# VULNERABILITY & ADAPTATION

## EVALUATION AND REGIONAL SYNTHESIS OF NATIONAL ASSESSMENTS OF VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

South Pacific Regional Environment Programme (SPREP)

SPREP's Climate Change and Integrated Coastal Management Programme

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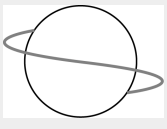

GEF

This report was prepared for the South Pacific Regional Environment Programme by John E. Hay and Graham Sem

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# Executive summary for policy makers

The Pacific Islands Climate Change Assistance Programme (PICCAP) is a three-year climate change enabling activity involving 10 Pacific Island Countries (PICs): Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Samoa, Solomon Islands, Tuvalu and Vanuatu. PICCAP is designed to assist PICs in meeting their reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC). The project is funded by the Global Environment Facility (GEF), implemented by the United Nations Development Programme (UNDP) and executed by the South Pacific Regional Environment Programme (SPREP).

To enable countries to fulfill their reporting requirements, PICCAP has been providing and facilitating technical assistance to national climate change teams and experts. This assistance has resulted in technical studies that will form the basis for their initial national communications to the Conference of the Parties (CoP) to the UNFCCC. Five activities have been undertaken by the national teams and experts, including a national assessment of vulnerability and adaptation to climate change. To ensure maximum value is gained from this work, the findings from each country need to be reviewed, evaluated and synthesised. The current regional assessment and synthesis is intended to complement and facilitate completion of the initial national communications.

In addition to fulfilling obligations under the Convention, the completion of these vulnerability and adaptation assessments is also of note for a number of important reasons:

- the completed assessments provide a comprehensive set of national findings prepared using international best practices;
- the information can be used in the preparation of national sustainable development strategies and for assessing the success of these strategies over time;
- the findings can be used to shape the positions taken in both national and international environmental policy discussions. In this respect, it is especially helpful to be able to describe, in both qualitative and quantitative terms, national and local vulnerability to climate change and the adaptive capacities at both national and local levels;
- the assessment results provide guidance for international, regional and bilateral agencies and donors willing to provide financial, technical and other support for adaptation projects and programmes. The newly acquired assessment findings assist agencies and donors to identify where the greatest environmental, social and economic benefits can be achieved; and
- by combining the findings of the 10 national assessments it is possible to prepare the first substantive assessment of the Pacific Island region's vulnerability to climate change and the capacity to implement adaptive responses.

The obvious and overall strength of the 10 national assessments is that they have been prepared using comparable methods that are in turn based on international best practices. The commendable effort that has gone into compiling the findings will be invaluable for estimating the region-wide vulnerability, its capacity to adapt and the means by which this might be achieved.

An historic overview of national assessments of vulnerability and of adaptation options is presented first as a background. This leads into a description of the new national studies recently undertaken with support by PICCAP. The contributions made to our overall understanding of the region's vulnerability and options for adaptation are highlighted.

The recently completed assessments represent a significant advancement in terms of both the ability to undertake such studies and the level of understanding of the extent to which PICs are vulnerable and are able to respond to the threats and realities of climate change. However, considerable additional work is needed to address shortcomings in the methodologies, gaps in our knowledge, data constraints and remaining uncertainties.

The UNFCCC guidelines for the preparation of initial communications by non-Annex 1 Parties signal a clear preference for information to be presented in the form of numerical indicators. The 10 PICCAP countries were unable to report their findings in such a manner. Indeed, there is an urgent need to strengthen the vulnerability assessment methodology, which is based on the Intergovernmental Panel on Climate Change (IPCC), so that the findings can be expressed this way.

The resulting national assessments have been reviewed, and common themes identified.

All 10 studies chose to focus on specific sectors, as well as assessing vulnerability on a cross-sectoral basis. The most commonly studied sectors were agriculture, water resources, coastal systems and human health. Only two assessments addressed the vulnerability of the fisheries sector. This may well reflect the difficulty of undertaking a vulnerability assessment for this sector, due in part to the lack of relevant information.

The assessments showed that climate variability, development and social changes, and the rapid population growth being experienced by most PICs are already placing pressure on sensitive environmental and human systems. The adverse impacts arising from these sources of stress on environmental and other systems would be exacerbated when the anticipated changes in climate and sea level (including extreme events) do materialise. Similarly, the future health and productivity of coral reef and mangrove ecosystems will have a significant influence on the future wellbeing of most PICs; for example, the anticipated detrimental effects on coral reefs arising from higher sea surface temperatures and CO2 levels will be worsened by the degraded nature of these ecosystems. Moreover, land use changes, including settlement and use of fragile and vulnerable lands for agriculture, are decreasing the natural resilience of environmental systems and hence their ability to accommodate the anticipated additional stresses arising from changes in climate and sea level.

Given the limited area and low elevation of the habitable lands, the most direct and severe effects of climate and sea level changes will be increasing risks of coastal erosion, flooding and inundation. These adverse effects would be exacerbated by any combination of seasonal storms, high tides and storm surges. Other direct consequences of anticipated climate and sea level changes would likely include a reduction in subsistence and commercial agriculture production of such crops as taro and coconut, and decreased security of potable and other water supplies. Assessments also indicate increased risk of dengue fever, malaria, cholera and diarrhoeal diseases and decreased human comfort, especially in houses constructed in western style and materials.

Groundwater resources in the lowlands of high islands and atolls will likely be adversely affected by flooding and inundation associated with sea level rise. Moreover, water catchments of smaller, low-lying islands will be at risk from any changes in the frequency of extreme events. Climate and related oceanic variations already have significant adverse impacts on fish catches, both subsistence and commercial. The anticipated changes in climate and ocean conditions will further reduce the security of this resource.

1. The national assessments of potential adaptation measures had many elements in common, reflecting the similarities in vulnerability, as described above.

   (1) Where agriculture is practiced in vulnerable, low-lying areas, the breeding and introduction of salt tolerant root crops is seen as an effective measure. Alternatively, different cultivation practices might have to be considered, such as the use of irrigated raised-bed systems. For drought prone upland areas the breeding of more drought resistant cultivars and crops is advocated. One effective adaptation strategy would be to develop a formal plan related to the use of plants and trees, and to selectively plant species that are best suited to a particular physical environment, purpose and use. Improved soil and water conservation practices in both drought and flood prone areas is seen as an important means of maintaining productivity, and hence food security. Intercropping and increased diversity of crops is also viewed as a strategy for increasing the resilience of the agriculture sector in both coastal and upland areas. Thus diversification to a wider range of plantation crops would spread the risk of loss from climate change, including increased incidence of extreme events. Likewise, it is considered prudent to extend the planting of plantation crops to other areas or islands. This would again spread the risk of production losses due to extreme events such as cyclones.

(2) The resilience of traditional agricultural systems could be enhanced by diversifying subsistence crops, promoting agro-forestry, encouraging sustainable practices and developing economic opportunities. Re-evaluation of the traditional value system of the products and uses of trees and other plants is advocated for appropriate areas.

(3) Quarantine surveillance should be increased against introduced and invasive species that have higher temperature optima, or which may become adapted to environments at higher elevations, and the like.

(4) Introduction of appropriate disincentive policies related to the consumption of imported staple foods (such as price controls on rice and flour) should be reconsidered, and incentive policies for the production and consumption of local foods should be given priority. This will enhance the security of food supplies.

(5) Agricultural policies, such as subsidies on cash crops, should be evaluated and monitored to ensure they do not undermine cultural and social systems and the traditional values underlying subsistence agricultural systems. Such considerations will enhance the resilience of these systems to climate change and other stresses.

(6) Enhanced protection of mangrove areas and sensitive coral reef systems is considered an effective way to ensure these systems can cope with the added stresses arising from climate change and sea level rise. Integrated catchment and coastal management planning would produce a variety of outcomes that collectively increase the resilience of coastal systems. In heavily populated areas, or those associated with high value infrastructure or economic activity, foreshore protection measures including revegetation and establishment of setback zones are considered to be cost effective adaptation measures to protect against flooding and erosion. Measures to protect existing foreshore vegetation and encourage revegetation would help reduce the vulnerability of coastal areas. Moreover, the replanting of littoral forests would help protect sensitive coastal environments. Sea walls are seen as a high cost adaptation option that would only be of value for very specific areas, and impractical on a large scale.

(7) Preventing the discharge of pollutants in coastal and marine areas is identified as a priority measure to enhance the resilience of coastal and marine ecosystems.

(8) In some areas an appropriate response may be to re-establish traditional systems of ownership and specific rights on coastal areas such as reef patches and shoals.

(9) Measures to control aggregate removal for construction and other uses would also help reduce the risk of erosion and other undesirable impacts of climate change and sea level rise. Similarly, reclamation should be actively discouraged.

(10) Resettlement options may become necessary for some areas, but the high social, economic and environmental costs associated with resettlement make it an option of ‘last resort’.

(11) Public awareness programmes related to malaria, dengue fever and other diseases are an essential, low-cost method for reducing the public health risk. Such programmes have already been initiated and are considered to be relatively effective, as is the use of bed nets and mosquito screens.

Past experience suggests that mosquito eradication is not a practicable option, due to the high financial and environmental costs, and no guarantee of success. However, biological control may become a viable option some time in the future. Moreover, reduction of mosquito breeding sites within towns and villages (e.g. informal waste dumps, open water tanks, discarded containers such as cans, tyres) is already considered to be an effective method for reducing local malaria risk. Enhanced quarantine measures are also suggested as a priority response.

(12) In general, an improvement in medical services is viewed as an appropriate response strategy, due to the high benefits that accrue to local

communities. Similar reasoning suggests the increased use of traditional medicines.

(13) Improved management and maintenance of existing water supply systems has been identified as a high priority response, due to the relatively low costs associated with reducing system losses and improving water quality. Centralised water treatment to improve water quality is considered viable for most urban centres, but at the village level it is argued that more cost effective measures need to be developed. User pay systems may have to be more widespread. Catchment protection and conservation are also considered to be relatively low cost measures that would help ensure maintenance of supplies during adverse conditions. Such measures would have wider environmental benefits, such as reduced erosion and soil loss and maintenance of biodiversity and land productivity. Drought and flood preparedness strategies should be developed, as appropriate, including identification of responsibilities for pre-defined actions. While increasing water storage capacity through the increased use of water tanks and/or the construction of small-scale dams is acknowledged to be expensive, the added security in the supply of water may well justify such expenditure. Development of runways and other impermeable surfaces as a water catchment is seen as possible, but an extreme measure in most instances. Priority should be given to collecting water from the roofs of buildings.

(14) Measures to protect ground-water resources need to be evaluated and adopted, including those that limit pollution and the potential for salt-water intrusion. The limited ground-water resources that are as yet unutilised in the outer islands of many countries could be investigated and, where appropriate, measures implemented for their protection, enhancement and sustainable use. The development of desalination facilities is considered to be an option for supplementing water supplies during times of drought, but in most instances the high costs would rule this out as a widespread adaptation option.

