis on climate change related issues  |

| 5. FEDERATED STATES of MICRONESIA                |  |                                  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc) | ADB Current Adaptation Related Priorities<br>(COBP-FSM-2007.pdf) | Adaptation Opportunities for ADB |

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|   | <i>MultiDonorPipeline_Update 20112008.xls)</i>   |  |
| <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Improve community water systems on atolls and in other insular coastal and rural areas by identifying and constructing additional sources of potable freshwater (e.g. small-scale, low technology, low maintenance, inexpensive, solar desalination systems; roof rainwater catchments)</li> </ul> <p><b>Agriculture/ agroforestry</b></p> <ul style="list-style-type: none"> <li>-Encourage farmers to improve farming practices to suit changing climate.</li> </ul>  | <p><b>Good Governance</b></p> <ul style="list-style-type: none"> <li>- TA 4961: Strengthening Economic Management and Planning</li> <li>- TA 6064 Climate Change Adaptation Project for the Pacific</li> </ul>   | <ul style="list-style-type: none"> <li>Cluster TA on strategic sectoral planning and budgeting that include climate change adaptation (mainstreaming)</li> <li>- Up scaling climate adaptation projects considering low and efficient technologies</li> </ul>                |
| <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Identify and construct appropriate additional locations, deep wells (bores), and suitable water system infrastructure</li> </ul> <p><b>Agriculture/ agroforestry</b></p> <ul style="list-style-type: none"> <li>-Ensure and facilitate an appropriate upland watershed protection program component is integrated into any nationwide community-based coral reef protection program and coastal zone management.</li> </ul>   | <p><b>Inclusive Social Development</b></p> <ul style="list-style-type: none"> <li>- Ln 1816(SF): Basic Social Services</li> <li>- TA 4789: Implementation of Public Sector Capacity Building Roadmap</li> </ul>  | <ul style="list-style-type: none"> <li>Cluster TAs to address climate change risks/vulnerability reduction in selected public utilities</li> <li>- Partnerships for Climate Change Adaptation and Disaster Preparedness</li> </ul>   |
| <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Improve community water systems on atolls and in other insular coastal and rural areas by identifying and constructing additional sources of potable freshwater (e.g. small-scale, low technology, low maintenance, inexpensive, solar desalination systems; roof rainwater catchments)</li> </ul> <p><b>Agriculture/ agroforestry</b></p> <ul style="list-style-type: none"> <li>-Encourage farmers to improve farming practices to suit changing climate.</li> <li>-Establish marine protected areas that provide for the customary harvesting of reef resources by Micronesians using traditional collection methods.</li> </ul> | <p><b>Pro-Poor Economic Growth</b></p> <ul style="list-style-type: none"> <li>- Ln1874(SF): Private Sector Development Project</li> <li>- Ln 2099(SF)/2100: Omnibus Infrastructure Development Loan</li> <li>- TA Capacity Building and Community Awareness Raising for Selected Public Utilities</li> </ul> | <ul style="list-style-type: none"> <li>- Climate proofing of infrastructure projects</li> <li>- Capacity building to include climate resiliency in sectoral plans implementation.</li> <li>- Partnerships for Climate Change Adaptation and Disaster Preparedness</li> </ul> |

| 6. SAMOA  |  |  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)  | ADB Current Adaptation Related Priorities<br>(CPS-SAM-2008-2012-.pdf)  | Adaptation Opportunities for ADB   |
| <p><b>Agriculture</b></p> <ul style="list-style-type: none"> <li>- Marketing and trading</li> <li>- Alternative crop research</li> <li>- Early warning systems</li> <li>-Traditional Planting scheduling</li> </ul> <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Water purification programs</li> <li>- Alternative water supply and storage programs</li> <li>- Watershed management plans</li> </ul> | <p><b>Private Sector-Led Economic Growth and Employment Creation</b></p> <ul style="list-style-type: none"> <li>- RETA6204: Mainstreaming Environmental Considerations in Economic and Development Planning</li> <li>- Sanitation and drainage project for Apia area</li> <li>- TA capacity building sanitation/ drainage</li> </ul> | <ul style="list-style-type: none"> <li>- Marketing and trading</li> <li>- Watershed management plans</li> <li>- Alternative water supply and storage programs</li> <li>- Inclusion of climate change risks and adaptation information in the project cycle</li> </ul>  |
| <p><b>Coastal sector / Tourism Industry</b></p> <ul style="list-style-type: none"> <li>- Training for operator and tourism management</li> <li>- Sustainable tourism: developing a Tourism Environmental Policy</li> <li>- Emergency Management plans</li> </ul> <p><b>Human Health</b></p> <ul style="list-style-type: none"> <li>- Climate-adaptive health programs</li> <li>- Awareness activities and training</li> </ul> | <p><b>Improved delivery of public services, including the removal of infrastructure constraints</b></p> <ul style="list-style-type: none"> <li>- TA7033: Support for the Formulation and Implementation of the Strategy for the Development of Samoa</li> </ul>  | <ul style="list-style-type: none"> <li>- Sustainable tourism : developing a Tourism Environmental Policy</li> <li>- Zoning, disaster planning &amp; urban planning</li> <li>- Revising building codes to increase resilience to cyclones</li> <li>- Coastal infrastructure protection</li> <li>- Integrating risk management as an integral component of policies, plans, programs and projects</li> </ul> |

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| <ul style="list-style-type: none"> <li>- Early warning system and emergency measures</li> <li>- Climate-health cooperation program</li> </ul>  |   | <ul style="list-style-type: none"> <li>- Climate-adaptive health programs</li> </ul>  |
| <b>Agriculture</b> <ul style="list-style-type: none"> <li>- Marketing and trading</li> <li>- Alternative crop research</li> </ul>  | <b>Improving governance</b> <ul style="list-style-type: none"> <li>- TA3936: Strengthening of Economic Sectors Planning and Management</li> </ul> |   |
| <b>Coastal/Tourism Industry</b> <ul style="list-style-type: none"> <li>- Sustainable tourism: developing a Tourism Environmental Policy</li> <li>- Emergency Management plans</li> </ul> | <ul style="list-style-type: none"> <li>- TA3860: Implementation of the Urban Planning and Management Strategy</li> </ul>                          | <ul style="list-style-type: none"> <li>- Strategic planning and budgeting processes that include climate change concerns</li> </ul> |

