VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SMALL ISLAND DEVELOPING STATES

Background paper for the expert meeting on adaptation for small island developing States

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CONTENTS

ACRONYMS

ADB	Asian Development Bank
AOGCM	Atmosphere-Ocean General Circulation Model
AOSIS	Alliance of Small Island States
BPoA	Barbados Programme of Action for the Sustainable Development of Small Island Developing States
CARICOM	Caribbean Community and Common Market
CDERA	Caribbean Disaster Emergency Response Agency
CEP	Caribbean Environment Programme of UNEP
CHAMP	Caribbean Hazard Mitigation Capacity Building Programme
CPACC	Caribbean Planning for Adaptation to Climate Change
CRIF	Catastrophic Risk Insurance Facility (within the World Bank)
CSI	Coastal Regions and Small Islands platform of UNESCO
CSIRO	Commonwealth Scientific and Industrial Research Organization
DIVA	Digital Interactive Vulnerability Analysis
DSSAT	Decision Support System for Agro-technology Transfer
ENSO	El Niño-Southern Oscillation
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GHG	Greenhouse gas
GIN	Global Islands Network
GSN	GCOS Surface Network
GUAN	GCOS Upper-Air Network
HADCM	Hadley Centre Coupled Model (GCM produced by the Hadley Centre of the United Kingdom Met Office)
IBRD	International Bank for Reconstruction and Development
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOC	Indian Ocean Commission
IPCC	Intergovernmental Panel on Climate Change
KAP	Kiribati Adaptation Programme
LDC	Least Developed Country
MACC	Mainstreaming Adaptation to Climate Change (Caribbean)
MAGICC	Model for the Assessment of Greenhouse-gas Induced Climate Change
MEA	Multilateral environmental agreement
MSG	Meteosat Second Generation satellite

NAH	North Atlantic subtropical high
NAPA	National adaptation programme of action
OAS	Organization of American States
ODA	Official Development Assistance
OECS	Organization of Eastern Caribbean States
PACCLIM	Pacific Climate Impacts Model
RANET	RAdio & InterNET for the Communication of Hydro-Meteorological and Climate Related Information
SCENGEN	Scenario Generator (Used to generate global and regional scenarios of climate change)
SIDS	Small island developing States
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
SPREP	Pacific Regional Environment Programme
SPSLCM	South Pacific Sea Level and Climate Monitoring
SRES	Special Report on Emissions Scenarios (from the IPCC)
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VSAT	Very Small Aperture Terminal (Broadband satellite internet)
WEAP	Water Evaluation and Planning System (a software tool for integrated water resources planning)
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

A. Context for adaptation to climate change for SIDS

1. There are 51 small island developing states which, in spite of their geographical and cultural diversity, share similar economic and sustainable development challenges including low availability of resources, a small but rapidly growing population, remoteness, susceptibility to natural disasters, excessive dependence on international trade and vulnerability to global developments. SIDS also have to contend with a lack of economies of scale, high transportation and communication costs, and costly public administration and infrastructure.

2. The climate of small island states is influenced by large ocean-atmosphere interactions such as trade winds, El Niño and the monsoons; tropical cyclones and hurricanes are also important components of the climate, as well as sea-level rise. These climate characteristics, combined with their particular socio-economic situations make SIDS, among which are 12 LDCs, some of the most vulnerable countries in the world to climate change. This, added to the fact that SIDS produce such extremely low levels of greenhouse gas emissions, means that they will suffer disproportionately from the damaging impacts of climate change.

B. Data, methods and tools for national assessments of impacts, vulnerability and adaptation

3. The collection of climate related data is especially important in the case of SIDS since they are highly sensitive to changes in the climate and to sea-level rise and are experiencing the more severe effects of climate change sooner than most other countries.

4. With regard to systematic observation, many SIDS are in a good position since observation networks have already been established through regional initiatives such as South Pacific Sea Level and Climate Monitoring, and Caribbean Planning for Adaptation to Climate Change.

5. Problems faced by SIDS with regard to climate related data and observations include linking historical and anecdotal information to climate variability, climate change and sea-level rise; retrogression in the condition of the networks due to sensors not being replaced or repaired; problems with telecommunications preventing data being transmitted; and a need to expand observations to other relevant parameters. Easy access to the data for the climate monitoring community is also lacking, along with the translation of results into a format useful for policymakers.

6. GCOS is currently implementing Regional Action Plans which will help respond to these problems. The Pacific Islands Action Plan was used as a pilot by GCOS therefore many activities have already been implemented. Although less advanced in its implementation, the Action Plan for Latin America and the Caribbean has also prompted activities which will increase the effectiveness of observations in this region.

7. SIDS used both top-down, scenario-driven approaches (some accompanied by regional downscaling techniques), and bottom-up vulnerability based approaches when carrying out their vulnerability and adaptation assessments.

C. Key vulnerabilities to climate change for SIDS

8. A warming of the ocean surface around small island states has already been detected, and this trend is expected to continue. Projections show that this warming will be accompanied by an increase in heavy rainfall events and other temporal and spatial changes in precipitation patterns, and by more intense or frequent cyclones/hurricanes. Arable land, water resources and biodiversity are already under pressure from increases in population on small island states and the unsustainable use of available natural resources. With climate change, negative impacts on agriculture are predicted; coral reefs will be threatened by increased sea surface temperatures and acidification of the oceans; mangroves will be threatened by sea-level rise and an increase in extreme weather events. Water resources are expected to be stressed by changes in precipitation patterns.

9. Tourism and agriculture, in particular, will be negatively impacted by these changes. Likewise climate change, through these impacts, threatens the achievement of the sustainable development goals

contained in the Mauritius Strategy. Responses to climate change and sea-level rise could be coordinated and integrated with existing policies of socio-economic development and environmental conservation to facilitate sustainable development.