(15) The development and extension of marine breeding and re-stocking programmes, for both fish and corals, are seen as effective means of increasing the resilience and sustainability of inshore marine resources. Similarly, further expansion of marine reserves and other conservation instruments would help protect subsistence fish stocks and coastal marine resources and enhance their ability to withstand the added stresses arising from climate and related changes. Such measures are capable of reducing human impact on the marine environment and hence enhance the resilience of the marine ecosystem. Enhanced enforcement of legislation to prevent the use of destructive fishing methods is also advocated as a no-regrets response option. Community participation in the development and implementation of compliance and enforcement programmes is advocated. Improved monitoring and quota management systems for migratory fish stocks are considered to be desirable. Not only would these measures prevent over-exploitation of these resources, but they are also effective ways of ensuring there is a buffer against climate related stresses.

(16) Measures to ‘cyclone-proof’ houses and other buildings, such as through structural design and choice of construction materials, have been identified as desirable. Reductions in heat stress and discomfort may be achieved through the planting of shade tress and by building houses with improved insulation and ventilation. Air-conditioning is not considered to be a viable response, in general.

(17) Conservation of biodiversity is considered to be a viable, no-regrets adaptation measure. It should be associated with a sharpened recognition of the values of local trees and other plants, and a new sense of ownership for trees and plants. Community-based forest conservation projects can enhance the resilience of managed and natural forest systems. Forest management should place a high priority on land and soil conservation, water conservation, nature conservation, wood production, and the quality of the human living experience. In this way there will be added resilience to the effects of global warming. The introduction and enforcement of appropriate

legislation and policies for the conservation and sustainable use of living resources will also enhance the ability to adapt to climate change.

Specific measures for adapting to the adverse effects of climate change and sea level rise can only be implemented effectively if a number of associated actions are taken, aimed at providing a favourable context for the adaptation measures. This includes addressing the wider development issues, and hence seeing responses to climate change as an integral part of national planning. These more comprehensive actions include development of a national policy framework, capacity building (including institutional strengthening) and enhanced public awareness and education.

Assessing and strengthening the adaptive capacity of PICs is also the key to providing a favourable context for adaptation measures. In combination with the identified vulnerabilities, the adaptive capacity identifies what actions must be taken to avoid or remedy the key impacts of climate change. Adaptive capacity includes not only the intrinsic resilience of natural ecosystems but goes well beyond that to include institutional, political, financial and cultural and other human factors that influence the ability of systems to cope with, or adjust to, climate change.

Three strategies of adaptation that facilitate inclusion of adaptation options into development may be recognised: (1) incorporating climate change and sea level rise considerations into new development proposals; (2) undertaking planning and actions specifically aimed at addressing the potential effects of climate change and sea level rise; and (3) undertaking actions related to strengthening the institutional and technical capacities that facilitate successful implementation of the preceding strategies, and hence avoidance and mitigation of the adverse effects of climate change and sea level rise, and enhancement of any positive consequences.

In all three instances, optimal adaptation approaches will be anticipatory and will be harmonised with regional, national and local development planning.

Enhancing the capacity to undertake vulnerability and adaptation assessments is as critical as improving methodology and developing tools and techniques. Moreover, building capacity at national and regional levels must take place on a number of fronts. It may be necessary for institutions to be strengthened and institutional arrangements modified in ways that reflect the multiplicity of stakeholders, the need to adopt more integrated approaches to decision making, and the need to ensure that responses to climate change are considered alongside development and other planning issues. Establishment of interdisciplinary and multi-sectoral climate change country teams has been an appropriate initial response.

Improved ability to communicate the assessment findings to politicians, government officials and leaders in industry and commerce is also needed. Such people should be made more aware of the ways in which climate change can impact on their interests, and given guidance regarding appropriate responses. Similarly, community and other groups need to be made aware of the real risks associated with climate change. They should also be equipped with the requisite ability to reduce those risks to acceptable levels. Action-oriented public awareness programmes are therefore an integral part of a well-conceived climate change response programme.

There is a growing incompatibility between the analytical methods required to address the increasingly sophisticated needs of decision makers for policy guidance and local capacities to provide such information. While qualitative, descriptive studies are generally compatible with local capacities (information resources, human expertise and so on), the more sophisticated diagnostic assessments and prognostic analyses that are increasingly demanded by policy and decision makers typically require levels of information and expertise that are not widely and readily available in PICs. Universities, technical institutes and other research bodies, together with industry and the technical departments of government, need to play their key roles in enhancing the quality, relevance and accessibility of both traditional and newer information and understanding. They should also be able to assist with adapting and adopting imported and indigenous technologies for both assessment and adaptation. Finally, it is important that they be capable of developing and strengthening assessment methods so that they are more compatible with local needs and capacities.

The report concludes with the identification of projects that would address many of the policy and capacity building implications that have been identified in the synthesis. These include projects to improve the assessment methodologies and make them more applicable to the needs and circumstances of PICs and initiatives that will improve the comprehensiveness, relevance and accessibility of data and other information required in the assessment process. Another proposed project would enhance the methods for identifying, characterising, evaluating and prioritising adaptation strategies to help ensure a more effective linkage between identified vulnerabilities and proposed adaptation measures. A priority project is to build on the findings of national and regional assessments of adaptive capacity by undertaking capacity building activities that address the identified gaps and barriers to successful implementation of adaptation measures.

**Acknowledgements**

Appreciation is offered to all the named and unnamed individuals and organisations who contributed to the completion of the vulnerability and adaptation assessment reports in the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Nauru, Samoa, the Solomon Islands, Tuvalu and Vanuatu.

# 1. Introduction

The Pacific Islands Climate Change Assistance Programme (PICCAP) is a three-year climate change enabling activity involving 10 Pacific Island Countries (PICs): Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Samoa, Solomon Islands, Tuvalu and Vanuatu. PICCAP is designed to assist PICs in meeting their reporting requirements under Articles 4 and 12 of the United Nations Framework Convention on Climate Change (UNFCCC). The project is funded by the Global Environment Facility (GEF), implemented by the United Nations Development Programme (UNDP) and executed by the South Pacific Regional Environment Programme (SPREP).

To enable countries to fulfill their reporting requirements under the UNFCCC, PICCAP has been providing and facilitating technical assistance to national climate change teams and experts. This assistance has allowed them to undertake technical studies that will form the basis for their initial national communications to the Conference of the Parties (CoP) to the UNFCCC. Expert advice, knowledge, skills and technical assistance has been provided through a series of training workshops and a University-based certificate training programme. In addition, in-country technical missions have been conducted by PICCAP and other regional partner institutions that work closely with the country teams and experts. These have helped ensure timely completion of the comprehensive technical studies.

Assessments of vulnerability and adaptation to climate change are one of five activities undertaken by national teams and experts. To ensure that maximum value can be gained from this work, the findings of the national studies require review, evaluation and synthesis. At the second PICCAP Advisory Group Meeting (PAGII) held in Auckland, New Zealand, and the second Multipartite Review Meeting (MPRII) held in Apia, Samoa, it was agreed that the national vulnerability and adaptation assessments be reviewed and a regional synthesis of vulnerability and adaptation to climate change be produced by a regional consultant working in close collaboration with the PICCAP Scientific/Technical Adviser. This regional assessment and synthesis is intended to complement and facilitate completion of the initial national communications.

## 1.1 Terms of reference

The regional consultant and the PICCAP Scientific/ Technical Adviser will produce a Regional Synthesis Report on Vulnerability and Adaptation in the Pacific Islands region. In preparing the Report, the authors will work closely with the national teams and experts. They will also use the format and guidance provided by Decision 10/CP.2 for Non-Annex I National Communications and the IPCC Technical Guidelines on Climate Change Vulnerability and Adaptation Assessment.

1. The authors will prepare a Regional Synthesis Report on Vulnerability and Adaptation in the Pacific Islands region. The report should include:

   (a) a description of all climate change related vulnerability and adaptation activities and studies carried out or referred to in the national statements and reports;

   (b) a summary of the major findings of those studies and their implications for the Pacific Islands region;

   (c) identification of major gaps in those studies, constraints to vulnerability and adaptation activities and how they can be overcome (e.g. gaps, data constraints, problems with IPCC methodology, technology needs);

   (d) an outline of policy implications for vulnerability and adaptation activities, highlighting national priorities and issues, sectoral impacts and adaptation options, and the relationship to the UNFCCC process;

   (e) identification of capacity building needs and implementation requirements for future vulnerability and adaptation activities in the Pacific Islands region;

   (f) identification of possible vulnerability and adaptation projects for the Pacific Islands region; and

   (g) consideration of any other matters relating to the Pacific Islands region vulnerability and adaptation activities stated or implied in the

UNFCCC or identified by regional agencies, PICCAP management and the national PICCAP teams and experts.

2. A policy makers summary of the Regional Synthesis Report should accompany the full report.

3. The results of the Regional Synthesis Report are to be presented at a regional meeting at a venue and date to be determined by PICCAP.

## 1.2 Approach and methods

Draft vulnerability and adaptation assessment reports for the 10 PICCAP countries served as the basis of the regional synthesis. For eight of the countries, these reports were complemented by vulnerability and adaptation statements that summarised the content of the draft reports and had been subject to review by the respective national governments.

Prior to undertaking the synthesis, both the reports and statements were assessed in order to identify major gaps in the vulnerability and adaptation assessments on which the statements and reports are based. Constraints to fulfilling the intent of the vulnerability and adaptation studies were also identified. These included consideration of such factors as data constraints, methodological limitations and access to appropriate technologies.

The regional synthesis compiled and interpreted the findings of the vulnerability and adaptation studies undertaken in all 10 countries. Both common findings and relevant exceptions were identified. Conclusions were formulated in the context of the wider body of information available in relation to the vulnerability, adaptive capacity and adaptation options of Pacific Island countries.

Finally, the findings were used to guide a discussion which addressed implications for policy and for capacity building activities at both national and regional levels, and to identify gaps, constraints and issues for further elaboration, further refinement of the level of vulnerability of Pacific Island countries and identification of adaptation options.

## 1.3 Outline of report

Section 2 provides an historic overview of vulnerability and adaptation studies related to PICs. This leads into a description of the national studies undertaken with support by PICCAP. The contributions made to our overall understanding of the vulnerability of PICs, and of the available options for adaptation, will be highlighted.

The recently completed vulnerability and adaptation studies (assessment reports and statements) represent a significant advancement in terms of both our ability to undertake such studies and our level of understanding of the extent to which the changes in climate attributable to human activities are threatening the security of, and quality of life, in PICs. These accomplishments will be described in Section 3. Section 4 identifies the need for additional work to address shortcomings in the methodologies, gaps in our knowledge, data constraints and remaining uncertainties.