| 7. MARSHALL ISLANDS  |  |  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)   | ADB Current Adaptation Related Priorities<br>(CSP-RMI-2006.pdf, MultiDonorPipeline_Update 20112008.xls and <a href="http://www.adb.org/Projects">http://www.adb.org/Projects</a> )   | Adaptation Opportunities for ADB*  |
| <b>General strategy</b> <ul style="list-style-type: none"> <li>- CC mainstream into sectoral planning and management (water, coastal, agricultural, marine and human health)</li> </ul> <b>Infrastructure</b> <ul style="list-style-type: none"> <li>- Building design / materials/ traditional building styles</li> <li>- Optimize sanitation infrastructure design</li> </ul>                  | <b>Enhanced Private Sector Environment</b> <ul style="list-style-type: none"> <li>- TA 4439: Improving the Environment for Private Sector Development</li> <li>- TA2483: Tourism Development (Supplementary)</li> </ul>  | <ul style="list-style-type: none"> <li>- Enabling PSD environment through strategic planning and budgeting that include climate change concerns</li> <li>- Harmonizing and Strengthening Traditional and Modern Methods for Coastal Protection and Erosion Control and infrastructure design, in general, factoring in climate change.</li> <li>- Barriers removal towards investment for low cost climate friendly technology</li> <li>- Sustainable tourism : developing a Tourism Environmental Policy</li> </ul>                                     |
| <b>General strategy</b> <ul style="list-style-type: none"> <li>- Limited retreat to less inhabited atolls.</li> <li>- Strengthen environmental and natural resources policies, legislation and regulations</li> </ul> <b>Disaster Risk Reduction</b> <ul style="list-style-type: none"> <li>- Disaster preparedness</li> <li>- Natural Hazard Management</li> <li>- Land Use Planning</li> </ul> | <b>Good Governance</b> <ul style="list-style-type: none"> <li>- TA4199 36365: Strengthening the Economic Planning, Policy, and Statistics Office</li> <li>- TA3522: Community-Based Coastal Marine Resources Development</li> <li>- RETA6204: Mainstreaming Environmental Considerations in Economic and Development Planning</li> </ul> | <ul style="list-style-type: none"> <li>- Capacity building for strategic planning and budgeting that include climate change concerns</li> <li>- Mainstreaming climate change into environmental and natural resources policies, legislation and regulations</li> <li>- Enhancing Early Warning Systems for Disaster Risks that include climate change risks reduction</li> <li>- Developing Policies and Procedures, and Enhancing Capacity of Local Government Level for Land Use Planning and Regulation of Building and Other Development.</li> </ul> |
| <b>Human Health and Safety</b> <ul style="list-style-type: none"> <li>- Comprehensive human health policies, disease and pest controls.</li> </ul>   | <b>Support Physical Economic and Social Infrastructure Development</b> <ul style="list-style-type: none"> <li>- TA3611: Reviewing the Health Management Information System</li> <li>- Ln1694: Ebeye Health and Infrastructure Project</li> </ul>   | <ul style="list-style-type: none"> <li>- Comprehensive human health policies, disease and pest controls</li> </ul>   |

| 8. SOLOMON ISLANDS  |  |  |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)  | ADB Current Adaptation Related Priorities<br>(CS-PAC-2008.pdf, CSP-SOL-2006.pdf and MultiDonorPipeline_Update 20112008.xls))                             | Adaptation Opportunities for ADB*  |
| <b>General Strategy</b> <ul style="list-style-type: none"> <li>- Development of a national policy framework (land use management, coastal zone management, fisheries, etc.)</li> <li>- Capacity building and institutional strengthening</li> <li>- Public awareness and education</li> </ul> | <b>Support a Conducive Environment for the Private Sector</b> <ul style="list-style-type: none"> <li>- TA4700: Supporting Business Law Reform</li> </ul> | <ul style="list-style-type: none"> <li>- Strategic planning and budgeting, including climate change adaptation.</li> <li>- Removal of barriers to investment on low cost and climate friendly technologies.</li> </ul> |

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| <p><b>Agriculture Sector</b></p> <ul style="list-style-type: none"> <li>- Improved agricultural practices (e.g. diversification, soil and water conservation) and use of technology.</li> <li>- Protection of mangrove and coral reefs system</li> <li>- Improved water management, supply, distribution and storage.</li> </ul> <p><b>Disaster Risk Reduction</b></p> <ul style="list-style-type: none"> <li>- Selective flood protection infrastructure such as plantation and other important areas.</li> <li>- Selective resettlement options.</li> </ul> | <p><b>Support Physical Economic and Social Infrastructure Development</b></p> <ul style="list-style-type: none"> <li>- TA4944: Strengthening Disaster Recovery Planning and Coordination (piggybacked to Grant-Emergency Assistance Project)</li> <li>- Grant0078: Emergency Assistance Project</li> </ul> | <ul style="list-style-type: none"> <li>- Mainstreaming climate change risks into disaster and health risks management.</li> <li>- Mainstreaming climate change risks into project designs and implementation (climate proofing)</li> </ul> |
| <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Development of a national policy framework (landuse management, coastal zone management, fisheries, etc.)</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Improved medical and health services, both preventive and curative.</li> </ul>  | <p><b>Good Governance</b></p> <ul style="list-style-type: none"> <li>- TA3061: Strengthening of Public Sector Management</li> <li>- TA3264 Population Policy and Services</li> </ul>   | <ul style="list-style-type: none"> <li>- Mainstreaming climate change concerns into developmental planning and implementation.</li> <li>- Comprehensive health policies, disease and pest controls</li> </ul>                              |