10. Other projected impacts include: economic losses from reduced agricultural yields, for example from shortening of the growing season or drought; loss of mangrove forests due to sea-level rise, loss of coral reefs due to bleaching and acidification of the oceans and damage to terrestrial forests due to extreme events; reduction in the size of freshwater lenses and general water resource availability due to decreased rainfall and saltwater intrusion; inundation of settlements and arable land on the coast and reduction in tourism resulting from increases in extreme weather and environmental degradation.

D. Adaptation to climate change

11. SIDS have ongoing projects and projects in the pipeline which will implement adaptation measures to help increase resilience to the impacts of climate change on a global, regional and national level. These projects involve strengthening of institutions, policy and regulations, but also ground-level tasks such as water storage and drought resistant crops. Many follow on from, or are acting in synergy with, projects for the mainstreaming of adaptation. Some completed adaptation projects date back to the 1990s and have published outcomes which can be used as a resource for SIDS investigating adaptation approaches.

12. The projects and programmes on issues relating to impacts, vulnerability and adaptation in SIDS are diverse. They are being implemented within the UNFCCC process by other UN agencies which also serve as Global Environment Facility (GEF) implementing agencies (activities include projects sponsored by GEF and non-GEF funded projects) and by multilateral financial institutions and bilateral development assistance agencies.

13. Regional adaptation initiatives have focussed on capacity-building and mainstreaming adaptation into government policy and strategies (e.g. KAP-I and MACC). Mainstreaming has allowed projects to move into phases involving the implementation of pilot projects (e.g. KAP-II and Implementation of Pilot Adaptation Measures in coastal areas of Dominica, St. Lucia and St. Vincent & the Grenadines). Adaptation activities "on the ground" have been taking place mainly in an ad-hoc, individual way on a local scale. The application of tradition knowledge to newly arising or worsening situations has helped maintain the resilience of SIDS up to now, but may not be enough in the future.

14. National adaptation programmes of action have been useful in helping the most vulnerable SIDS to identify their most urgent adaptation needs. Samoa and the Union of Comoros have already completed the process and there are lessons to be gained from their conclusions. The priority activities of both countries related to dealing with water shortages, either for the population or for agriculture.

15. There are a multitude of possible adaptation options for SIDS which include engineering solutions such as sea defences, hurricane resistant buildings and the provision of water storage; legislative solutions such as revised building codes, land zoning around coasts and rivers and updating water policy; and technological solutions such as using more resilient crops.

16. However, in spite of the wide range of adaptation options that could be successfully implemented in SIDS, there are constraints that can limit the choices of options and their implementation such as inadequate data and technical capacity, weak human and institutional capacity and limited financial resources. Maladaptation, caused by governments underestimating, overestimating or mis-estimating the climate impact, can also hinder the adaptation process, since it can be used as a reason for going through with adaptation options.

E. Risk management, risk reduction and the role of insurance

17. Risk management practices have the potential to greatly help SIDS in preparing for climate change impacts especially in the form of increased extreme events, and organisations and companies are taking actions to decrease risk from natural disasters on SIDS. For example, the Caribbean Hazard Mitigation Capacity Building Programme of CARICOM is helping Caribbean countries to create national hazard vulnerability reduction policies; and the United Insurance Company of Barbados gives financial incentives for homeowners to put preventative measures in place. The Catastrophic Risk Insurance Facility (CRIF)

within the World Bank is piloting a scheme for small States to buy parametric insurance coverage against natural disaster risk.

18. Risk transfer could occur through micro-insurance, catastrophe bonds and reduced insurance premiums as an incentive to take preventative measures. Insurance is often cited as an option with high potential. However, the small risk pool and lack of financial mechanisms act as an obstacle to insurance initiatives.

F. Climate change and sustainable development goals in SIDS: the Mauritius Strategy

19. The adverse impacts of climate change are a major barrier to the achievement of sustainable development goals in SIDS. They are anticipated to further exacerbate the impact of existing development challenges such as loss of market and declining value of traditional exports; declining domestic food production and increasing imports; difficulties associated with attracting foreign direct investment; increasing cost of petroleum relative to value of traditional exports; reduction in official development assistance, increasing populations and unemployment and environmental degradation.

20. The Barbados Programme of Action of the Sustainable Development of Small Island Developing States (BPoA) and the Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States guide the implementation of sustainable development in SIDS, and both explicitly recognise the threat that climate change poses to SIDS. Recommendations on actions to be taken to help SIDS adapt which were suggested in the BPoA are strengthened in the Mauritius strategy and include the transfer of technologies and practices to address climate change, building and enhancing scientific capacities and enhancing the implementation of global atmospheric observing systems.

G. Cooperation and opportunities for adaptation

21. There are various multilateral sources of funding for adaptation available which include the GEF Trust Fund, the Special Climate Change Fund, the Least Developed Countries Fund and the Adaptation Fund. Funding is also available through other bilateral and multilateral sources, including those that support the implementation of multilateral environmental agreements such as the Convention on Biological Diversity.

22. Numerous regional organizations, groups and networks exist between SIDS. Some of these networks have included adaptation to climate change as part of their activities but there are synergies that remain unexploited, highlighting the need for continued mainstreaming of climate change.

23. In addition, there are international organizations such as UNESCO and UNEP which have regional programmes specifically for SIDS. Such programmes provide useful opportunities for catalyzing additional support for, and synergistic implementation of adaptation activities in SIDS at both the national and regional level.