Section 5 provides a regionally focused synthesis of the findings of the 10 national studies, in terms of both vulnerability to climate change and the ability and options related to adaptation. This section also explores the implications of the preceding findings for regional policies, including those dealing with technical, environmental and development issues.

The national and regional assessments of vulnerability and adaptation have identified areas where further capacity building is required. As described in Section 6, these include strengthening of technical abilities related to the assessments themselves, the need for enhancing the ability to meet the evolving requirements of the UNFCCC and the need to ensure that the assessment findings are reflected appropriately in national and regional policies and plans.

The report concludes with the identification of projects that would address many of the policy and capacity building implications that have been identified in the regional synthesis.

# 2. Review of national assessments of vulnerability to climate change and options for adaptation

The summary presented in Annex 1 is restricted to providing an historic overview of programmes and activities assessing vulnerability to climate and related environmental changes on Pacific Island countries, and the options for adaptation to the identified impacts. Broader historic perspectives on global and regional environmental changes and their implications for the sustainable development of Pacific Island countries may be found in Hay (1994) and Hay and Humphries (1994).

## 2.1 Current studies supported by PICCAP

PICCAP has supported and facilitated the preparation of national assessments of vulnerability and adaptation for all 10 of its participating countries. These initiatives included a six-month training course attended by two people from each of the participating countries. On behalf of PICCAP, the training course was developed and implemented by the International Global Change Institute, University of Waikato (Hamilton, New Zealand), working in collaboration with SPREP, the United Nations Institute for Training and Research (UNITAR) programme on climate change training (CC:TRAIN) and other organisations.

The aim of the training course was to familiarise the participants with the use and practical application of the Intergovernmental Panel on Climate Change (IPCC) Technical Guidelines on Climate Change Vulnerability and Adaptation Assessment (Carter et al., 1994). Participants, working in both sector and assessment teams, simulated the vulnerability and adaptation procedures for a fictitious PIC and completed a comprehensive assessment for their own country. In the latter regard, they were also assisted by their national Climate Change Country Team and other individuals and agencies from their home country. Participants spent two months of the six-month course in their home country collecting relevant information, working closely with the Country Team and gaining appropriate practical experience. While they were working in-country the participants were visited and advised by members of the training team.

The final two months of the course were devoted to drafting the vulnerability assessment and assessing adaptation options. These tasks, and the draft vulnerability and assessment report, were completed upon return to the home country.

Subsequent to completion of the draft vulnerability and adaptation assessment reports, individual PICCAP countries were encouraged to prepare vulnerability and adaptation statements. Technical assistance and guidance was provided by PICCAP to facilitate this process. To a large extent, the statements were to be based on the draft assessment reports. The intention is for these statements to form part of the National Communications submitted at, or prior to, CoP 5 of the UNFCCC.

## 2.2 Accomplishments

The ultimate objective of the UNFCCC is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. However, in achieving this objective Parties are to be guided by the need, amongst other matters, to give full consideration to the specific requirements and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change. Such considerations are specifically directed to those developing country Parties that would bear a disproportionate or abnormal burden.

Explicitly, Parties are obligated to formulate, implement, publish and update national and, where appropriate, regional programmes containing measures to facilitate adequate adaptation to climate change. They must also cooperate in preparing for adaptation. This can be achieved by developing and elaborating appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas affected by drought and floods. Developed country Parties are obligated to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs incurred in adapting to those effects.

In the Kyoto Protocol to the UNFCCC, the respective rights and obligations of vulnerable developing countries and developed countries are even more explicit. Moreover, Decision 10/CP.2 of the Parties to

the UNFCCC calls on non-Annex 1 Parties to specify their national and regional development priorities, objectives and circumstances on the basis of which they will address climate change and its adverse impacts. It urges these same countries to use the Technical Guidelines for Assessing Climate Change Impacts and Adaptation in order to fulfil their commitments under the Convention.

To give effect to these commitments, the 10 countries participating in PICCAP have prepared and submitted draft reports on the national assessments on vulnerability and adaptation to climate change. They are also in the process of preparing summaries for inclusion in their National Communications to the CoP.

In addition to fulfilling obligations under the Convention, the completion of these national assessments is also of note for the following important reasons:

(1) The completed assessments provide a comprehensive set of national findings on vulnerability and adaptation, prepared using international best practices. This information can be used in the preparation of national sustainable development strategies and for assessing the success of these strategies over time.

(2) The findings can be used to shape the positions taken in both national and international environmental policy discussions. In this respect, the ability to characterise national vulnerabilities to climate change and the capacity to adapt are especially helpful.

(3) The assessment results provide guidance for investment decisions by the private sector and by international, regional and bilateral donors. The newly acquired information on adaptation needs and options will assist donors and investors, especially those facilitating technology transfer, to determine where the greatest environmental benefits can be achieved.

(4) By combining the findings from the 10 studies, it is possible to prepare the first credible assessment of the region's vulnerability to climate change.

# 3. Evaluation of the vulnerability and adaptation assessments

## 3.1 Introduction

To facilitate the evaluation reported in this section, a checklist of desirable attributes for a national assessment of vulnerability and adaptation to climate change was developed. The checklist was based on the guidance included in Carter et al. (1994) and the Guidelines for Initial Communications of non-Annex 1 Parties (UNFCC Decision 10/CP.2). A summary of the findings using the checklist is presented in Table 3.1.

For each item in the checklist, the assessment reports and statements (where available) were scored. The following scale was used:

0—not addressed in report or statement

1—need for substantial additional attention

2—need for considerable additional attention

3—need for minimal additional attention

The scale is not an absolute; for example, a score of 3 is given when the quality of the information provided in the report almost meets reasonable expectations, given the relative inexperience of the assessment team and the significant practical challenges they would have faced when completing the assessment.

It is intended that the detailed information presented in this section be used for three purposes:

(1) to highlight where improvements can be made in the completeness and usefulness of the current assessments;

(2) to provide guidance as to how future assessments can be enhanced in terms of both the methods used and the information that is produced; and

(3) to identify areas for future assessment work so that a higher level of transparency, consistency and comparability can be achieved.

This is each country's first attempt to produce an assessment of vulnerability and adaptation using IPCC technical guidelines by their own trained nationals. The level of achievement to date is therefore commendable. Many strengths can be identified. The shortcomings are noted in order to enhance the quality of future assessments and related work.

It is important to note that only assessment guidelines that are appropriate and consistent with data and information available in countries can be used. Thus, if it is indicated that a given number of countries did not evaluate the data or undertake other assessment procedures, it does not necessarily mean that the particular step was ignored. Rather, failure to undertake the given procedure might be the consequence of an absence or paucity of data. In such cases, the methodology would have been adapted to reflect the prevailing situation, and any consequential gaps in the assessment identified. These gaps are discussed further in section 3.3.

## 3.2 Strengths

The obvious and overall strength of the 10 national inventories is that they have been prepared using comparable methods that are in turn based on international best practices (Carter et al., 1994). The effort that has gone into preparing the vulnerability and adaptation assessments for 10 Pacific Island countries is critical to the identification of vulnerable countries, vulnerable sectors and systems within those countries, and for the Pacific Islands region as a whole. Similarly, common and differentiated adaptive capacities and adaptation options and strategies can now be recognised.

Table 3.1 shows that, overall, there were clearly identified goals for the assessments, and appropriate consideration was given to the identification and justification of study sectors, study areas and time frames. Current climatological baselines were reasonably well defined. The development of scenarios of future climate and sea level changes was generally well done, especially given the current lack of country, or even region specific information on possible future climatic and sea level conditions. Qualitative descriptions of the impacts arising from possible changes in the climate were generally comprehensive and well documented. In many instances the studies identified adaptive responses related to the potential impacts.

**Table 3.1 Number of countries addressing each step involved in the National Assessments, grouped by the level of attention given to each step.**

| Step 1: Scoping the assessment | Not addressed (score =0) | Substantial additional attention required (score =1) | Considerable additional attention required (score= 2) | Minimal additional attention required (score= 3) |
|---|---|---|---|---|
| Clearly stated goals for the assessment | 2 | 0 | 3 | 5 |
| Identification and justification of study sectors | 0 | 2 | 4 | 4 |
| Identification and justification of exposure units | 2 | 1 | 5 | 2 |
| Identification and justification of study area(s) | 0 | 3 | 3 | 4 |
| Identification and justification of time frame | 1 | 2 | 5 | 2 |
| Characterisation of potential methods | 2 | 1 | 3 | 4 |
| Identification and description of dependencies between study sectors | 5 | 3 | 2 | 0 |
| Identification and justification of non-climatic stressors | 7 | 1 | 2 | 0 |
| Step 2: Method selection | | | | |
| Review of general assessment approaches | 2 | 2 | 2 | 4 |
| Methods evaluation | 6 | 4 | 0 | 0 |
| Step 3: Developing datasets and baselines | Not addressed | Substantial additional attention required | Considerable additional attention required | Minimal additional attention required |
| Identification and discussion of data needs | 7 | 2 | 1 | 0 |
| Assessment of data availability | 7 | 3 | 0 | 0 |
| Evaluation of available data | 9 | 1 | 0 | 0 |
| Develop climatological baseline, including necessary interpolations | 0 | 1 | 8 | 1 |
| Develop non-climatic baselines, including necessary interpolations | 0 | 3 | 4 | 3 |
| Datasets for method development, calibration, testing, interpretation | 10 | 0 | 0 | 0 |
| Consideration of uncertainties | 10 | 0 | 0 | 0 |
| Step 4: Testing methods | | | | |
| Assess validity and uncertainties of methods—present day conditions | 10 | 0 | 0 | 0 |
| Assess validity and uncertainties of methods—future conditions | 10 | 0 | 0 | 0 |
| Step 5: Scenario development | | | | |
| Factors influencing scenario selection and development | 9 | 1 | 0 | 0 |
| Development of future baselines—environmental and socio-economic | 0 | 4 | 6 | 0 |
| Development of future climate and sea level changes | 0 | 0 | 10 | 0 |
| Projecting environmental trends, with climate change | 1 | 9 | 0 | 0 |
| Projecting socio-economic trends, with climate change | 1 | 9 | 0 | 0 |
| Consideration of uncertainties | 8 | 0 | 1 | 1 |