| 9. TONGA  |   |  |
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| <b>Adaptation</b><br>(Source: Country Matrix PDMCs.doc)   | ADB Current Adaptation Related Priorities (CPS-Tonga-2007-2012.pdf, CS-PAC-2008.pdf and MultiDonorPipeline_Update 20112008.xls))  | Adaptation Opportunities for ADB*  |
| <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>-Transfer of technology and knowledge; and research.</li> <li>- Long-term monitoring and research climate systems and impacts</li> <li>- Integrated management policy frameworks (coastal, water mgt)</li> <li>- Public awareness and promotion</li> <li>- Development of innovative approaches</li> </ul>  | <p><b>Support a Conducive Environment for the Private Sector</b></p> <ul style="list-style-type: none"> <li>- TA 4648: Preparing the Integrated Urban Development Project</li> <li>- TA 4488: for youth micro enterprise development</li> <li>- TA for Rationalization of Public Enterprises</li> <li>- RETA 6353 Private Sector Development Initiative</li> <li>- TA488:Youth Micro-finance</li> </ul> | <ul style="list-style-type: none"> <li>- Integrated Urban Planning, Development and Management, with Infrastructure Enhancement Component</li> <li>- Removal of barriers to technological innovation and transfer of knowledge , particularly on low cost and low maintenance technologies for climate change adaptation</li> </ul>  |
| <p><b>Coastal Sector</b></p> <ul style="list-style-type: none"> <li>- Foreshore protection infrastructure against rising sea level and extreme events</li> <li>- Land use planning and management; in particular, reclamation against rising sea level</li> <li>-Coastal replantation and revegetation</li> <li>-Integrated coral management plan</li> </ul> <p><b>Health Sector</b></p> <ul style="list-style-type: none"> <li>- Development of a standardized health impact assessment procedures, tools</li> </ul> | <p><b>Support Physical Economic and Social Infrastructure Development</b></p> <ul style="list-style-type: none"> <li>- TA 4648: Integrated Urban Development Sector Project (Urban infrastructure -roads, drainage and sanitation; Urban planning and management)</li> </ul>  | <ul style="list-style-type: none"> <li>- Mainstreaming of climate change concerns into the planning and budgeting of developmental projects (climate proofing)</li> <li>- Sustainable tourism : developing a Tourism Environmental and Disaster Risk Reduction Policy</li> <li>- Development of a standardized health impact assessment procedure / tool, including risks due to climate change</li> </ul> |
| <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Integrated management policy frameworks (land use, coastal, water mgt, disaster risk mgt. and urban planning &amp; management)</li> </ul>   | <p><b>Good Governance</b></p> <ul style="list-style-type: none"> <li>- TA4865 for Supporting Implementation of SDP-8</li> <li>- Support for economic and public sector reforms</li> <li>- Macroeconomic capacity building</li> <li>- Fiscal Governance</li> <li>- Institutional building of NRBT</li> </ul>   | <ul style="list-style-type: none"> <li>- TA for fiscal governance and macroeconomic capacity building, focusing on investments in climate resiliency</li> </ul>  |

| 10. TUVALU  |  |   |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)  | ADB Current Adaptation Related Priorities<br>(CSP-TUV-2008-2012.pdf and CSP-PAC-2006.pdf and MultiDonorPipeline_Update 20112008.xls))  | Adaptation Opportunities for ADB  |
| <u>General Strategy</u><br><br>- Strengthen Tuvalu Trust Fund capital base  | <u>Support to effective fiscal governance and management</u><br><br>Grant-0139: Improved Financial Management Program (Co-financed by the Government of Australia)                             | - Long term capacity development for improved financial management, that will include planning and budgeting for climate change adaptation.   |
| -Improved practices in agriculture, water conservation and coastal protections, among others.   | <u>Emphasis and support on social inclusiveness</u><br><br>-TA-4306: Education Sector Master Plan<br>-TA-4214: Effective Waste Management and Recycling  | - A RETA on climate change adaptation and impact mitigation<br>- Capacity building for strategic planning and budgeting for climate change adaptation.  |
| - Public education and awareness<br><br>- Research on the Islands carrying capacities, monitoring and observation.<br><br>- Research and capacity building on the use of technology | Increased resource allocation toward basic education<br><br>TA-4466: Education Sector Reform and Development<br>TA-3565: Preparing a Project to Upgrade the Tuvalu Maritime Training Institute | - Enhanced support for human capital development to prepare Tuvalu for a rather uncertain future in light of climate change,<br>- Capacity building to support for long-term programmes that include primary education and preventative health care |

| 11. VANUATU   |  |   |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)  | ADB Current Adaptation Related Priorities<br>(COBP-VAN-2009-2011.pdf)  | Adaptation Opportunities for ADB*   |
| <u>Agriculture Sector</u><br><br>- Expansion of the range of agricultural products;<br>- Capacity building (particularly on the science-based knowledge) and public awareness.<br><br>---<br>- Selection of plant varieties better suited to predicted future climates;<br><br><u>Coastal Sector</u><br>- Identification of opportunities to reduce reliance on coastal marine resources; | <u>Increase Private Sector Contribution to the Economy</u><br><br>- TA-7023 Expanding Access to Financial Services (Japan Special Fund)<br><br>- TA-4457: Secured Transactions Reforms       | - Capacity building to remove barriers to micro financing (as a form of adaptation)<br><br>---<br>- Sustainable Tourism Development<br>- Identification of opportunities to reduce reliance on natural resources and coastal/ marine resources; and capacity building |
| <u>Disaster Risk Reduction</u><br><br>- Relocation of infrastructure to areas of low vulnerability.   | <u>Supporting sustainable growth through infrastructure delivery and services</u><br><br>- TA-3224: Outer Islands Infrastructure Development<br>- Loan-1684 Cyclone Emergency Rehabilitation | - A RETA on climate change adaptation and impact mitigation through disaster risk reduction.<br>- Climate proofing in infrastructure design and specifications  |

| 12. NAURU  |   |   |
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| Adaptation<br>(Source: Country Matrix PDMCs.doc)   | ADB Current Adaptation Related Priorities<br>(Source: CPS-PAC-2006.pdf)   | Adaptation Opportunities for ADB  |
| <u>General strategy</u><br><br>- Control of population and urban growth<br>- Appropriate infrastructural development                                       | <u>Support a Conducive Environment for the Private Sector</u><br><br>TA-4590: Reform of the Nauru Phosphate Corporation                                     | - Mainstreaming environmental consideration, including climate risk assessment, into development projects. (Climate proofing) |
| <u>General strategy</u><br><br>- Land rehabilitation and protection<br>- Strengthening environmental education<br>- Control of population and urban growth | <u>Support Physical Economic and Social Infrastructure Development</u><br><br>TA-3163 Social Awareness and Transitional Requirements for the Reform Program | - Strengthening environmental education<br>- Urban planning and management  |
| <u>Coastal / marine tourism sectors</u><br>-Conservation of bio-diversity<br>- Pollution and waste management  |   |   |