I. Introduction

1. The Conference of the Parties (COP), by its decision 1/CP.10, requested the secretariat to organize three regional workshops and an expert meeting for small island developing States (SIDS), reflecting issues of priority identified by that group, in order to facilitate information exchange and integrated assessments to assist in identifying specific adaptation needs and concerns.

2. This background paper presents input for the expert meetings on adaptation for the Caribbean (to be held in Jamaica from 5 to 7 February 2007) and the Pacific region (to be held in the Cook Islands from 26 to 28 February 2007). The paper covers a range of issues relating to adaptation including: climate change impacts; vulnerability and adaptation assessments; lessons learned; risk management; insurance and funding and regional and international cooperation.

3. The main purpose of this paper is to stimulate discussion on priorities and issues for further consideration. It also aims to facilitate the exchange of information and experiences of different practices within the SIDS.

II. Context for adaptation to climate change for small island developing States

4. According to the current list of the United Nations Department of Economic and Social Affairs, 51 states and territories[1] are categorized as small island developing States (SIDS). SIDS are located across the Indian, Pacific and Atlantic oceans, and also in the Caribbean Sea. The southwest Pacific has a high concentration of SIDS, as does the Caribbean region. In the Atlantic and Indian oceans SIDS are located predominantly around the African continent.

5. SIDS are located mainly in tropical and sub-tropical oceans. Their climate is influenced strongly by ocean-atmosphere interactions which often manifest themselves in extreme weather events such as hurricanes and cyclones. These events are associated with storm surges, coral bleaching, inundation of land, and erosion (with resulting high-cost damages to socio-economic and cultural infrastructure). In the Pacific islands region cyclones accounted for 76 per cent of the reported disasters from 1950 to 2004 with the average costs relating to damage caused per cyclone standing at USD 75.7 million in real 2004 value.[2] The 2004 Caribbean hurricane season alone caused damages estimated at USD 2.2 billion in only four countries: the Bahamas, Grenada, Jamaica and the Dominican Republic.[3]

6. Rainfall variations provide a dominant climate regime for many SIDS. For example, the climate of tropical Pacific islands is influenced by trade wind systems, Hadley and Walker circulation systems, the movement of the inter-tropical convergence zone, the South Pacific Convergence Zone and the El Niño-Southern Oscillation (ENSO). A major mode of climate variability is influenced by the Madden-Julian Oscillation often on time scales of 30 to 70 days and the inter-decadal Pacific Oscillation on a decadal time scale.

7. The climate in the Caribbean region is characterized by dry winters and wet summers with the dominant influence of the North Atlantic subtropical high (NAH). During winter, the NAH lies further south with strong easterly trade winds modulating the climate and weather in the region, which is usually at its driest with reduced atmospheric humidity. Island climates in the Indian Ocean region are dominated to a large extent by the Asian Monsoon system, composed of the southwest or summer monsoon and the northeast or winter monsoon.

8. These climate characteristics and their particular socio-economic situations make SIDS some of the most vulnerable countries in the world to climate change. This, combined with the fact that SIDS produce extremely low levels of greenhouse gases (GHG), means that they will suffer disproportionately from the damaging impacts of climate change.

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[1] <http://www.un.org/special-rep/ohrlls/sid/list.htm>.
[2] World Bank, 2006, *Not If, But When: Adapting to Natural Hazards in the Pacific Islands Region*, A Policy Note
[3] United Nations Economic Commission for Latin America and the Caribbean press release <www.reliefweb.int/rw/rwb.nsf/db900SID/JCDR-677LG5?OpenDocument>.

9. SIDS face similar sustainable development challenges, among which are small population, low availability of resources, remoteness, susceptibility to natural disasters, excessive dependence on international trade and vulnerability to global developments. They also suffer from lack of economies of scale, high transportation and communication costs, and costly public administration and infrastructure.

10. SIDS also have some common economic concerns. They are generally more exposed to internal and external shocks, such as social conflict, extreme events and climate change, than larger countries. Many of them rely on one or few economic activities such as tourism or fisheries. SIDS are also often heavily dependent on imported petroleum products which leads to high electricity prices (ranging from USD 0.13 to over USD 0.30 per kWh) and constrains economic and social development efforts. Twelve of the SIDS are also least developed countries, with especially vulnerable economies.

11. In the climate change context, an important feature of SIDS is that, although they rely heavily on fossil-fuel based energy for their economic and social development, they account for less than one per cent of global GHGs.[4] For example, in the Pacific islands the average per capita equivalent emissions are 0.96 tonnes of carbon dioxide (CO_2) per year; this equates to only approximately 25 per cent of the CO_2 emissions attributable to the average person worldwide.[4]

12. Many SIDS have identified the development of sustainable energy systems as a priority. For example, in the Pacific islands the identified need is for economically sustainable, clean, renewable and moderate-scale energy production technology to initially complement, and eventually replace, existing sources of energy. This technology would immediately make significant reductions in emissions of industrially generated GHGs, in particular CO_2.

13. SIDS are already experiencing the adverse effects of climate change. Sea-level rise has been negatively impacting the national economies of SIDS and the potential to cause further damage. Significant socio-economic impacts of climate change which are distinctive to many SIDS relate to equity and sovereignty. The impacts of climate change have the potential to make some atoll islands such as Kiribati, Tuvalu and the Maldives uninhabitable through changes in precipitation (causing drought which affects drinking water directly and food security through agriculture), sea surface temperatures (causing coral bleaching which affects artisanal fisheries and reduces storm surge protection) and extreme events (which impact infrastructure, agriculture and cause salt water intrusion into the freshwater lens). If societies, or even communities, are forced to leave because of these impacts, some nations may lose their sovereignty.[5]

14. Significant challenges for policy development have been identified in relation to a range of likely impacts of climate change, including the loss of revenue across productive sectors; damage to coastal infrastructure and accelerated coastal erosion; depletion and/or shifting of fish stocks; bleaching and ultimately death of coral reefs; and the availability and quality of water resources required for local communities and tourism. There is a need for economic diversification to improve resilience and for interventions to prevent human health related problems and social and cultural disruption, including displacement and adverse effects on traditional systems.