| Step 6: Assess future impacts | Not addressed | Substantial additional attention required | Considerable additional attention required | Minimal additional attention required |
|---|---|---|---|---|
| Description and assessment of methods | 9 | 1 | 0 | 0 |
| Qualitative description of impacts | 0 | 0 | 7 | 3 |
| Quantitative description of impacts: sensitivity of exposure units and sectors | 4 | 3 | 3 | 0 |
| Characterisation and assessment of uncertainties | 10 | 0 | 0 | 0 |
| Assessment of significance of changes and of overall vulnerability | 3 | 2 | 5 | 0 |
| Step 7: Adaptation | | | | |
| Adaptive responses reflect findings in Step 6 | 0 | 4 | 6 | 0 |
| Assessment of capacity to adapt | 8 | 1 | 1 | 0 |
| Consideration of time scales of adaptation | 10 | 0 | 0 | 0 |
| Recognition of autonomous adjustments | 10 | 0 | 0 | 0 |
| Consideration of both anticipatory and reactive adaptation options | 0 | 7 | 3 | 0 |
| Consideration of no-regrets adaptation options | 3 | 7 | 0 | 0 |
| Evaluation of adaptation options using appropriate criteria and methods | 9 | 1 | 0 | 0 |
| Identification of responsibilities regarding implementation of adaptation Options | 6 | 4 | 0 | 0 |

| Step 8: Synthesis of findings into national report and statement | Not addressed | Substantial additional attention required | Considerable additional attention required | Minimal additional attention required |
|---|---|---|---|---|
| Summary for policy makers | 2 | 0 | 5 | 3 |
| Goals and objectives | 2 | 0 | 5 | 3 |
| Scope of assessment | 0 | 2 | 8 | 0 |
| Data, methods, assumptions and uncertainties | 0 | 9 | 1 | 0 |
| Reference to relevant literature and regional and international contexts for assessment | 0 | 10 | 0 | 0 |
| Vulnerability findings, by sector and internationally across sectors, and uncertainties | 0 | 1 | 5 | 4 |
| Recommendations regarding adapt. With justifications and uncertainties | 0 | 3 | 6 | 1 |
| Gaps in information and understanding—recommendations for further studies | 4 | 1 | 2 | 3 |
| Citations—information sources and literature | 7 | 1 | 2 | 0 |
| Annexes—for highly technical information and for large data sets | 7 | 0 | 3 | 0 |
| Overall technical quality of written report | 0 | 1 | 7 | 2 |

Typically the national reports and statements provided a comprehensive and well supported synthesis of the assessments of vulnerability and of adaptation options. In this regard the national statements are particularly informative. The reports and statements generally contain clear goals and/or objectives and indicate their scope. The vulnerability findings, by sector and integrated across sectors, are usually described in adequate detail. Many reports and statements also identified and elaborated a suite of adaptive responses that could be used to reduce the vulnerability of sensitive and valued sectors and exposure units.

Overall, the technical quality of the reports and statements was such that a good understanding of vulnerability to climate change was conveyed, along with the possible response strategies.

The figures shown in the Table 3.1 refer to the number of countries (out of 10) who scored 0, 1, 2 or 3 for the level of attention given to each step in the process.

## 3.3 Gaps

Table 3.1 also identifies a number of shortcomings in the assessments. When scoping the assessment there was little attention given to the dependencies between study sectors or to non-climatic stressors. These omissions have implications for the remainder of the study, especially for the development of an integrated and coherent suite of response strategies that can be harmonised and mainstreamed with national development plans.

Few studies provided an appropriate overview of the assessment methods and approaches, and even fewer undertook any form of evaluation of these methods to assess their relevance to the assessment objectives. This gap suggests that those undertaking the assessments were more inclined to follow a prescribed set of procedures and less concerned with gaining an overview of the assessment process. A critical evaluation of methods, in terms of their appropriateness to the circumstances and objectives of a specific study, is essential to ensuring the assessment gains the optimal outcome. The widespread absence of such an evaluation is consistent with other omissions in subsequent stages of the assessments. Specifically, few of the reports and statements discussed data needs and availability for developing baselines, both climatic and non-climatic. Similarly, there was no discussion of datasets for method development, calibration, testing and interpretation. Consistent with this was the general failure to assess the validity of the methods used to characterise present or future conditions and impacts.

The foregoing situation is largely a reflection of the current lack or paucity of the appropriate and relevant data required to validate and evaluate the methods. This shortcoming needs to be addressed, but is not merely restricted to the requirements of, and barriers to, effective vulnerability and adaptation assessments. Another factor may well be insufficient awareness and understanding of such procedures as data calibration, testing, interpretation and evaluation. Again, such shortcomings can be addressed over time.

A major gap in the report and statements was the widespread lack of reference to uncertainty. Such a finding is surprising since the training programme conducted in conjunction with the vulnerability and adaptation assessments placed considerable emphasis on the sources, nature and implications of uncertainty. It is critical that those making use of the assessment findings be fully aware of the levels of uncertainty in both the information and methods used in the assessments, and in the subsequent findings.

While uncertainty is critical, it is often the most difficult part of the assessment to understand and apply. Even though a considerable emphasis is placed on uncertainty in the assessment guidance, those undertaking the studies had clearly had considerable difficulty dealing with this concept and its practical implications.

While much of the scenario development was well executed, little consideration was given to considering the factors that influence scenario selection and development. Given the multiplicity of options for scenarios, it is important that there be a rational basis for this important stage of the assessment. Similarly, few of the studies appeared to grasp the conceptual and practical importance of projecting environmental and socio-economic trends, with and without climate change.

Many of the assessments make some attempt to give a quantitative value to impacts, but given the paucity the relevant datasets and the need for further development of appropriate methods, much more substantive work is possible, and indeed desirable. The same point can be made in terms of assessing overall vulnerability to climate change. In this case, an enhanced consideration of the interactive nature of natural and human systems would also be required. It is clear that not all authors of

the reports had an adequate understanding of the meaning and practical importance of 'vulnerability'. Little attention was given to the capacity to adapt. 'Adaptive capacity' is the capability of a system (natural or managed) to change in ways which improve its ability to function effectively despite climate change related pressures, or the impacts and other consequences of those pressures. Thus adaptive capacity includes not only the intrinsic resilience of natural ecosystems but goes well beyond that to include institutional, political, financial, cultural and other human factors that influence the ability of systems to cope with, or adjust to, climate change. Assessing the adaptive capacity of Pacific Island countries is thus a critical procedure, for in combination with the identified vulnerabilities, the adaptive capacity shows what actions must be taken to avoid or remedy the key impacts of climate change.

While all assessments did identify a range of adaptive responses, more effort could have been made to ensure that these suggestions were better linked to the findings related to impacts and vulnerability. More attention could be given to considerations such as the time scales of adaptation and the role of autonomous adjustments. While few reports and statements formally recognised the distinctions between, and relative merits of, anticipatory, reactive and no-regrets options, most did include such a range of responses in the suggested measures for dealing with the adverse impacts of climate change.

Given the lack of emphasis on methodological considerations, it is again not surprising to observe that there was a general absence of systematic evaluation of adaptation options. Moreover, few responses suggested those who may have principal responsibility for their implementation. Again this reflects a lack of understanding of the broader implications of adaptation. The current lack of relevant examples of appropriate adaptation strategies makes it difficult to evaluate options.

While the reports and statements were generally well organised and written, most did suffer from a failure to refer to the findings of previous studies, including those undertaken in the country of concern or in other countries where analogous conditions prevail. Similarly, given the target audiences for the reports and statements, more attention could have been given to regional and international contexts for the assessments. Critical to improving this situation are measures that will improve access to information and enhance the knowledge base of those who support and undertake the assessments. The current reliance on methods that reflect the generic IPCC guidelines is also an issue.

When data and other information are used, the sources should be identified. In this respect, none of the assessment reports or statements provided adequate information (i.e. citations) regarding the literature that was referenced in the assessment. More effective use could also be made of appendices.

Some of the reports contained perceptive and comprehensive discussions regarding gaps in information and understanding, and provided very useful suggestions as to how these might be addressed. In contrast, other reports failed to take this opportunity to identify and propose ways of addressing the gaps. Since in all cases there was clear evidence of significant gaps, as indicated in the preceding discussion, this omission is unfortunate. It should be noted that in both the training and the actual assessments, there was only limited opportunity to deal with identified gaps in information. Such measures were beyond the scope of the training programme and the assessments themselves. Rather, the focus was solely on developing and applying the ability to undertake assessments that were consistent with the IPCC guidelines.

A final ommission from the overall assessment process was the failure to identify and describe any positive impacts of climate change. This occurred despite the fact that those undertaking the assessments were urged to take steps to address this potential gap in the assessment methodology. While positive impacts may be few and of far less significance, the opportunity to partially offset the negative impacts of climate change by enhancing positive impacts should not be ignored. This matter is worthy of future consideration in the planning and implementation of vulnerability and adaptation assessments.

## 3.4 Data and other information constraints

In vulnerability and adaptation assessments there are many instances where data constraints can be critical to achieving comprehensive and useful findings. Data and other sources of information are required at several stages of the assessment process. In terms of country specific data, these include:

- identifying study sectors and exposure units;
- identifying study areas and time frames;

- identifying and characterising dependencies between sectors;
- identifying and characterising uncertainties in methods and findings;
- development of present day and future baselines, both climatic and non-climatic;
- development of climate and sea level scenarios for the future;
- projecting environmental and socio-economic trends, with climate change;
- assessing future impacts;
- assessing capacity to adapt; and
- systematic evaluation of adaptation options.

As noted earlier, few of the reports made any, or substantive, attempts to specifically identify data needs and assess these needs in light of available data.

However, it is apparent from the reports and statements that a lack of country specific data and other information severely limited the assessment process. The most critical constraints were as follows:

- characterising the detailed topography and high resolution land cover, land use and infrastructure patterns in the coastal zones of the country concerned;
- characterising the climate of the study areas, in terms of both mean and extreme conditions;
- characterising the socio-economic conditions of the study areas, and especially the interdependencies between sectors;
- the nature and sensitivity of interactions between commercial and subsistence activities and environmental conditions (e.g. the influence of floods and drought on productivity of the agriculture sector);
- data and other information on the likely changes in environmental and socio-economic conditions during the time frame of the study and for the specific study areas;
- climate (especially seasonal means and extremes of temperature and rainfall) and sea level (mean and extremes such as storm surges) scenarios for the time frame of the study and for the specific study areas;
- information on likely changes in interannual variations in atmospheric and oceanic conditions (e.g ENSO) and in extreme events (e.g. frequency, intensity and tracks of tropical cyclones);
- information on adaptive capacity, at local and national levels;
- information that would facilitate formal analysis of adaptive response options for a given impact; and
- data and other information that would facilitate a more rigorous evaluation of adaptation options, including effectiveness in mitigating impact, economic efficiency, practicability given local capacities and compatibility with social, cultural and environmental systems and with equity considerations.