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| <p><b>General strategy</b></p> <ul style="list-style-type: none"> <li>- Strengthening environmental institutions and legislation</li> <li>-</li> </ul> <p><b>Coastal / marine tourism sectors</b></p> <ul style="list-style-type: none"> <li>- Promotion of the sustainable use of marine resources</li> </ul> | <p><b>Good Governance</b></p> <p>TA-3125: Capacity Building for Financial and Economic Management</p> | <ul style="list-style-type: none"> <li>- Capacity building on strategic and sectoral planning and budgeting to include climate change adaptation</li> </ul> |
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| 13. PALAU   |   |  |
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| Adaptation<br>(Source: <i>Country Matrix PDMCs.doc</i> )  | ADB Current Adaptation Related Priorities<br>(Source: <i>CPS-PAC-2006.pdf</i> ,<br><i>MultiDonorPipeline_Update 20112008.xls</i> and<br><i>http://www.adb.org/Projects</i> )  | Adaptation Opportunities for ADB   |
| <p><b>General Strategy</b></p> <ul style="list-style-type: none"> <li>- Increased knowledge and scientific basis of current and future changes in climate, sea level and their impacts.</li> <li>- Identify mechanisms that allow development policies and plans to incorporate climate change considerations to minimize risks.</li> </ul> <p><b>Coastal Sector/Tourism</b></p> <ul style="list-style-type: none"> <li>-Protection of mangrove / wetlands</li> <li>-Setting-up of conservation and reserve areas</li> </ul> <p><b>Water Sector</b></p> <ul style="list-style-type: none"> <li>- Sustainable land-use within watersheds; riparian buffer zones to protect watersheds from development and sedimentation</li> <li>-Land-use restrictions for primary protection zones surrounding stream banks; holistic land use management plan</li> <li>-Drought mitigation planning and implementation.</li> </ul> | <p><b>Good Governance</b></p> <p>RETA6204 - Mainstreaming Environmental Considerations in Economic and Development Planning</p> <p><b>Support Physical Economic and Social Infrastructure Development</b></p> <ul style="list-style-type: none"> <li>- TA-7079: Development of a Sustainable Health Financing Scheme</li> <li>- TA4977: Babeldaob Water Supply Project: Palau</li> <li>- TA-4929: Facility for Economic and Infrastructure Management (formerly Economic, Financial and Infrastructure Policy Formulation)</li> </ul> | <ul style="list-style-type: none"> <li>- Mainstreaming climate change adaptation n to economic and developmental planning</li> <li>- Capacity building on strategic and sectoral planning and budgeting to include climate change adaptation</li> </ul> <ul style="list-style-type: none"> <li>- Mainstream climate change factors into the project design and implementation</li> <li>- PPTA on climate change adaptation and impact mitigation through disaster risk reduction.</li> </ul> |

| 14. TIMOR LESTE  |   |                                  |
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| Adaptation<br>(Source: <i>Country Matrix PDMCs.doc</i> ) | ADB Current Adaptation Related Priorities | Adaptation Opportunities for ADB |

### C. Regional Synthesis Statement on Sectoral Adaptation

In the Pacific the success of adaptation interventions will be especially sensitive to the enabling conditions and elements at national level. Countries need to ensure the following:

- Adequate institutional arrangements, including systematic planning capacity in a cooperative institutional, setting consistent policies, and measures and regulatory frameworks;
- Strong coordination of ongoing activities on a sub-national level, which could include activities that are driven by NGOs, research institutions, the private sector and by local governments;
- Scientific and technical capacities to understand the problem and its effects at the national and sub-national level, model its long-term impacts, and elaborate responses and adaptive strategies up to the stage of implementation;
- Enhanced program and project preparation capacities; and
- Citizen awareness and participation that prioritize and sustain climate change actions.

**Water.** Further flood-control measures are needed in some PDMCs in order to cope with increasing extreme high-rainfall events. Improvements in catchment management include

reforestation, land-use controls, protection of wetlands and soil conservation. Drought-alleviation measures include management of water resources (e.g. reduction of leakage, demand pricing system, waiving of import duties on water technologies), water legislation, development of alternative water resources such as groundwater and the increased use of roof catchments. Flood-damage potential can be reduced by regulating development on flood plains and promoting flood-proof building design. Various activities at community level can improve awareness of water conservation and emergency response. Institutional development such as the creation of catchment and water authorities will help build capacity to improve the management of water resources.

**Agriculture.** Several areas would benefit from additional research and capacity building, including: (i) assessing the sustainable qualities of traditional agricultural systems and developing appropriate approaches to intensive commercial agriculture; (ii) identifying more flexible farming systems that are tolerant to climatic variability; (iii) strengthening of land use planning to improve identification of areas most suitable for key commercial and subsistence crops; (iv) assessing economic agricultural policies such as subsidies; (v) identifying and maximizing opportunities created by climate change to grow new crops and in other ways benefit from climate change; and (vi) establishing and maintaining gene banks and planting materials, including drought and salt resistant crops.

There is also a need for improved understanding of climate variability and its impact on cropping and tillage patterns and on income and employment structures, leading to specific agri-adaptation strategies. This will likely result in the need for technical assistance to support the implementation of adaptation interventions, including access to agrometeorologists/hydrologists, climate modelers, risk management specialists, adaptation economists/socio-economists, crop and climate modelers/bio-economic modelers, and climate impact and risk specialists with expertise in geographic information systems and remote sensing.

**Natural Disasters and Hazards.** Natural hazard management policies and plans should be enhanced to enable urban and remote communities to deal with extreme events such as droughts and storms. These should include: (i) implementing disaster preparedness activities such as an inventory of appropriate sites and infrastructure for potential shelters; (ii) climate proofing critical assets such as reservoirs, waste management facilities and coastal protection; (iii) reducing risk of post-disaster disease outbreaks by optimizing sanitation infrastructure design; and (iv) implementing appropriate public awareness strategies. National Red Cross/Red Crescent Societies are at the front line in civil defence and have a long track record in risk management activities. They should be engaged in ADB's climate change responses, to promote synergies between disaster risk reduction and climate risk management and adaptation activities.

**Coastal and Marine.** A broad spectrum of coastal and marine protection options should be considered, and tailored to those which can be implemented at community level. This includes creation/protection of natural marine buffer zones such as sand bars, nearshore coral reefs, and on-shore coastal dunes, especially in high risk mangroves and coral reef areas vulnerable to sedimentation and bleaching. Introduction of fish aggregating devices can also bolster near-shore fish nurseries and improve demersal fish stocks. Improved understanding of coastal systems, such as sediment transport, is required. Land use policies should discourage settlement in low-lying coastal areas, consistent with cultural practices and land tenure systems. Reclamation of mangrove areas for residential, commercial, tourism, industrial, and other purposes should be discouraged and reduced, and mangrove rehabilitation should be undertaken where possible. Water-catchment management and soil-

conservation measures will reduce erosion and sedimentation. Mangrove and reef protection measures include public awareness and legislative measures such as penalties for mangrove and reef destruction. Enhancement programs for fish stocks and corals should be explored, including the use of artificial reefs as a way to enhance coastal protection and increase species diversity and abundance. Use of coral as a construction aggregate should be discouraged.