15. In addition, changes in global markets have caused further marginalization of many SIDS, putting them under increased pressure. This factor may exacerbate the vulnerability of SIDS to climate change by adversely affecting their economies, and therefore their resilience and adaptive capacity.

[4] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[5] Barnett, J. and Adger, N. 2003. 'Climate Dangers and Atoll Countries', *Climatic Change*, 61(3): 321-337.

III. Data, methods and tools for national assessments of impacts, vulnerability and adaptation

A. Data and observations

1. Data needs and observations

16. Programmes such as the South Pacific Sea Level and Climate Monitoring project (SPSLCM) and Caribbean Planning for Adaptation to Climate Change (CPACC) have created monitoring and observation networks for Pacific SIDS and Caribbean SIDS, respectively.

17. In most countries, the meteorological agency is responsible for undertaking and coordinating observations. The scope of observations varies among SIDS. For example, Nauru and Tuvalu concentrate on oceanographic[6] observations while the Marshall Islands have oceanographic stations and climate stations. The Cook Islands has a observation network composed of synoptic stations, oceanographic stations, upper-air observing stations and radar stations, among others. Grenada carries out meteorological, climate, oceanographic, hydrological monitoring along with measuring precipitation. Mauritius complements readings from oceanographic and meteorological stations with satellite and aeronautical observations.[7]

18. However, these networks are often not working at their maximum efficiency, some of the reasons why are described below.[8]

19. Interruptions in data transmissions due to a limited assigned satellite window can cause problems, as can the low frequency of recordings; taking readings on a monthly basis does not adequately capture data on extreme weather events which prevents long term data records to be compiled. In addition, higher frequency readings and near-real-time observations would also be useful. Upgrading of the telecommunications network between small island states is a common requirement for improving climate observations.

20. There is a general need to strengthen and upgrade the observation networks and to smooth out the irregular distribution of stations. However, there are more specific problems such as delays in the maintenance and replacement of sensors resulting in data gaps and that sensors are sometimes maintained in an improper and irregular manner. Equipment that cannot be repaired is sometimes not replaced, causing a retrogression in the condition of the network; and sensors are not calibrated correctly for sea temperature, resulting in datasets that cannot be compiled and compared.

21. Dissemination of the climate data is important; potential users often cannot access data products in a reliable and easy fashion. Climate data archives are in the process of being digitized and integrated into modern datasets for use by the climate monitoring community. There is also a need to translate data into a format understandable by policy makers, the private sector and the general public.

22. The scope of observations is, in some cases, not optimum. For example, with regard to coral reefs, variables such as sea temperature, salinity, photosynthetic active radiation, ultraviolet radiation and wind speeds are required to fully understand changes that are occurring. Hydrological monitoring (e.g. of groundwater levels) is becoming important for SIDS, and better bathymetry data are required for sea-level rise studies.

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[6] Oceanographic stations includes marine stations and tide gauges.
[7] FCCC/SBI/2005/18/Add.4.
[8] Extracted from the Report of the Pacific Islands Regional Implementation Workshop on Improving Global Climate Observing Systems and the Report of the Global Climate Observing System (GCOS) Regional Workshop for Central America and the Caribbean <http://www.wmo.ch/web/gcos/gcoshome.html>.

2. Participation in the Global Climate Observing System[9]

23. GCOS, fulfilling its responsibilities under the UNFCCC, has held ten regional workshops on climate monitoring between 2000 and 2006. As a result of these workshops, Regional Action Plans have been created to respond to the specific observing needs of the region.

24. Pacific island countries are in a good position with regard to systematic observations and their contribution to GCOS, largely due to forward planning by the South Pacific Regional Environment Programme (SPREP)[10] which has created a framework on which GCOS can build. In the Caribbean, the Caribbean Planning for Adaptation to Global Climate Change (CPACC) project has also played an important role in establishing an observation system for GCOS to expand and improve.

25. The Pacific Islands Action Plan was implemented as a pilot and therefore the Pacific islands have progressed further than any other region in implementing their Action Plan. A sound management structure has been established and a full-time technical coordinator is in place. Many projects and activities have either been completed or are at advanced stages of implementation, addressing priorities such as capacity building; enhanced operation of the GCOS Upper-Air Network (GUAN), the GCOS Surface Network (GSN) and tide gauge stations; definition of user requirements; climate prediction; and improved telecommunications and data rescue.[11]

26. Specific activities undertaken include: identification of end user needs in nine Pacific island countries through in-country workshops; renovation of several GUAN stations such as in the Cook Islands and Papua New Guinea; production and circulation of three sub-regional climate bulletins, for example Island Climate Update; data rescue to safeguard paper climate records in five Pacific Island countries (Fiji, Kiribati, Vanuatu, Papua New Guinea and the Solomon Islands); improved inter-island communications through RANET, MSG and VSAT systems; upgrading tide gauge stations and increased monitoring of sea-level rise; climatology and climate change training; and database creation and management.

27. Implementation of the Regional Action Plan for Central America and the Caribbean is not as advanced, although, many elements of the action plan have been implemented or are currently being addressed. These include upgrades of tide gauges (through the MACC project) and upgrades of the GUAN and GSN networks; data rescue; replacement of the telecommunications systems in all participating countries and the establishment of a Regional Technical Support team. Surface and groundwater monitoring networks are in the process of being assessed and regional data warehousing is being created (GCOS, 2006).