In summary, the preceding observations indicate that the major constraints are related to a lack of information, knowledge and hence understanding of local conditions and dependencies. More comprehensive information on present day conditions, and specifically how the environmental and socio-economic systems respond to present day variations in climate (both mean conditions and extreme events), would support major improvements in the quality of the vulnerability and adaptation assessments, and hence make them much more useful to policy and decision makers. Improved understanding of contemporary interactions between environmental and socio-economic systems is critical to determining how these same systems will respond when, in the future, they are influenced by global and regional changes in atmospheric and oceanic conditions.

## 3.5 Methodological issues

Evaluation of the assessments has identified major shortcomings in conforming to the IPCC guidelines. As a result, no attempt has been made to address all of the steps and procedures identified in the guidelines. Rather, efforts have been made to modify and adapt the guidelines to better reflect and suit local conditions. Such changes are advantageous given the constraints

under which the assessments were made and the fact that IPCC guidelines place high demands on data and other information.

The methodological framework for all 10 assessments was provided by the IPCC Technical Guidelines (Carter et al., 1994), with minor modifications to reflect the needs and circumstances of Pacific Island countries and the region as a whole. As noted above (Section 2.1.2c), Kaluwin (1993) and others have expressed concerns about the applicability of the IPCC methodology to the Pacific Island region. However, the IPCC methodology is presented in the form of 'guidelines'. These can, and have been, adapted to suit local conditions. On the other hand, it is highly desirable to be consistent with the IPCC guidelines wherever appropriate as, amongst other considerations, this facilitates regional and global aggregations and syntheses of the national findings.

Based on the reports and statements provided by the 10 PICs, it is possible to identify several additional barriers to successful implementation of the IPCC methodology for assessing vulnerability and adaptive responses in the Pacific Island region. These include:

- the relatively high levels of interannual variability in the climate and ocean systems. As a result, there is a very real possibility that an assessment will be more reflective of the impacts of these natural variations in climate than of those arising changes in climate due to the enhanced greenhouse effect. Climate variability is very real for PICs and is capable of producing adverse impacts that may well be of similar significance to those anticipated to result from climate change; there is a fine line between acknowledging the consequences of natural interannual variations in climate, and focussing solely on the impacts of human-induced climate change, as is required under the UNFCCC;

- available studies show that the sensitivities of mean atmospheric and oceanic systems of the Pacific basin to increases in atmospheric concentrations of greenhouse gas suggest that extreme events may become the dominant source of climate change induced stresses on Pacific Island countries. The assessment methodology based on the IPCC Guidelines is oriented more to assessing the consequences of changes in mean conditions. Far less is known about the extreme events, in terms of both how they will respond to global warming, and how natural and human systems respond to changes in the magnitude and frequency of extreme events;

- data and other information constraints, as elaborated above, are a significant barrier. In this context, of particular note is the current inability to develop future scenarios for climate and oceanic conditions at the national level, let alone with the resolution required for detailed sectoral studies;

- the key to the method is the ability to project both environmental and socio-economic trends over time, with the effects of climate change incorporated in the projections. This is an immense challenge in the case of PICs, where non-climate related changes in the economic, social and environmental systems will certainly dominate in the short term, although they are are poorly understood. Hence uncertainties are large, resulting in an inability to make specific statements about impacts attributable to climate change with a high level of certainty;

- the time frame of the study is often extended to a period when the climate change will be a significant, if not dominant, driver of change. In doing so there is a trade off between increasing uncertainty in the climate projections and decreasing relevance of such long time scales to the political processes of policy and decision making;

- incompatibility of analytical methods with local needs and capacities—while qualitative descriptive studies are generally compatible with local capacities (information resources, human expertise etc.), the more sophisticated diagnostic assessments and prognostic analyses typically require levels of information and expertise that are not widely and readily available in PICs;

- the methodology based on the IPCC Guidelines is essentially a 'top down' assessment. In many cases this is incompatible with the policy and decision making processes and planning procedures in PICs. In the latter situation, the dominance of locally owned land and village-

based systems of resource and environmental management, mean that knowledge of vulnerability to change and the most effective ways to mitigate impacts is largely held at the local level. This presents a considerable challenge to nationally implemented assessments;

- incompatibility of internationally developed integrated assessment, policy development and decision support tools with the nature and special characteristics of Pacific Island societies, economies and environments—the social, economic and environmental systems of PICs are highly interdependent and sensitive to any perturbation, be it natural or of human origin. Increased attention needs to be given to the development of integrated assessment and policy development tools that are compatible with the information resources, technical abilities, economic systems and policy development and decision making systems of PICs;

- lack of adequate information management tools—the methods used in vulnerability and adaptation assessment are information intensive. Internationally, the typical solution has been to use geographic information and similar systems to assist in data manipulation and interpretation;

- the methodology based on the IPCC Guidelines involves iterative steps; thus any reports describing the assessment findings must be seen as work in progress, rather than definitive statements. This is also true of the assessment findings that are included in the National Communications prepared in partial fulfillment of national obligations under the UNFCCC;

- the UNFCCC Guidelines for the Preparation of Initial Communications by non-Annex 1 Countries call for information, including the findings of the vulnerability and adaptation assessments, to be presented in the form of numerical indicators. The IPCC Guidelines for Assessing Climate Change Impacts and Adaptations do not provide any substantive suggestions as to what indicators might be used and how they might be applied;

- vulnerability is partly determined by the capacity to adapt. There is little guidance as to how this is appropriately assessed, yet in PICs this is clearly a key issue;

- given the relative importance of subsistence and other traditional forms of lifestyle and decision making in PICs, autonomous adjustments to climate change may well play a greater role than in developed countries. Methods based on the IPCC Guidelines are largely inadequate to deal with this increased relative importance and with the greater role of traditional management practices. Many of these practices are not well documented and even anecdotal information may not be readily available to people who are not part of the immediate community;

- the methodology is largely silent in regards to the identification and evaluation of specific adaptation strategies—identification and elaboration of adaptive responses is very much left to members of the assessment team. Moreover, the criteria for evaluation of the responses, and for developing a prioritised list, are similarly few in number and detail. Local attitudes and values will often dominate in evaluations undertaken for PICs, requiring the assessment team to have considerable local knowledge, understanding and empathy in terms of both the ability to identify appropriate adaptive responses, and the ability to undertake a meaningful evaluation of the various options;

- the methodology needs to give more explicit attention to identification of the positive impacts of climate change, and how these might be enhanced through appropriate adaptation measures; and

- the methodology is also largely silent in regards to identifying responsibilities for the implementation of adaptation options. As already noted, in PICs the community rather than government will likely play a dominant role in implementation. This is in marked contrast to most larger, developed countries.

## 3.6 Other challenges

The following considerations, if addressed, will also help to improve the quality and usefulness of vulnerability and adaptation assessments:

- Institutional arrangements Vulnerability and adaptation assessment is an interdisciplinary and cross-sectoral task, with mutliple stakeholders. The assessment thus requires inputs from, and has implications for, industry, communities and all levels of government. Climate change country teams can go some way towards alleviating problems associated with the integrated nature of the assessment and its outputs, but they are unable to resolve all difficulties related to the cross-sectoral ramifications of the assessment;

- Political buy-in The principal intent of a vulnerability and adaptation assessment is to assist a country to fulfil its commitments under the Convention and to guide national- and local-level policy and decision making by government. While the assessment itself is a technical undertaking, uptake of the findings requires political acceptance of both the procedures used and the findings themselves. In addition, the findings must complete with nearer-term, and higher profile issues that many would claim are more certain, have greater potential impact and are already part of public and political conscientiousness;

- Public awareness For similar reasons to the need for political buy-in, individuals and communities need to be aware of the real risks associated with climate change, and how those risks might best be managed through appropriate responses by individuals and communities. Aadaptation to climate change may be facilitated by government, but typically it will be individuals and communities who give effect to the response strategies. Again, these individuals and communities may be faced with what they perceive to be more urgent, important and certain challenges to their quality of life;

- Private sector participation Successful adaptation to climate change will require the involvement of the private sector in diverse ways, including financial mechanisms, insurance and the transfer and development of appropriate technology. Uunless the commercial and industrial sectors are aware and convinced of both needs and opportunities, their participation will be sub-optimal or, at worst, non-existent; and

- Intellectual and technical assistance Many of the requirements for improving the quality and usefulness of the vulnerability and adaptation assessments will only come if there are fundamental improvements in both the information and methods used in the assessment. Universities, technical institutes and other research bodies, together with industry and the technical departments of government, can play critical roles in enhancing the quality and relevance of the information resources. This can be achieved by developing and adapting imported and indigenous technologies for both assessment and adaptation and by developing and strengthening methods so that they are more compatible with local needs and capacities. In an increasingly ‘user pays’ society, concerted action needs to be taken so that bodies will be committed and empowered to provide research-based and technical assistance for vulnerability and adaptation studies.

# 4. Removing the barriers and constraints, including addressing technology needs

Sections 3.5 and 3.6 outlined many difficulties that arise when assessing the vulnerability of PICs to climate change and developing possible adaptation strategies. Suggestions for facilitating future vulnerability and adaptation assessments in the Pacific Islands region are provided below.

## 4.1 Improvements in the assessment methodologies

In general and somewhat idealistic terms, the assessment methodologies should be capable of delivering three outputs:

- quantitative, composite measures or indicators of the vulnerability of exposure units, sectors and other aggregations of economic, social and environmental systems, mapped spatially with appropriate resolution and for selected time frames and also instructive as to strategies for avoiding and/or mitigating adverse impacts;

- prioritised recommendations regarding strategies for adapting to climate change, with justifications for the ranking based on the vulnerability assessment and cost-benefit or other objective analyses; and

- a statement of the uncertainties associated with the foregoing findings, how these might influence decisions based on the findings, and how the uncertainties might best be reduced over time.

Any improvements in the methodology in order to achieve these goals, especially in relation to acknowledging and addressing the special demands imposed by its application to PICs, should also be consistent with the need to retain international comparability in the assessment methods. Thus the following suggestions are designed to build on, and strengthen, the existing IPCC-based methodology, rather than propose a fundamentally new approach.

However, strengthening the methodology will likely incur additional demands for data and other information, and impose added requirements on the expertise needed to undertake the assessments. If neither the additional information nor the expertise is forthcoming, any improvements in methodology will be redundant. Hence, it is necessary to ensure in advance that the ability to implement the suggestions does exist, or can be developed through capacity building initiatives. It is for this reason that an assessment of adaptive capacity (i.e. the ability to assess, implement and sustain adaptations to climate change) is critical to any further development of the methods used to assess vulnerability and options for adaptation.