**Infrastructure, Human Settlements and Livelihoods.** Vulnerability to extreme weather and climate events increases with additional human settlement close to the high water mark, as well as a result of the ecological and economic risks posed by lagoon pollution, beach degradation. This highlights the need for better monitoring and management of current development efforts and projected economic growth. Urbanization has reduced the availability of productive agricultural land. The remaining areas will often require special alternative systems of cultivation and salt resistant crops. When responding to the challenges of shoreline change, limited retreat is an adaptation option for some of the larger islands in less inhabited atolls, but can only occur with the concurrence of the owners of the less affected land. Such adaptation will require long-term land use planning, along with changes to traditional patterns of land tenure. This may be difficult to achieve without appropriate compensation mechanisms. Moreover, retreat may not be an option for people of some of the more highly populated islands. Where there has been considerable investment in housing and infrastructure the provision of costly shoreline protection works may be necessary. But this raises several issues: who is going to pay for the protection works, who will undertake the construction of the protective structures and where will the materials for the defensive works come from? For some people, resettlement off-island may be another option. However, this will need to be accommodated without disruption to the new host communities and with due sensitivity for the traditional values of the island peoples. This applies to both the relocated and host communities.

For existing infrastructure, each PDMC should develop an infrastructure portfolio at risk and consider adaptive redesign retro-fitting of existing stock to build resilience against expected climate impacts. For new developments, PDMCs need to incorporate climate-oriented design engineering, include protocols in their development plans and incorporate stringent climate adaptive development guidelines (e.g. coastal setback guidelines and land use variance policies to reduce possible risks from climate and extreme weather impacts.

**Gender.** Inequality is a major contributing factor to vulnerability to climate change. It is important to map the multiple vulnerabilities of various groups across the population, from children to the elderly and people with disabilities. Special attention needs to be given in all policy areas to the different impacts that climate change-related factors will have on women. Greater equity and social justice could save at least as many lives as a large infrastructure construction project. The gender dimension needs to become a central focus of discussions to increase our understanding of the impacts on resilience and adaptive capacity to climate change. On the ground, responses to climate change focus on subsistence sectors primarily managed by women, such as agriculture, water and energy. While women may be the primary laborers, they are often not the decision-makers. Therefore, by increasing the control of women over resources and decision-making through improved access to knowledge and information, there are opportunities to increase both women's empowerment and the effectiveness of measures for climate change adaptation and mitigation, particularly at the community level through support and self-help groups.

**Human Health.** Detailed studies on the impacts of climate change on human health should be undertaken, including monitoring of relevant diseases and prevalence rates. Pathways

through which the diseases spread should also be determined. The use of appropriate traditional medicines should be encouraged. There is also a need to ensure that overall development policies do not exacerbate disease risk. The serious implications of climate change for human health in the Pacific may well require development of a comprehensive suite of human health policies to address water borne diseases and other sicknesses that are related to climate-induced change, including those arising from poor water quality and nutrition. Adaptation options for the effective control of dengue fever include eradication of artificial breeding sites (e.g. litter, solid waste, water containers), preventing entry of mosquitoes by strengthening quarantine regulations and border surveillance, and decreasing exposure by using more appropriate building designs and as well as mosquito nets. Key interventions that would reduce the climate-change-related effects on the incidence of diarrhoeal disease include improved reliability and safety of water supply, improved sanitation, improved refrigeration and storage of perishable foods, preparation of emergency strategies to cope with the effects of floods and droughts and improved provision of, and access to, primary health care. Potential problems with heat stroke and discomfort should be addressed through improved building design and materials, including increased use of traditional building styles and shade trees.

**Relocation.** As noted above, the long-term effects of climate change may result in the relocation of substantial numbers of people, if not the entire population of a country. Thus increased migration has the potential to be a significant consequence of climate change. Potentially, the Pacific region is the most vulnerable region worldwide to climate change induced migration. The International Organization for Migration notes that small islands will face the highest relative increase in risk, and highlights the vulnerability of the Pacific. The risk that climate change might trigger mass migration has significant implications for development. Forced migration can hinder development by increasing pressure on urban infrastructure, undermining economic growth, increasing the risk of conflict and leading to worse health, educational and social indicators among migrants. Climate change migration also has implications for the nature of development support. Local infrastructure projects might provide limited benefits if people are going to be compelled to leave an area. Effort might be better directed towards giving people the skills to make their move as easy as possible. The vulnerability of the Pacific region means that these considerations are particularly important for ADB.

## Appendix 6: Sector-based Mitigation Strategies

This appendix provides detailed estimates of EE and RE potential. The estimates do not include possible efficiency gains from expanded natural gas utilization in PNG and Timor-Leste.

The appendix also provides guidance on the focus of sector-based mitigation strategies for individual PDMCs as well as regionally.