28. In many countries the extent to which the observation network has been developed is proportional to the amount of funding received. Other networks, such as the Global Coral Reef Monitoring Network, are also important in increasing the collection of climate related data in SIDS.

B. Methods and tools for assessments

1. Application of scenario-based and vulnerability-based approaches

29. Many SIDS, especially in the first round of their national communications submitted as part of their responsibilities under the UNFCCC, used the scenario-based approach for the assessment of future impacts, vulnerability and adaptation to climate change based on utilising outputs from general circulation models to provide scenarios of future climate change. Some have used global projections from IPCC reports (e.g. Cook Islands from the Second Assessment Report) or other relevant literature (e.g. Bahamas from the

[9] The Global Climate Observing System was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. It is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission of UNESCO, UNEP and the International Council for Science.

[10] Pacific Island GCOS Action Plan, 2002 <www.wmo.ch/web/gcos/gcoshome.html>.

[11] GCOS, 2006, Report of the GCOS Regional Workshop Programme, produced for the 14th Session of the GCOS Steering Committee, Geneva, Switzerland, page 9.

publication *Effects of climate change: hydrometeorological and land-based effects in the Bahamas*[12]). Marshall Islands, St. Kitts and Nevis, Vanuatu, the Cook Islands and the Maldives have used the HADCM from the United Kingdom and CSIRO (Australia) general circulation models as the basis of their vulnerability and adaptation assessment, combined with IPCC emission scenarios. The Maldives has used MAGICC/SCENGEN to develop the scenarios further.

30. Global climate models, as well as many regional climate models, are based on atmosphere-ocean general circulation models and are characterised by resolutions that do not provide adequate coverage of individual SIDS. High dynamic or statistical downscaling techniques can be helpful for simulating local climatic variations and for conducting impact assessments. It is also possible to use the outputs for raising awareness about the long-term effects of climate change. However, the applicability of the top-down approach, including sophisticated downscaling techniques, for developing sound practical adaptation measures in small island states is questionable because of the complexity of the assessment processes, uncertainties of the model results, the small land areas involved, limited stakeholder involvement and the limited use for policymaking at the national level (see box I).

Box I: Experience of the Cook Islands in applying impacts assessments methodologies[13]

As part of the Pacific Island Climate Change Assistance Programme (PICCAP) which aims to help Pacific islands meet their reporting obligations to the UNFCCC, the Cook Islands applied the prototype integrated assessment model PACCLIM (PACific CLimate Impacts Model). This model was developed by the International Global Change Institute in New Zealand and involved the integration of a global climate model with climate data and a regional climate scenario generator.

Socio-economic elements for the Cook Islands include tourism, pearls, commercial and subsistence fisheries and coastal floodplain agriculture. The Cook Islands faced numerous challenges when carrying out the assessment, including gaining trust for the project, the limited time to carry out the project, the presentation of complex material, gathering the relevant input, recording feedback, verifying anecdotal evidence and quantifying observations and uncertainties.

The conclusion was that the tool had limited applicability for the Cook Islands and was rather complicated and, that it would be better to focus on refining data collection and on improving results by using simpler methods. The tool could be better used for training in identifying cross-sectoral considerations. Useful application at the decision-maker level would require more motivation and a greater level of completeness.

31. At a later stage some SIDS used a bottom-up, vulnerability-based approach for vulnerability and adaptation assessments in their national communications. For example, Barbados based its assessment of vulnerability on findings from the CPACC project which focuses on assessing current vulnerability to both climate related factors (e.g. climate variability, drought, flooding and extreme weather events) and non-climate related factors (e.g. lack of resources, inadequate institutions and poverty) and on examining current practices in adaptation. In addition, it includes the evaluation of vulnerability to future climate related risks and involves key stakeholders in the evaluation process. National adaptation programmes of action (NAPAs) produced by least developed countries (LDCs) for the UNFCCC are a good example of application of a bottom-up vulnerability-based assessment (see box II, below).

32. In general, the application of different approaches in SIDS shows that the top-down, scenario based approaches and tools, including impact and integrated models, are strong in terms of biophysical aspects of impacts and certain types of dynamic interactions, but do not perform well in representing human interactions and local abilities to adapt. Vulnerability-based (bottom-up) approaches are more attuned to the local institutional, economic and productivity contexts, and are better able to represent local options and constraints than are scenario-driven studies, which is important feature for SIDS. They are useful for

[12] Martin and Bruce, 1999, Effects of climate change: hydrometerological and land-based effects in the Bahamas, Global Change Strategies Inc, Ottawa, Canada, 34pp.

[13] Adapted from a presentation given by Ms. Pasha Carruthers on this topic at the UNFCCC CGE Regional Hands-on Training Workshop on Vulnerability and Adaptation Assessments for the Asia and the Pacific Region, held in Jakarta, Indonesia on 20 to 24 March 2006.

developing specific strategies and in policy implementation but are often limited by lack of data (in terms of type and level of detail).

2. Needs, requirements and training opportunities

33. In most SIDS, there is a lack of baseline information for understanding the complex interplay between and within natural and human systems. This is a considerable gap in information on likely changes in climate and human systems at the small-island scale. Consequently, most SIDS have not yet been able to undertake in-depth, nationwide climate change impact and vulnerability assessments in an integrated manner. Without such national assessments as a sound basis for designing and planning adaptation policies, strategies and programmes, decisions on adaptation will remain tentative.