Given the above, improvements in the methodology based on the IPCC Guidelines might best be made in terms of the following:

(1) Further work is needed to improve our understanding of adaptations and of maladaptations to changes, including those that are climate and non-climate related. This need is not addressed adequately in the IPCC guidelines. The guidelines should be strengthened to facilitate identification of how countries can best adapt to climate change, to assess if countries have the internal capacity to adapt and, if not, how the capacity can best be improved. There is an urgent need for enhanced methods for characterising adaptive capacity at regional, national and local levels, such that recommendations for adaptation strategies will be consistent with the ability of the economic, social and technology systems to assess, support and sustain the recommended policy initiatives and practical actions. In this regard, relevant aspects of the methods developed for environmental technology assessment, especially those related to assessing the capacity of the given society to sustain an imported or indigenous technology (e.g. Hay and Noonan, 1999), may be helpful in assessing the capacity of that society to adapt to climate change.

(2) Enhanced methods for identifying autonomous adjustments. As noted above, the relative importance of subsistence and other traditional forms of lifestyle and decision making in PICs means that autonomous adjustments to climate change may play a greater role than in developed countries, and also be of a different nature to those found in other regions and countries. A series of

well-chosen case studies may be the most productive approach to first identifying historic examples of autonomous adjustments to change (whether of economic, social or environmental origins), followed by the use of this empirical evidence to develop and test methods for recognising the autonomous adjustments that might occur in response to climate change. Jepna and Munasinghe (1998) present various analytical frameworks and specific techniques that would assist in improving these aspects of the IPCC-based methodology. The Third Assessment Report of Working Group II of the IPCC is also expected to contain some very useful guidance.

(3) Enhanced methods for identifying, characterising, evaluating and prioritising adaptation strategies. These methods should be responsive to the findings of a rigorous and comprehensive vulnerability assessment. They should be capable of distinguishing between the advantages and disadvantages of anticipatory, reactive and no-regrets adaptation options and those based on the use of indigenous and imported technologies, and able to provide full guidance to decision makers through the use of cost-benefit and other objective analyses. Once again, Jepna and Munasinghe (1998) present various decision analytical frameworks and specific techniques that would enhance the usefulness of any guidance. These include cost-benefit-based decision tools, economic and non-market cost-benefit analysis, cost-effectiveness analysis, least-cost solution, multicriteria analysis, decision analysis and integrated assessment. Of particular relevance to PICs is the use of non-market techniques and analytic frameworks. The Third Assessment Report of Working Group II of the IPCC is again expected to contain some very useful guidance.

(4) The results of adapatation assessments are now being used to guide policy making and the implementation of practical actions. There is thus a growing and urgent need to extend the IPCC-based methodology to include the monitoring and evaluation of the effectiveness of the policy implementation, and of related actions. In effect, this would amount to an assessment of the validity of the policy advice provided to decision makers. This aspect of the assessment is thus an iterative process, designed to lead to continuous improvement in the quality advice. The approach forms a major part of adaptive management, and is a critical aspect of the methodology given the high levels of uncertainty that exist. To date, there has been little effort devoted to the development of methods to monitor and evaluate the effectiveness of implementing adaptation policies related to climate change. For the PICs this is an important omission given the high vulnerability to climate change, the almost total reliance on adaptation, the lack of experience and understanding as to what responses might be most appropriate and the consequent and overall high levels of uncertainty.

(5) Enhanced methods for providing quantitative indicators of vulnerability to climate change as an improvement to Step 6 of the existing methodology. In this regard, earlier and ongoing work, including the System Sustainable Capacity Index (SSCI) of Kay and Hay (1993), the Environmental Vulnerability Index of Kaly et al. (1999) and the economic vulnerability indices developed by Briguglio (1995, 1997), the Commonwealth Secretariat (Wells, 1996, 1997; Atkins et al., and the Caribbean Development Bank (Crowards, 1999), may be instructive.

## 4.2 Overcoming data and other information constraints

Section 3.4 noted that a lack of country specific data and other information has severely constrained the vulnerability and adaptation assessments undertaken to date. The major constraints are related to a lack of information, and hence a consequent lack of understanding, with respect to both local conditions and the interactions between components of the environmental, social and economic systems. It was argued that improved understanding of contemporary interactions between environmental and socio-economic systems is critical to determining how these same systems will respond to the changes in atmospheric and oceanic conditions that may take place in the future.

The fundamental need for increased understanding can only be addressed through focussed and targeted studies of the relevant systems, at both local and national levels. There is an urgent need to determine the sensitivities of system components to pressures similar to those that might arise from climate change, and to identify any thresholds that are associated with irreversible or other major changes in the resilience of individual and integrated systems. In addition to specific research into

the dynamics of individual systems, there is also an urgent need to undertake holistic and interdisciplinary studies of integrated systems to reveal the nature and extent of the interactions between economic, social and environmental systems. These studies should also be conducted at both local and national levels.

The large interannual variability in many environmental conditions, related to El Nino-Southern Oscillation (ENSO), does give the Pacific Islands region at least one advantage when it comes to enhancing the knowledge base and increasing understanding. The substantial variations in both atmospheric and oceanic conditions facilitate the use of historic analogues. Historic analogues relate to atmospheric and oceanic conditions that may have existed in the past, and which could be used to explain present and future conditions (states). These can provide insights to coping with extreme conditions and adapting to climate and sea level change in the future. Here too there is an urgent need to capitalise on this opportunity by assembling the relevant information on historic analogues and making it available to the user community in a readily accessible form.

While considerable progress has been made in developing, for the Pacific Islands region, climate scenarios for future time frames (e.g. Jones et al., 1999), the spatial resolution of the resulting information is still too coarse relative to the spatial dimensions of each island state and of individual islands. Moreover, in some crucial areas such as tropical cyclone frequency and intensity and sea level, little information on likely future conditions can be offered with any degree of certainty, regardless of spatial scale. It is desirable that the current momentum and progress in developing climate change scenarios for the Pacific Islands region be maintained, while acknowledging the inherent limitations imposed by the chaotic nature of the systems being modelled.

## 4.3 Use of indigenous, imported and new technology

Technology, or 'know how' can play a variety of roles in overcoming the barriers and constraints that have been identified in the preceding sections. In general, technology can enhance the quality and usefulness of both vulnerability and adaptation assessments and increase the opportunities for effective responses to climate change. Technology can thus be applied in response to a broad spectrum of needs, from the acquisition and dissemination of information to the strengthening of traditional responses and the development of innovative strategies.

Four specific instances where technology can assist PICs to assess their vulnerability to climate change and develop appropriate adaptive response strategies will be highlighted here.

The first is by the use of both appropriate indigenous and imported technology to characterise the responses of environmental systems to both internal and external stresses, including those arising from climate variations and change. Some examples of indigenous technology include systems of land tenure, welfare, trade and methods for coping with natural disasters, for example relocation of settlements/villages from impact areas. Indigenous technology also includes traditional knowledge and skills used in response to natural disasters. The application of traditional indicators for monitoring environmental quality and change, in conjunction with methods based on imported technologies, will do much to bridge the information gap that currently impairs the quality and usefulness of the vulnerability and adaptation assessments. Such approaches, based on an appropriate mix of traditional knowledge, community experience, government information resources and scientific information, will produce much more robust and useful assessments.

The second area is the development and implementation of models and other tools capable of providing quantitative estimates of the sensitivity and threshold responses of selected exposure units, sectors and integrated economic, social and environmental systems to given changes in key environmental parameters. The latter would include mean and extreme conditions of temperature, rainfall, wind velocity, cloudiness and sea level and state, both individually and in selected combinations. Considerable progress is currently being made through the development and application of models such as VANDACLIM and PACCLIM. However, in general their use to date has done more to highlight the potential of such models than to increase our understanding with regards to the vulnerability of PICs and the responses they should be invoking. That situation is likely to change in the very near future. The models are evolving in response to the needs of users, users are making more effective use of the modelling tools and the requisite data for effective implementation of the models is starting to be assembled.

The third area where technology can assist is in the development of visualisation software to facilitate the interpretation and application of the findings of both environmental monitoring and modelling activities. Again, VANDACLIM and PACCLIM have demonstrated the potential of such technology, as has the use of geographical information systems at both national and regional levels. Additional effort is required to see the realisation of this potential for the benefit of PICs.

Finally, successful adaptation to climate change will require the use of a suite of appropriate indigenous and imported technologies. Furthermore, adaptation measures will be successful only if they are supported and sustained by the requisite skills and knowledge. Thus it is necessary to enhance the awareness and other supportive capacities of communities, the private sector and governments of developing countries with respect to both the adaptation options that already exist, and to those that might be acquired through transfer of adaptation 'know how'. Introduced, or newly developed know how related to adaptation must be integrated with the existing experiential base if communities are to be successful in accommodating future changes in climate.

# 5. Regional synthesis of the national findings

## 5.1 Introduction

There are three intended outcomes from this regional synthesis of the 10 national assessments of vulnerability to climate change and of the options for adaptation:

- to identify commonalities in both vulnerability and adaptation and, by doing so, highlight opportunities for sharing experiences, understanding and other forms of assistance, through regional cooperation;
- to characterise the vulnerability of the region as a whole, as a contribution to international discussions on responses to climate change; and
- to describe adaptation strategies that are common to the region, but are beyond the current capacity of the region to implement.

## 5.2 Regional vulnerability to climate change

The UNFCCC guidelines for the preparation of initial communications by non-Annex 1 Parties signal a clear preference for information to be presented in the form of numerical indicators. As previously noted, the 10 PICCAP countries were unable to report their findings in such a manner. Indeed, and as also noted earlier, there is an urgent need to strengthen the IPCC-based vulnerability assessment methodology so that the findings can be expressed this way.

In the interim, the more descriptive, qualitative findings in the national assessments have been reviewed, and common themes identified.

All 10 studies chose to focus on specific sectors, as well as assessing vulnerability on a cross-sectoral basis. Table 5.1 shows that the most commonly studied sectors were agriculture, water resources, coastal systems and human health. Only two assessments addressed the vulnerability of the fisheries sector. This may well reflect the difficulty of undertaking a vulnerability assessment for this sector, due in part to the lack of relevant information.

The current lack of detailed regional and national information on anticipated climate and sea level changes, including projected changes in the variability and extremes, resulted in most assessments being limited to using current knowledge to answer 'what if' questions regarding environmental and human responses to possible stresses.

Overall, the main conclusions of the vulnerability assessments were as follows.

Climate variability, development and social changes and the rapid population growth being experienced by most PICs are already placing pressure on sensitive environmental and human systems. The adverse impacts arising from these sources of stress on environmental

**Table 5.1 Sectoral Focus of the National Vulnerability Assessments**

| Sector | Cook Islands | Fiji | FSM | Kiribati | Marshall Islands | Nauru | Samoa | Solomon Islands | Tuvalu | Vanuatu |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture | X | X | X | X | X | | X | X | X | X |
| Forestry | | X | | | | | | | | |
| Agro-forestry | | | | | | X | | | | |
| Biodiversity | | | | | | | X | | | |
| Water resources | X | X | X | X | X | X | X | | X | X |
| Coastal | X | X | X | X | X | X | X | X | X | X |
| Marine resources | | | | | X | | | | | |
| Fisheries | | | X | X | | | | | | |
| Housing | | | | | | | | | X | |
| Human health | X | X | | X | X | X | X | X | X | X |

and other systems would be exacerbated if the anticipated changes in climate and sea level (including extreme events) did materialise.