### Energy Balances, GHG Emissions, and RE and CDM Potential

| Fuel Use Million L/y (except as noted)               |                                | Cook Islands | Fiji   | Kiribati | RMI   | FSM   | Nauru | Palau | PNG     | Samoa  | Solomons |
|--|--------------------------------|--------------|--------|----------|-------|-------|-------|-------|---------|--------|----------|
| <b>Gasoline</b>                                      | Sugar cane area (ha) for E100* | 4.1          | 82.4   | 2.9      |       | 7.0   | n/a   |       | 120.1   | 25.5   | 16.2     |
| Jet fuel   |                                | 2,425        | 49,191 | 1,732    |       | 4,157 | n/a   |       | 71,707  | 15,242 | 9,700    |
| Kerosene   |                                | 12.8         | 27.9   | 1.2      |       | 8.7   | n/a   |       | 79.5    | 0.0    | 2.3      |
| Distillate   |                                | 0.0          | 18.6   | 2.3      |       | 0.0   | n/a   |       | 25.5    | 9.9    | 2.3      |
| Residual   |                                | 8.1          | 307.5  | 4.6      |       | 4.6   | n/a   |       | 724.7   | 26.1   | 49.9     |
| LPGs   |                                | 0.0          | 4.1    | 0.0      |       | 38.9  | n/a   |       | 481.0   | 0.0    | 0.0      |
| Unspecified  |                                | 0.0          | 14.5   | 0.0      |       | 0.0   | n/a   |       | 7.5     | 0.0    | 1.7      |
| Natural Gas (M m3/y)                                 |                                | 0            | 44.1   | 1.2      |       | 0.0   | n/a   |       | 12.8    | 0.0    | 2.3      |
| Coal (1000 tons/y)                                   |                                | 0            |        |          |       |       |       |       | 139.9   |        |          |
| <b>EXISTING POWER SYSTEMS</b>                        |                                |              |        |          |       |       |       |       |         |        |          |
| Hydroelectric (MW)                                   | Generation MWh                 |              | 79     |          |       |       |       |       | 224     | 12     |          |
|  | Availability                   |              | 670    |          |       |       |       |       | 925     | 40     |          |
| Thermal (MW)   | Generation MWh                 | 8            | 120    | 3        |       | 10    |       |       | 320     | 18     | 12       |
|  | Availability                   | 28           | 282    | 9        |       | 30    |       |       | 2419    | 66     | 55       |
| Geothermal / other installed (MW)                    |                                | 41%          | 28%    | 35%      |       | 35%   |       |       | 89%     | 43%    | 54%      |
| <b>Transmission &amp; Distribution Losses</b>        |                                |              |        |          |       |       |       |       |         |        |          |
|  |                                | 7.1%         | 7.0%   | 11.1%    |       | 6.7%  |       |       | 7.0%    | 6.6%   | 7.3%     |
| <b>Total GHG Emissions (M m ton CO2)</b>             |                                | 0.06         | 1.47   | 0.03     |       | 0.17  |       |       | 4.69    | 0.15   | 0.19     |
| <b>Cumulative Emissions</b>                          |                                | 0.06         | 1.53   | 1.56     |       | 1.73  |       |       | 6.42    | 6.57   | 6.76     |
| <b>% of regional total</b>                           |                                | 0.86%        | 21.06% | 0.43%    |       | 2.44% |       |       | 67.19%  | 2.15%  | 2.72%    |
| <b>% of global total emissions</b>                   |                                |              |        |          |       |       |       |       |         |        |          |
| <b>Renewable Energy Potential (MW)**</b>             |                                | 2.14         | 107.5  | 0.14     | 0.137 | 2.86  | 0.015 | 0.529 | 238     | 11.2   | 0.64     |
| <b>Possible CDM Projects (MW except as noted)***</b> | Biomass Power                  |              | 85.8   |          |       |       |       |       |         | 7.5    |          |
|  | Geothermal                     |              |        |          |       |       |       |       | 50      |        |          |
|  | Hydropower                     |              | 41.8   |          |       | 8.7   |       |       | 315.7   | 9.95   |          |
|  | Solar                          |              | 1.8    |          | 0.15  |       |       |       |         | 1.35   |          |
|  | Wind                           |              | 45.9   |          |       |       |       |       |         |        |          |
| <b>Energy Efficiency (MW-hours)</b>                  |                                |              |        |          |       |       |       |       |         |        |          |
| Landfill gas (Tons/year CO2 equivalent)              |                                | 2997         | 41,675 | 1,872    |       |       |       |       | 14,760  | 108    |          |
| Forestry (Tons/year CO2 equivalent)                  |                                | 1,451,523    |        |          |       |       |       |       | 339,699 | 4,600  | 4,273    |
| Number of Small Scale Forestry Projects              |                                | 182          |        |          |       |       |       |       | 494     |        |          |

**Sources:**

Fuel use, existing power systems information, and GHG emissions from US DOE EIA 2004

\*\*Estimated renewable energy potential from PIC CDM report prepared by S. Srikanth. 2008. In-country Capacity Building and Uptake of Clean Development Mechanism (CDM) Projects in the Pacific Island Countries. [Provided by Yiyang Shen, Senior Energy and Carbon Finance Consultant, ADB-RSID.]

\*\*\* Possible CDM project information from SMEC, Baker & McKenzie. 2007. Baseline Study on Opportunities under the Clean Development Mechanism (CDM). N. Sydney Australia [prepared for the Pacific Islands Forum Secretariat.]

**Energy.** Energy development is now driven from the perspectives of (i) energy and economic security, (ii) sustainable development, and (iii) sustainable environment, locally, nationally and globally. The present approach is considered more participatory and holistic, and has an improved chance of success.

All PDMCs have potential to reduce GHG emissions through energy efficiency (EE) and conservation measures, and to develop some mix of hydropower, wind, solar, biomass, geothermal, and ocean-based energy resources. The share of renewable energy in the power generation mix ranges from 0% in most PDMCs to more than 50% in a few, with hydropower accounting for most of the renewable generating capacity (see Appendix 4). Opportunities exist for energy efficiency improvements on both supply and demand sides. These should be pursued on high priority basis, prior to merely expanding energy supplies.

Total EE and RE potential estimates range from about 365 MW to over 600 MW.<sup>7</sup> Donors are generally including EE and renewable energy (RE) development in their assistance portfolios, and there is a real prospect for transitioning to a near zero-GHG economy in the foreseeable future. Recent RE projects appear to be more successful, especially in countries where sector reforms are fostering fully commercial power operations. RE is also recognized as being more reliable for off-grid applications than conventional diesel generator sets. RE costs are becoming increasingly competitive: electricity cost for solar photovoltaic systems is now typically \$0.20 per kilowatt-hour (kWh), modern biomass cogeneration is typically \$0.06 – 0.08 /kWh, and small-scale biogas systems are \$0.07 – 0.10 / kWh,<sup>8</sup> vs. \$0.45 – 0.65 /kWh for conventional diesel generator sets.<sup>9</sup>

Despite the EE and RE potential, significant financing via the Clean Development Mechanism (CDM) or other carbon markets has yet to be mobilized for GHG mitigation, with only 2 exceptions.<sup>10</sup> This is attributable to low GHG baselines, small candidate project size, high transaction costs, and limited in-country expertise to identify candidate projects and prepare the necessary documentation.<sup>11</sup> Thus, most PDMCs face the combined challenge of expanding modern clean energy supplies and services, with limited local expertise and institutional capacity, and constraints on access to carbon finance. However, Global Environment Facility funds are available and new funds for mitigation and adaptation are expected to become available in 2009.

Given the low GHG emissions on a total and per capita basis, mitigation has traditionally had lower priority than adaptation. The relative effort also reflects the historic emphasis of international assistance on mitigation as opposed to adaptation. The surge in crude oil and petroleum product prices from 2007-2008 has engendered renewed interest in reducing consumption, for both economic and financial reasons. Historically, petroleum imports have been equivalent to about 20% of the total exports of a few countries, to more than 40% in most. In recent years, surging petroleum prices caused the value of fuel imports to exceed total merchandise

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<sup>7</sup> This is in addition to existing generation capacity from diesel, geothermal, and hydropower totaling about 882 MW.