34. Understanding the effects of climate change, and associated enhanced climate variability and sea-level rise, at the local and national levels is critical for adaptation, as is the capacity to select and apply appropriate methods and tools to prepare for adaptation. Furthermore, the development of technology; the use and integration of traditional knowledge and the communication of science in ways that can be understood and used by SIDS policy makers and their constituencies are also crucial. This includes the need to link scientific analysis to downstream social and economic effects. User-friendly documentation of successful pilot schemes on adaptation assessment, information clearinghouses, and stronger public education and outreach programmes are useful in disseminating information relating to the potential impacts of climate change, and the benefits and advantages of reducing vulnerabilities.

35. The Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention has held hands-on training workshops to familiarize experts involved in preparing second national communications with UNFCCC guidelines for reporting vulnerability and adaptation assessments and with the tools for conducting and integrating sectoral assessments. During these workshops tools such as: MAGICC/SCENGEN, DIVA (dynamic interactive vulnerability analysis), WEAP (water evaluation and planning system), DSSAT (decision support system for agro-technology transfer) were used to illustrate the main concerns when carrying out adaptation assessments. Other training opportunities might be provided as a part of different projects on enabling activities and capacity building for national communications.

IV. Key vulnerabilities to climate change for SIDS

A. Observed and projected climate changes

36. Observational records show that sea surface temperatures have been increasing by 0.1ºC per decade in the oceans where most SIDS are located.[14]

37. In the Caribbean, analysis of data from the late 1950s to 2000 has shown that the number of very warm days and nights is increasing dramatically and the number of very cool days and nights are decreasing, while the extreme inter-annual temperature range is decreasing. The Caribbean Sea has warmed by 1.5ºC over the last century.[15] The maximum number of consecutive dry days is decreasing and the number of heavy rainfall events is increasing.[14] However, there is a trend towards an overall decrease in precipitation, with prolonged dry spells having occurred over the last few decades.[15]

38. In Southeast Asia and the South Pacific significant increases have been detected in the annual number of hot days and warm nights, with significant decreases in the annual number of cool days and cold nights. Almost all observation stations have exhibited increases in the frequency of hot extremes and decreases in cold extremes, with many of these trends being statistically significant. Mean rainfall has showed an increasing trend in, and north east of, the South Pacific Convergence Zone. Extreme rainfall trends were less spatially coherent, with some stations showing increases in the proportion of annual

[14] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[15] Tompkins, E.L., et al, 2005, Surviving Climate Change in Small Islands - A guidebook, produced by the Tyndall Centre for Climate Change Research, United Kingdom.

rainfall from extreme events and some showing decrease in the number of rain days. The annual and seasonal ocean surface and island air temperatures have increased by 0.6 to 1.0ºC since 1910 throughout a large part of the South Pacific and to the northeast where decadal increases of 0.3ºC to 0.5ºC in annual temperature have been observed since 1970. The increases in surface air temperatures have been greater in the Pacific than global rates of warming.[16]

39. The projections of global warming indicate a warming trend for all small island states ranging from an annual mean change of 1.98°C in the Pacific Ocean to a change of 2.10°C in the Indian Ocean by the 2050s. With respect to precipitation, the range of projections is still large, and even the direction of change is unclear (see table 1 for a summary of projections taken from IPCC Third Assessment Report). Sea surface temperatures are projected to increase by 1°C.

40. Tropical cyclone intensities could increase 5 to 10 per cent by about 2020 whereas the peak precipitation rates are likely to increase by 25 per cent in response to increases in maximum and mean tropical cyclone intensities. The IPCC Third Assessment Report also highlights that, with climate change, the intensity of tropical cyclones in the Pacific may increase, thus there is a possibility that more persistent and devastating tropical cyclones may occur. Likewise, for the Caribbean, extreme events (e.g. drought) may become more frequent with global warming, and hurricane intensity could increase. The climate of small islands is strongly affected by the ENSO phenomenon; with climate change ENSO-like patterns are projected to become more frequent. For example, in the Caribbean the El Niño condition is associated with a suppressed hurricane season, whereas the La Nina events create conditions more favourable for Atlantic hurricanes.

41. Atmosphere-ocean global circulation models (AOGCMs) have simulated well the broad scale pattern of temperature and precipitation across the major SIDS regions. However, rainfall amounts vary between models, with some underestimating or overestimating the intensity of rainfall in the high rainfall zones. AOGCMs can also represent current climate and ENSO-related climate variability reasonably well at a regional level. However, there is considerable variation in model performance at finer or island scale. Table 1 shows projected changes from the AOGCMs that simulate current climate and climate variability for small islands states reasonably well.[17]

Table 1: Ensemble of annual mean climate change scenarios for small islands for the 2050s and 2080s as inferred from AOGCMs. Numbers in brackets show standard deviation between model projections; +A is the projected change with the aerosol effect added (adapted from Nurse et al[14]).

	Annual Mean Temperature Change (°C)					**Annual Mean Precipitation Change (%)**			
	2050s		2080s			2050s		2080s	
Region	GHG	GHG+A	GHG	GHG+A		GHG	GHG+A	GHG	GHG+A
Atlantic Ocean and Caribbean	2.03 (±0.43)	1.71 (±0.25)	3.06 (±0.84)	2.64 (±0.61)		-5.2 (±11.9)	-1.3 (±7.8)	-6.8 (±15.8)	-0.7 (±12.3)
Pacific Ocean	1.98 (±0.41)	1.63 (±0.23)	2.99 (±0.87)	2.54 (±0.63)		5.5 (±2.5)	4.9 (±0.8)	7.6 (±3.3)	7 (±1.9)
Indian Ocean	2.1 (±0.43)	1.64 (±0.23)	3.16 (±0.89)	2.61 (±0.65)		3.1 (±4.5)	1.6 (±3.9)	5.1 (±4.3)	4.3 (±4.9)

[16] World Bank, 2000. *Cities, Seas, and Storms: Managing Change in Pacific Island Economies.* Volume I: Summary Report (draft). Papua New Guinea and Pacific Islands Country Unit. The World Bank. Washington, D.C.