The future health and productivity of coral reef and mangrove ecosystems will have a significant influence on the future wellbeing of most PICs. The anticipated detrimental effects on coral reefs arising from higher sea surface temperatures and CO2 levels will be worsened by the degraded nature of these ecosystems.

Land use changes, including settlement and use of fragile and vulnerable lands for agriculture, are decreasing the natural resilience of environmental systems and hence their ability to accommodate the anticipated additional stresses arising from changes in climate and sea level.

Given the limited area and low elevation of habitable lands, the most direct and severe effects of climate and sea level changes will be increasing risks of coastal erosion, flooding and inundation. These adverse effects would be exacerbated by any combination of seasonal storms, high tides and storm surges.

Other direct consequences of anticipated climate and sea level changes would likely include a reduction in subsistence and commercial agriculture production of such crops as taro and coconut and decreased security of potable and other water supplies. Assessments also indicate increased risk of dengue fever, malaria, cholera and diarrhoeal diseases, and decreased human comfort, especially in houses constructed in western style and materials.

Groundwater resources of the lowlands of high islands and atolls will likely be adversely affected by flooding and inundation associated with sea level rise. Moreover, water catchments of smaller, low-lying islands will be at risk from any changes in the frequency of extreme events.

Climate and related oceanic variations have already had significant adverse impacts on fish catches, both subsistence and commercial. The anticipated changes in climate and ocean conditions will further reduce the security of this resource.

The overall impacts of changes in climate and sea level identified above will likely be cumulative. The integrated consequences of climate change and sea level rise for PICs will be determined by the interactions between individual exposure units and given sectors, in terms of both the stresses to which they are exposed and the economic, social and environmental changes that result.

## 5.3 Common adaptation strategies

The national assessments of potential adaptation measures had many elements in common, reflecting similarities in vulnerability, as described above. These common elements are described below, in the context of the principal sectors to which they relate. It should be noted that most of the proposed adaptation measures may be described as 'no regrets' options.

### 5.3.1 Agriculture

The uses, potential uses, and the preferred growing environment of tree and plant species should be identified and documented. An effective adaptation strategy would be to develop a formal plan related to the use of plants and trees, and to selectively plant species that are best suited to a particular physical environment, and to a particular purpose and use. There is a need to recognise the importance of biodiversity and agrodiversity in current land use systems. Their integration into conservation would be useful as a strategy for adaptation and for the long-term sustenance of agricultural systems in PICs.

Where agriculture is practiced in vulnerable, low-lying areas, the breeding and introduction of salt tolerant root crops is seen as an effective measure. Alternatively, different cultivation practices might have to be considered, such as the use of irrigated, raised-bed systems. For drought prone upland areas the breeding of more drought resistant cultivars and crops is advocated. Improved soil and water conservation practices in both drought and flood prone areas is seen as an important means of maintaining productivity, and hence food security. Intercropping and increased diversity of crops is also viewed as a strategy for increasing the resilience of the agriculture sector in both coastal and upland areas. Thus diversification to a wider range of plantation crops would spread the risk of loss from climate change, including increased incidence of extreme events. Likewise, it is considered prudent to extend the planting of plantation crops to other land areas, or islands. This would again spread the risk of production losses due to extreme events such as cyclones.

The resilience of traditional agricultural systems could be enhanced by diversifying subsistence crops, promoting agro-forestry, encouraging sustainable practices and developing economic opportunities. Re-evaluation of the traditional value system of the products and uses of trees and other plants is advocated for appropriate areas.

Quarantine surveillance should be increased against introduced and invasive species that have higher temperature optima, or which may become adapted to environments at higher elevations, and the like.

The introduction of appropriate disincentive policies related to the consumption of imported staple foods (such as price controls on rice and flour) should be reconsidered, and incentive policies for the production and consumption of local foods should be given priority. This will enhance the security of food supplies.

Economic agricultural policies, such as subsidies on cash crops, should be evaluated and monitored to ensure they do not undermine the cultural and social systems and the traditional values underlying subsistence agricultural systems. Such considerations will enhance the resilience of these systems to climate change and other stresses.

### 5.3.2 Coastal systems

Enhanced protection of mangrove areas and sensitive coral reef systems is considered an effective way to ensure these systems can cope with the added stresses arising from climate change and sea level rise. Such moves would help maintain the natural storm and erosion protection these systems offer and also help sustain their production of living resources. Integrated catchment and coastal management planning would produce a variety of outcomes that collectively increase the resilience of coastal systems.

In heavily populated areas, or those associated with high value infrastructure or economic activity, foreshore protection measures including revegetation and establishment of setback zones are considered to be cost effective adaptation measures to protect against flooding and erosion. Measures to protect existing foreshore vegetation and encourage revegetation would help reduce the vulnerability of coastal areas. Moreover, the replanting of littoral forests would help protect sensitive coastal environments. On the other hand, sea walls are seen as a high cost adaptation option that would only be of value for very specific areas, and impractical on a large scale.

Preventing the discharge of pollutants in coastal and marine areas is identified as a priority measure to enhance the resilience of coastal and marine ecosystems.

In some areas an appropriate response may be to re-establish traditional systems of ownership and specific rights on coastal areas such as reef patches and shoals.

Measures to control aggregate removal for construction and other uses would also help reduce the risk of erosion and other undesirable impacts of climate change and sea level rise. Similarly, reclamation should be actively discouraged.

Resettlement options may become necessary for some areas, but the high social, economic and environmental costs associated with resettlement make it an option of 'last resort'.

### 5.3.3 Human health

Public awareness programmes related to malaria, dengue fever and other diseases are an essential, low-cost method for reducing the public health risk. Such programmes have already been initiated and are considered to be relatively effective, as is the use of bed nets and mosquito screens.

Past experience suggests that mosquito eradication is not a practicable option, due to the high financial and environmental costs, and no guarantee of success. However, biological control may become a viable option some time in the future. Moreover, reduction of mosquito breeding sites within towns and villages (e.g. informal waste dumps, open water tanks, discarded containers such as cans, tyres) is already considered to be an effective method for reducing local malaria risk. There are also other benefits from such actions.

Enhanced quarantine measures are also suggested as a priority response.

In general, an improvement in medical services is viewed as an appropriate response strategy, due to the high benefits that accrue to local communities. Similar reasoning suggests the increased use of traditional medicines.

### 5.3.4 Water resources

Improved management and maintenance of existing water supply systems has been identified as a high priority response, due to the relatively low costs associated with reducing system losses and improving water quality. Centralised water treatment to improve water quality is considered viable for most urban centres but at the village level it is argued that more cost effective measures need to be developed. User pay systems may have to be more widespread.

Catchment protection and conservation are also considered to be relatively low cost measures that would help ensure that supplies are maintained during adverse conditions. Such measures would have wider environmental benefits, such as reduced erosion and soil loss and maintenance of biodiversity and land productivity.

Drought and flood preparedness strategies should be developed, as appropriate, including identification of responsibilities for pre-defined actions.

While increasing water storage capacity through the increased use of water tanks and/or the construction of small-scale dams is acknowledged to be expensive, the added security in the supply of water may well justify such expenditure. Development of runways and other impermeable surfaces as a water catchment is seen as possible, but an extreme measure in most instances. Priority should be given to collecting water from the roofs of buildings.

Measures to protect groundwater resources need to be evaluated and adopted, including those that limit pollution and the potential for salt-water intrusion. The limited groundwater resources that are as yet unutilised in the outer islands of many countries could be investigated and, where appropriate, measures implemented for their protection, enhancement and sustainable use.

The development of desalination facilities is considered to be an option for supplementing water supplies during times of drought, but in most instances the high costs are seen as preventing this being considered as a widespread adaptation option.

### 5.3.5 Living marine resources

The development and extension of marine breeding and re-stocking programmes, for both fish and corals, are seen as effective means of increasing the resilience and sustainability of inshore marine resources. Similarly, further expansion of marine reserves and other conservation instruments would help protect subsistence fish stocks and coastal marine resources and enhance their ability to withstand the added stresses arising from climate and related changes. Such measures are capable of reducing the impact of humans on the marine environment and hence enhance the resilience of the marine ecosystem.

Enhanced enforcement of legislation to prevent the use of destructive fishing methods is also advocated as a no-regrets response option. Community participation in the development and implementation of compliance and enforcement programmes is advocated.

Improved monitoring and quota management systems for migratory fish stocks are considered to be desirable. Not only would these measures prevent over-exploitation of these resources, but they are also considered to be effective ways of ensuring there is a buffer against climate related stresses.

### 5.3.6 Housing

Measures to 'cyclone-proof' houses and other buildings have been identified as desirable. This would include consideration being given to both structural design and the materials used in construction.

Reductions in heat stress and discomfort may be achieved through the planting of shade tress and by building houses with improved insulation and ventilation. Air-conditioning is not considered to be a viable response, in general.

### 5.3.7 Biodiversity

Conservation of biodiversity is considered to be a viable, no-regrets adaptation measure. It should be associated with a sharpened recognition of the values of local trees and other plants, and a new sense of ownership for trees and plants.

Community based forest conservation projects can enhance the resilience of managed and natural forest systems. Forest management should place a high priority on land and soil conservation, water conservation, nature conservation, wood production and the quality of the human living experience. In this way there will be added resilience to the effects of global warming. The introduction and enforcement of appropriate legislation and policies for the conservation

and sustainable use of living resources will also enhance the ability to adapt to climate change.

## 5.4 Policy implications of the findings of the vulnerability and adaptation assessments

Specific measures for adapting to the adverse effects of climate change and sea level rise can only be implemented effectively if a number of associated actions are taken, aimed at providing a favourable context for the adaptation measures. This includes addressing the wider development issues, and hence seeing responses to climate change as an integral part of national planning. These more comprehensive actions include development of a national policy framework, capacity building (including institutional strengthening) and enhanced public awareness and education as well as provision of resources (funds, skills and technology).

As noted by Campbell and de Wet (1999), three strategies of adaptation that facilitate inclusion of adaptation options into development may be recognised:

- incorporating climate change and sea level rise considerations into new development proposals;
- undertaking planning and actions specifically aimed at addressing the potential effects of climate change and sea level rise; and
- undertaking actions related to strengthening the institutional and technical capacities that facilitate successful implementation of the preceding strategies, and hence avoidance and mitigation of the adverse effects of climate change and sea level rise, and enhancement of any positive consequences.