<sup>8</sup> This estimate for biogas power generation is from J. Hedbrandh, RSID, memo dated 15 February 2008.

<sup>9</sup> Cost of diesel generation is from Peter Johnston "Report on a Brief Mission to Yap on Electric Power Issues: October 26-28, 2008." Prepared under ADB TA 6477-REG.

<sup>10</sup> As of December 2008, only 2 CDM projects had been registered in PARD countries: the Wainikasaou & Vaturu Hydropower Plants in Fiji (9.5 MW total), and the Lihir Geothermal Power Project in PNG (55 MW).

<sup>11</sup> This has also been the case for many countries in Africa.

exports from most PARD countries (e.g., double the exports in Samoa and Tonga, 85% of exports in Kiribati, and 66% in Fiji in 2005).

Currently there are many technical, market, finance, policy, institutional, and awareness barriers to renewable energy systems operating sustainably and being price-competitive relative to fossil fuel-based systems. Past RE projects have been designed to demonstrate the applicability of the technologies to the PDMC environment and for rural development purposes, and to some extent have been donor-driven and technology specific. Given the continued reliance on petroleum for power generation, it is safe to conclude that most of the past RE projects have not been successful due to the “demonstration” nature and lack of scale-up.

Since diesel generation technology is already widely used, some near-term attention should be directed to retrofit existing generation facilities with renewable energy technology for “hybrid” operations (including use of biodiesel blends). Modern biomass energy has not been widely developed, but should be considered in the context of renewable fuels for power generation and transport. E.g., Fiji has identified 9 biomass power projects with a total capacity of 85 MW. Feasibility studies in Samoa suggest that with appropriate electricity pricing, coconut-derived biodiesel could be feasible as a supplementary fuel for power generation. In Vanuatu, private utility UNELCO is running 2 generator sets on diesel-coconut oil mix (10% blend in 1 unit and 5% blend in a second unit). In the long-term, larger scale commercial biofuel production may become feasible, depending on crude oil prices.

**Transport.** The transport sector, which utilizes almost 100% fossil fuel, can be subdivided into local, inter-island, and regional subsectors. At the local level, urban public transport probably offers the best opportunity for efficiency improvements at scale. At the inter-island and regional level, existing ocean and aviation systems are expected to remain heavily reliant on petroleum fuels for the foreseeable future, with renewable fuels possibly gaining share over the long term. Compressed natural gas may be viable in PNG and Timor-Leste. Fuel efficiency gains in the transportation fleet will be limited by slow fleet turnover, and local markets which are dominated by imported used cars.

**Urban and Industrial Development.** Aside from transport and energy consumption in buildings, GHG emissions are derived from industry and waste management. Industrial emissions can best be addressed through energy efficiency and cleaner technology measures. Waste management presents opportunities for multiple benefits, i.e., solid waste management and wastewater treatment systems can be upgraded for energy recovery, which would serve to reduce local pollution loads, with concomitant public health co-benefits. Such energy recovery should qualify for carbon finance, e.g., CDM or voluntary market transactions (see Appendix 4 for prospective landfill gas recovery projects).

**Land Use.** As noted above, the PICCAP study and Pacific Region Environmental Strategy indicate that reforestation could provide carbon sinks, but that ongoing logging in some countries may result in positive GHG emissions for the region as a whole. Long-term land use issues are complicated by the prospect of total land area in the region decreasing as sea level rises. Smaller low-lying atolls may eventually be abandoned, with climate migrants relocating to high(er) islands, which would presumably increase pressure on forested areas. Alternatively, if climate migrants relocate outside the region, this might not become a major issue. Any biomass energy plantation development must be carefully managed in order to prevent increases in emissions, e.g., from chemical fertilizers, and avoid adverse impacts on other sectors and development priorities, such as food security. With appropriate

management and multi-cropping, biomass energy plantations could be an economically attractive means of reforestation with carbon sequestration benefits. Appendix 4 includes estimated CO<sub>2</sub> emissions reductions from forestry projects in Fiji, PNG, and Tonga.

**Country-specific Guidance on Priority Mitigation Interventions to be considered for Inclusion in CPSs<sup>12</sup>**

| Country                        | Proposed Priority Mitigation Interventions  |
|--------------------------------|---|
| Cook Islands                   | Reduced greenhouse gas emissions through improved energy efficiency and conservation. Possible use of small-scale combined cooling, heat, and power (tri-generation) at hotels, hospitals, schools, and commercial buildings  |
| Fiji Islands                   | Improved efficiency of energy consumption in the transport sector; improved awareness of the government and civil society of the benefits of energy efficient transport systems. Support for EE in industrial and commercial facilities. Support for expanded hydropower, biomass power, afforestation/reforestation, and possibly biofuels.  |
| Kiribati                       | Reduced green house gas emissions through use of clean renewable energy   |
| Marshall Islands               | Promote a coordinated approach to RE financing by donors and financiers. Possible support for small-scale solar PV systems.   |
| Federated States of Micronesia | Enhanced carbon sequestering through improved capacities for sustainable forest management, sustainable agriculture and reduced deforestation.  |
| Nauru                          | Reducing emissions from power generation; defining the baseline for mitigation projects; introduction and use of solar thermal energy for water heating and solar photovoltaic energy for lighting. Possible support for small hydropower projects under CDM  |
| Papua New Guinea               | Fuel switching from petroleum to natural gas for power generation and possibly urban transport. Widespread application of biomass-based energy systems, including residential/village scale biomass digester-gasifier systems and biomass cogeneration. Development of forestry-based CDM projects. Develop additional geothermal and hydropower capacity with private sector led investment. |
| Palau                          | Improved local expertise, experiences, and skills to monitor and analyze RE resources measurements and data; plan, design, monitor and maintain renewable energy installations.   |
| Samoa                          | Expanded use of coconut-derived biofuel as alternative to fossil fuel; improved EE design for buildings. Possible support for industrial cogeneration (including use of biofuel blends), and tri-generation in commercial and institutional facilities (hotels, hospitals, schools)   |
| Solomon Islands                | Increased reforestation and use of biomass energy   |
| Timor-Leste                    | Combating land degradation through integrated policies and development of alternative energy sources and improved agricultural practices for forest-reliant poor. Possible support for fuel switching from petroleum to natural gas for power generation and urban transport.   |
| Tonga                          | Improved energy efficiency of existing buildings, and energy efficiency compliance of new buildings.  |
| Tuvalu                         | Solar photovoltaic systems for seven outer islands to improve livelihoods of outer island communities and reduce greenhouse gas emissions   |
| Vanuatu                        | Improved energy efficiency through use of renewable sources; improved energy efficiency of motorized transport; higher levels of non-motorized transport; improved understanding of biofuels and possible support for small-scale ethanol and biodiesel production and use  |