[17] HadCM2 (United Kingdom); ECHAM4 (Germany); CSIRO (Australia); CCSR/NIES (Japan) and CCCma (Canada).

B. Current and future climate change impacts and vulnerabilities

1. Agriculture and fisheries

42. Agriculture has for a long time been the mainstay of survival and economic development in many SIDS. Subsistence agriculture provides local food security, and cash crop agriculture has enabled SIDS to earn export revenue and participate in world trade. Subsistence food production is vital in small islands even within those that have limited arable land. However, arable land for crop agriculture is increasingly in short supply and the likely prospect of land loss and salinization due to climate change and sea-level rise will threaten the sustainability of both subsistence and commercial agriculture.

43. The occurrence of extreme weather events usually causes irreparable damage to food crops and other livelihood material on which small island populations depend. Extended droughts often cause damage to agricultural crops resulting in low exports and high imports, the latter usually resulting in a huge burden on foreign exchange earnings.

44. Fisheries frequently contribute up to 10 per cent of the GDP in many SIDS and therefore the socio-economic implications of the impacts of climate change will be significant. Variations in tuna catches are especially significant during El Niño and La Nina years. For example, in the Maldives, the El Niño years of 1972–1973, 1976, 1982–83, 1987 and 1992–1994 negatively affected skipjack tuna catches highlighting the sensitivity of fish stocks to changes in the climate. Changes in migration patterns and depth of fish stocks are the two main factors affecting the distribution and availability of tuna during such periods and it is expected that changes in climate may cause migratory shifts in tuna aggregations to other locations.

45. The projected impacts of climate change for agriculture include extended periods of drought and loss of soil fertility which seriously affect agriculture and food security. Much of the prime agricultural land is located on the coastal plains which are threatened by sea-level rise.

46. Negative impacts on agriculture may lead to economic losses. However, the relative magnitude of these losses will differ among islands. For example, in the absence of adaptation on a high island such as Viti Levu in Fiji, the cost of damages could be in the range of USD 23–52 million per year by 2050 whereas in a low island such as Tarawa, Kiribati, the annual average cost of damages would be in the order of USD 8–16 million. The damage cost represents 2 to 3 per cent of Fiji's gross domestic product (GDP) in 2002 and 17 to 18 per cent of Kiribati's GDP for the same year.[18]

47. Research has indicated that in Guyana a shortening of the sugarcane growing season would result in an acceleration of maturation and reduce yields by 29.8 per cent under $2xCO_2$ conditions, in St. Kitts and Nevis climatic conditions would be too dry for rain-fed agriculture making it economically unviable, and there would be a 20 per cent decrease in productivity in St. Vincent and the Grenadines.

2. Biodiversity

48. SIDS are home to an important proportion of the world's biodiversity especially because of their geographic isolation which has lead to the formation of many endemic species. The biodiversity of upland and coastal forests, including mangroves, is threatened by both global change and local factors, for example more than a quarter of small island states have a greatly reduced forest cover as a result of encroachment from infrastructure development or agriculture.

49. Both terrestrial ecosystems on larger islands and coastal ecosystems on most islands have been subjected to increasing degradation and destruction. For example, analyses of coral reef surveys over a period of 30 years has revealed that coral cover across reefs in the Caribbean has declined by up to 80 per cent, a result attributed largely to continued and unabated pollution, sedimentation and over-fishing.

50. Mangrove accretion on-land may or may not be able to keep pace with rising sea level depending on composition of the forest, tidal range and sediment supply. Studies have projected that 3 per cent of Cuba's mangrove forests will be lost with a one meter rise in sea level. For the same rise in sea level a

[18] World Bank (2000). *Cities, Seas, and Storms: Managing Change in Pacific Island Economies*. Volume I: Summary Report (draft). Papua New Guinea and Pacific Islands Country Unit. The World Bank. Washington, D.C.

complete collapse of the Port Royal mangrove wetland in Jamaica is predicted since this system has shown little capacity to migrate over the last 300 years.[19]

51. Biodiversity is threatened by an increase in extreme events which decimate the forests in which the greatest levels of biodiversity are found. For example, in 1993, 30 per cent of the forested area on the Santa Cruz islands was lost during one cyclone event.[19] Samoa lost 92 per cent of its plantation estate in 1990 as a result of cyclones Ofa and Val, with the latter estimated to have caused damage costing over USD 300 million. In 2001, a storm in the Seychelles resulted in the loss of over 1,000 endemic palms.

52. Coral reefs are threatened by rises in sea surface temperatures which lead to coral bleaching. In the past 20 years, a sea surface temperature rise of approximately 1ºC above the normal maximum summer temperature has lead to bleaching events. Some studies have predicted that in the next 30 to 50 years bleaching events could occur every year in most tropical oceans.[19]

53. Another threat to coral reefs is that of rising CO_2 concentrations in the oceans related to rising atmospheric CO_2. Based on projected CO_2 levels it has been suggested that the calcification rate of corals could decrease by about 14 to 30 per cent by 2050.[19]

3. Water resources

54. Many SIDS already experience water stress at current levels of rainfall input and extraction of groundwater. Water pollution is one of the major problems facing small islands; poor water quality affects human health and the incidence of water-borne diseases. Owing to factors such as limited size, geology and topography, water resources in small islands are extremely vulnerable to changes and variations in climate, especially in rainfall, and with the rapid growth of tourism and service industries in many small islands, there is a need for both augmentation of the existing water resources and more efficient management of those resources that already exist.