In all three instances, optimal adaptation approaches will be anticipatory and will be harmonised with regional, national and local development planning.

Additional comment on these policy implications will be provided in Section 6.

# 6. Capacity building needs and implementation requirements

Sections 3 and 4 identified the need to enhance the undertaking of vulnerability and adaptation assessments, and some of the constraints and barriers to successful implementation.

Even if the suggested improvements in methodology are implemented and the technical tools and techniques are further developed, little will be achieved in real terms unless these improvements are consistent with the ability of the practitioners, users, institutions and other key players and stakeholders to take advantage of this strengthening of the assessment procedures. Enhancing the capacity to undertake vulnerability and adaptation assessments is as critical as is improving methodology and developing the tools and techniques. Moreover, building capacity at national and regional levels must take place on a number of fronts.

The findings of vulnerability and adaptation assessments have implications for the private sector, communities and all levels and sectors of government. It may be necessary for institutions to be strengthened and institutional arrangements to be modified in ways that reflect the multiplicity of stakeholders, the need to adopt more integrated approaches to decision making and the need to ensure that responses to climate change are considered alongside development and other planning issues. Establishment of interdisciplinary and multi-sectoral climate change country teams has been an appropriate initial response.

Any such changes will, in turn, require greater buy-in from both the government and the private sector. Thus improved ability to communicate the assessment findings to politicians, government officials and leaders in industry and commerce is also needed. Such people should be made more aware of the ways in which climate change can impact on their interests, and given guidance regarding appropriate responses.

Similarly, community and other groups need to be made aware of the real risks associated with climate change. They should also be equipped with the requisite ability to reduce those risks to acceptable levels. Action-oriented public awareness programmes are therefore an integral part of a well conceived climate change response programme.

As noted previously, many of the requirements for improving the quality and usefulness of the vulnerability and adaptation assessments will be met only if better use is made of the available and newly-derived information and of the methods, tools and techniques used in the assessment. There is a growing incompatibility between the analytical methods required to address the increasingly sophisticated needs of decision makers for policy guidance and local capacities to provide such information. While qualitative, descriptive studies are generally compatible with local capacities (information resources, human expertise and so on), the more sophisticated diagnostic assessments and prognostic analyses that are being increasingly demanded by policy and decision makers typically require levels of information and expertise that are not widely and readily available in PICs.

Universities, technical institutes and other research bodies, together with industry and the technical departments of government, need to play their key roles in enhancing the quality, relevance and accessibility of both traditional and new information and understanding. They should also be able to assist with adapting and adopting imported and indigenous technologies for both assessment and adaptation. Finally, it is important that they be capable of developing and strengthening assessment methods so that they are more compatible with local needs and capacities.

# 7. Possible vulnerability and adaptation projects

In the context of the previously identified gaps, barriers and constraints to successful implementation of vulnerability and adaptation assessments, and the need for additional capacity building, a number of possible vulnerability and adaptation projects can be identified.

Additional studies are required to improve the local knowledge, and hence understanding, with respect to local conditions and dependencies. More comprehensive information on present day conditions, and specifically how the environmental and socio-economic systems respond to present day variations in climate (both mean conditions and extreme events), would support major improvements in the quality of the vulnerability and adaptation assessments, and hence make them much more useful to policy and decision makers. Improved understanding of contemporary interactions between environmental and socio-economic systems is critical to determining how these same systems will respond when, in the future, they are influenced by global and regional changes in atmospheric and oceanic conditions.

More use could be made of traditional knowledge and of both indigenous and imported technology to characterise the responses of environmental systems to both internal and external stresses, including those arising from climate variations and change. The application of traditional indicators for monitoring environmental quality and change, in conjunction with methods based on imported technologies, will do much to bridge the information gap that currently impairs the quality and usefulness of the vulnerability and adaptation assessments. There is a need to strengthen and refine approaches based on an appropriate mix of traditional knowledge, community experience, government information resources and scientific information. This will produce much more robust and useful assessments. Such approaches need to be identified and evaluated as to their technical feasibility before decisions are made about their implementation.

A specific example of a project that would address the preceding concerns and grasp opportunities is a study that aids in distinguishing between the impacts of climate variability and those related to climate change; climate variability is very real for PICs and is capable of producing adverse impacts that are of similar significance to those anticipated to result from climate change. The UNFCCC requires assessments to focus solely on the impacts of climate change. However, much can be learned by placing such impacts in the context of the current dominance of climate variability.

Available studies indicate that the sensitivities of mean atmospheric and oceanic systems of the Pacific basin to increases in atmospheric concentrations of greenhouse gas are less than the associated global averages. Other studies suggest a de-coupling of the responses in the Pacific Ocean basin from those occurring globally. Improved understanding of such responses, and reduction in the current substantial uncertainties is a high priority. For example, a reduced sensitivity in mean conditions suggests that extreme events may become the dominant source of climate change induced stresses on Pacific Island countries. The assessment methodology based on the IPCC Guidelines is oriented more to assessing the consequences of changes in mean conditions. More needs to be known about the extreme events, in terms of both how they will respond to global warming, and how natural and human systems will respond to changes in the magnitude and frequency of extreme events.

The current inability to develop comprehensive and reliable future scenarios for climate and oceanic conditions at the national level, with the resolution required for detailed sectoral studies, should be addressed as a matter of priority. Furthermore, there is a need to improve the ability to project both environmental and socio-economic trends over time, with and without the effects of climate change being incorporated in the projections. This is an important task given that, in the case of PICs, non-climate related changes in the economic, social and environmental systems will dominate in the short term. However, such changes are poorly understood. Uncertainties are therefore large, resulting in an inability to make specific statements about impacts attributable to climate change with a useful degree of certainty.

As noted earlier, considerable progress is currently being made through the development and application of models such as VANDACLIM and PACCLIM. However, in general their use to date has done more to highlight the potential of such models than to increase

our understanding with regards to the vulnerability of PICs and the responses they should be invoking. Attention should be given to the development and implementation of models and other tools capable of providing quantitative estimates of the sensitivity and threshold responses of selected exposure units, sectors and integrated economic, social and environmental systems to given changes in key environmental parameters. The latter would include mean and extreme conditions of temperature, rainfall, wind velocity, cloudiness and sea level and state, both individually and in selected combinations. Considerable progress is currently being made through the development and application of models such as VANDACLIM and PACCLIM. Such models are becoming increasingly responsive to the needs of users and users are making more effective use of the modelling tools. Further and more rapid development of visualisation software to facilitate the interpretation and application of the findings of both environmental monitoring and modelling activities is also desirable.

A further project is to characterise the adaptive capacity at regional, national and local levels, focussing on the ability of the economic, social and technology systems to assess, support and sustain recommended policy initiatives and practical actions. Relevant aspects of the methods developed for environmental technology assessment, and especially those related to assessing the capacity of the given society to sustain an imported or indigenous technology (e.g. Hay and Noonan, 1999), may well be helpful in assessing the capacity of that society to adapt to climate change.

Improved methods for identifying autonomous adjustments are also required. As noted above, the relative importance of subsistence and other traditional forms of lifestyle and decision making in PICs means that autonomous adjustments to climate change may well play a greater role than in developed countries, and also be of a different nature to those found in other regions and countries. A series of well-chosen case studies may be the most productive approach to first identifying historic examples of autonomous adjustments to change (be it of economic, social or environmental origins), followed by the use of this empirical evidence to develop and test methods for recognising the autonomous adjustments that might occur in response to climate change.

Another timely project would be one which leads to enhanced methods for identifying, characterising, evaluating and prioritising adaptation strategies. The methods should help address the need for proposed adaptation measures to be more reflective of the findings of a rigorous and comprehensive vulnerability assessment. The methods should also enhance the ability to distinguish between the advantages and disadvantages of anticipatory, reactive and no-regrets adaptation options and provide the ability to distinguish the relative merits of those based on the use of indigenous and imported technologies. Even for predominantly subsistence economies it is important to be able to provide full guidance to decision makers through the use of cost-benefit and other objective analyses. These may be based on market or non-market values, as appropriate. Jepna and Munasinghe (1998) present various decision analytical frameworks and specific techniques that would enhance the usefulness of any guidance. These include cost-benefit-based decision tools, economic and non-market cost-benefit analysis, cost-effectiveness analysis, least-cost solution, multicriteria analysis, decision analysis and integrated assessment. Of particular relevance to PICs is the use of non-market techniques and analytic frameworks.

Given the growing and important place of climate change adaptations in national decision making and planning, there is an emerging need to extend the IPCC-based methodology to include monitoring and evaluation of the effectiveness of policy implementation, and of related actions. This would validate the effectiveness of the policy advice being provided to decision makers. As previously identified, to date there has been little effort devoted to the development of methods to monitor and evaluate the effectiveness of implementing adaptation policies related to climate change. For PICs, this is an important omission given the high vulnerability to climate change, the almost total reliance on adaptation, the lack of experience and understanding as to what responses might be most appropriate and the consequent and overall high levels of uncertainty.

In keeping with the comments made in Section 6, a priority project is to build on the findings of national and regional assessments of adaptive capacity by undertaking capacity building activities that address the identified gaps and barriers to successful implementation of adaptation measures. In addition to the existence of appropriate levels of awareness, understanding and expertise and of supportive institutional arrangements, successful adaptation to climate change will require the use of a suite of

indigenous and imported technologies. Thus it is necessary to enhance the awareness and other supportive capacities of communities, the private sector and governments with respect to both the adaptation options that already exist, and to those that might be acquired through transfer of adaptation 'know how'.

A more detailed project concept related to enhancing local capacity for adaptation to climate change is included in Annex 2.

# 8. Summary and conclusions

In the present study, draft reports and statements for the 10 PICCAP countries have provided the basis for an evaluation of the national assessments of vulnerability and adaptation to climate change and have been used to produce a regional synthesis of the national findings.

The national reports and statements were assessed in order to identify major gaps in the vulnerability and adaptation assessments. Constraints to fulfilling the intent of the vulnerability and adaptation studies were also identified. These included consideration of such factors as data constraints, methodological limitations and access to appropriate technologies.

The regional synthesis was undertaken by compiling and interpreting the findings of the vulnerability and adaptation studies undertaken in all 10 countries. The most commonly studied sectors were agriculture, water resources, coastal systems and human health. Most assessments were limited to using current knowledge to provide descriptive assessments of vulnerability. The synthesis is thus of a similar nature.

Most of the proposed adaptation measures were 'no regrets' options, involving a range of traditional and imported responses.

The national findings were used to identify implications for regional policies and for capacity building projects, at both national and regional levels, that would allow more effective assessments of the vulnerability of Pacific Island countries and identification and application of appropriate adaptation measures.

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