<sup>12</sup> Sources: Preparatory Reports for GEF Pacific Alliance for Sustainability, National Communications, National Adaptation Programs of Action and other sources listed in Appendix 2. CDM and RE project information from : (i) SMEC, Baker & McKenzie. 2007. Baseline Study on Opportunities under the Clean Development Mechanism (CDM). N. Sydney Australia [prepared for the Pacific Islands Forum Secretariat.] (ii) S. Srikanth. 2008. In-country Capacity Building and Uptake of Clean Development Mechanism (CDM) Projects in the Pacific Island Countries. [Report provided by Yiyang Shen, Senior Energy and Carbon Finance Consultant, ADB-RSID.]

**Appendix 7:**  
**Focus of Climate-related Activities by Key Donors in the Pacific**

| Donor                 | Adaptation   | Mitigation  |
|-----------------------|--|---|
| <b>ADB</b>            | Climate-proofing ongoing projects and building climate resilient design into new projects; assisting with mainstreaming climate change considerations into national policies and planning processes  | Assistance emphasizes energy conservation and efficiency (including supply- and demand-side measures), renewable energy deployment, reduction of GHG emissions from transport, solid waste, and wastewater treatment systems, and land use.   |
| <b>AusAID</b>         | Australia will invest \$150 million over three years to meet high priority climate adaptation needs in vulnerable countries; the primary geographic emphasis of the program will be Australia's neighboring island countries; the adaptation program is based on the premise that building the capacity of developing countries to respond effectively to the impacts of climate change is a long-term process, requiring sustained international technical support and financial assistance over decades  | An increasingly important area of work for AusAID is assisting countries to develop and strengthen policies and programs that support sustainable development, particularly through initiatives that reduce the carbon footprint associated with the growth of their economies; Australia provides assistance to improve energy sector policies, finance high priority energy projects and support clean energy initiatives; Australia's contribution to the World Bank's Forest Carbon Partnership Facility assists developing countries to establish credible estimates of their national forest carbon stocks, identify sources of forest-related emissions, determine the opportunity costs of avoided deforestation interventions and design appropriate response strategies |
| <b>European Union</b> | Assist partner countries adapt to the consequences of global warming (adaptation measures), while supporting their endeavors to limit emissions and to maintain carbon stocks, within the overall objective of sustainable development (attenuation measures). Areas of focus include: <ul style="list-style-type: none"> <li>▪ strengthening regional capacity to support national goals in RE and EE technologies, possibly by establishing a Centre of Excellence in RE;</li> <li>▪ Enhancing the regional capacity to support and implement national adaptation measures designed to build resilience to climate change;</li> <li>▪ provision of adequate additional technical and financial support to ensure that climate change policies, in particular for adaptation, are fully operations in all PICs;</li> <li>▪ supporting initiatives addressed disaster risk reduction and disaster management to reduce the overall vulnerability of the Pacific to both natural and other hazards and to increase community safety and resilience against the impact of disasters; and</li> <li>▪ supporting initiatives addressing security and potential conflicts linked to natural disasters and/or climate change.</li> </ul> |   |
| <b>GEF</b>            | Sustainable development in the Pacific Islands Region through improvements in natural resource and environmental management, by facilitating international financing for sustainable development of eligible PICs, including responses to climate change   |   |
| <b>Japan</b>          | Assistance for strengthening of the capacity to deal with sea-level rising caused by the global warming  |   |
|                       | Scientific capacity building/enhancement for sustainable development<br>Cooperation with Australia and New Zealand will be enhanced, as appropriate  |   |
| <b>NZAID</b>          | Addressing issues that are already development challenges but which could be exacerbated by climate change, including food and water security, health; enhancing the capacity to deal with extreme events such as tropical cyclones, flooding and droughts; responding to the immediate humanitarian needs after disasters; supporting and promoting longer-term disaster risk reduction, mitigation and preparedness, both regionally and through bilateral programs.   |   |

|                       |   |   |
|-----------------------|---|---|
|                       | Approximately NZ\$10 million assistance to Pacific Regional Organizations to support sustainable natural resource management, disaster risk reduction, renewable energy and climate change  |   |
| <b>United Kingdom</b> |   | Climate change and energy security is one of three key strategic headline priority areas for UK Foreign Policy focus in the Pacific; PNG has been highlighted by the UK as a frontline climate change country that is positioned to play a substantial role in the mitigation of global warming and the overall international response to climate change. |
| <b>UNDP</b>           |   | Energy efficiency, renewable energies, and sustainable transportation   |
|                       |   | Integrated and sustainable human development oriented strategies to address climate change mitigation, adaptation to climate risks and other hazards; strategic planning and policy at national level, implementation of adaptation and mitigation actions and on mainstreaming climate change into core national development activities                  |
| <b>UNITAR</b>         | Capacity Development for Adaptation to Climate Change and GHG Mitigation: €1 million grant from the European Commission, to establish seven regional centres of excellence, including one in the South Pacific  |   |
| <b>World Bank</b>     | <p>The World Bank undertakes analytical work on regional environmental issues, including climate change adaptation; it provides policy advice on environmental risk management and climate change adaptation, finances a small number of lending operations in the health and infrastructure (including natural hazard recovery) sectors and provides technical assistance grants in health, private sector development, environment and conservation, including support for capacity building; the Bank also provides tools and procedures to ensure that all projects and programs it finances adhere to internationally accepted good practices in environmental management; the Bank undertakes country-specific activities in its nine Pacific member countries, while its regional strategy focuses on creating an environment conducive to generating sustainable economic growth and employment, while recognizing that small populations and marked remoteness of PICs pose significant development challenges; the Bank delivers its assistance through strategic economic and sector work, multidonor dialogues to promote donor coordination on a thematic basis, targeted policy notes to disseminate key messages, and focused technical assistance to implement reforms. Selective lending activities actively seek to leverage donor resources to maximize their policy impact. The assistance balances demand-driven, country specific initiatives with regional level initiatives to help create regional public goods. Since the focus of the Bank's assistance is primarily on analytical and advisory work, intensified efforts at communications outreach and dissemination is emphasized</p> |   |