55. Taking into account their size and topography, SIDS tend to rely on any one or all of the three main natural sources of water: surface water (rivers, small lakes), rainwater and groundwater. Dominica in the Caribbean and Seychelles in the Indian Ocean, for example, are almost entirely dependent on surface water from ephemeral and perennial streams. Rainwater is the primary source of freshwater in several countries in the Pacific (e.g. Tuvalu and the northern atolls of the Cook Islands). Groundwater is the major source of water on many low-lying coral islands such as the Maldives and raised atolls such as Nauru, where the freshwater lens can vary in thickness and quality, depending on the rates of extraction and recharge from rainfall.

56. This dependency on rainfall increases the vulnerability of small islands to future changes and distribution of rainfall. Low rainfall can lead to a reduction in the amount of water that can be physically harvested, a reduction in river flow, and a slower rate of recharge of the freshwater lens, which can result in prolonged droughts. Since most of the islands are dependent upon surface water catchments for their water supply, it is likely that demand cannot be met during periods of low rainfall. On the other hand, during the rainy season, lack of suitable land areas for dams (e.g. in the Seychelles) and high runoff during storms (e.g. in Fiji) result in significant loss of surface and stream water to the sea.

57. The wet and dry cycles associated with ENSO episodes can have serious impacts on water supply and island economies, highlighting the vulnerability of water supplies to changes in the climate. For instance, the strong El Niño of 1998–2000 was responsible for acute water shortages in many islands in the Indian and Pacific oceans. In Fiji and Mauritius, borehole yields decreased by 40 per cent during the dry periods, and export crops including sugarcane were also severely affected. The situation was exacerbated by the lack of adequate infrastructure such as reservoirs and water distribution networks in most islands.

[19] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

58. Recent modelling of the current and future water resources on several small islands in the Caribbean, using a macro-scale hydrological model and the SRES scenarios found that many of these islands would be exposed to severe water stress under all SRES scenarios.

59. It has been estimated that a 10 per cent reduction in average rainfall by 2050 could produce a 20 per cent reduction in the size of the freshwater lens on Tarawa Atoll, Kiribati. Moreover, the thickness of the freshwater lens on atolls could be reduced by as much as 29 per cent. In addition, freshwater lenses are threatened by sea-level rise.

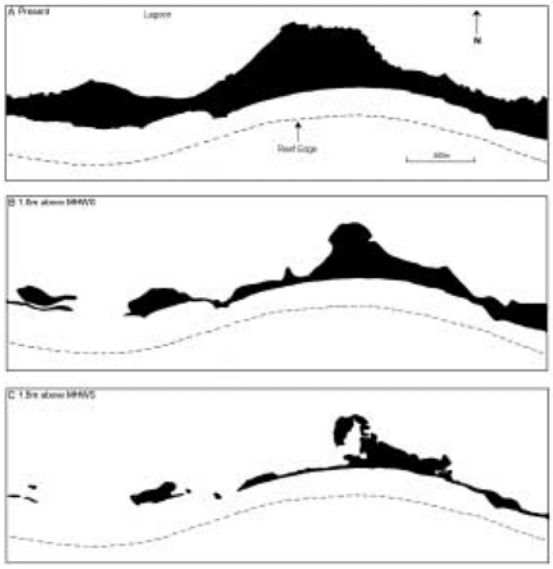

Figure 1: Projected inundation of Bikenibeu Island Tarawa, Kiribati under Worst Case Scenario (World Bank, 2000). Top: Present status; Middle: Residual island under worst case scenario 2100; Bottom: Residual island under worst case scenarios and storm surge, 2100.

4. Coastal zones, marine areas and settlements

60. The concentration of large settlements (with associated economic and social activities) at or near the coast is a well-documented feature of small islands. On Pacific and Indian Ocean atolls, villages are located on the sand terrace or on the beach itself, and in the Caribbean more than half of the population lives within 1.5 km of the shoreline. In many small islands such as along the north coast of Jamaica and the west and south coasts of Barbados, continuous corridors of development now occupy practically all of the prime coastal lands. Such land is also occupied by a range of other settlements, such as fishing villages, and on many small islands government buildings and important facilities such as hospitals are frequently located close to the shore.

61. Population growth and inward migration of people is putting additional pressure on coastal settlements, utilities and resources and creating a series of problems in terms of pollution, waste disposal and housing. In many parts of the Pacific, traditional housing styles, techniques and materials have ensured that islanders were resistant to damage or could be repair buildings quickly. Many of these traditional practices are being abandoned today, increasing the vulnerability of coastal settlements.

62. Coastal erosion is a major problem in small island states. It is a natural process which redistributes sediments but it can be accelerated by both natural and anthropogenic causes. Natural causes include hurricanes and storms. Anthropogenic activities which accelerate erosion include beach mining for building materials, unwise building practices on the coast and activities leading to the destruction of the coral reefs.

63. Projections based on HADCM2 and IS92a scenarios show that for a one metre rise in sea level, 98 coastal settlements in Cuba would be inundated affecting a population of over 50,000.[20] Protecting Jamaica's coast line from the impacts of a one-metre rise in sea level is expected to cost USD 426 million. This amounts to 19 per cent of Jamaica's GDP.[21]

64. A 50 cm in sea level could lead to 60 per cent of beaches in some areas of Grenada being lost.[21] For the Maldives, however, a one-meter rise in sea level amounts to the complete disappearance of the nation.

[20] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[21] UNFCCC, 2005, Climate change: Small Island Developing States, Bonn, Germany.

5. Tourism

65. Tourism is a major economic sector in many small islands and the impacts of climate change on the tourism sector are expected to be significant, and support for economic diversification towards other revenue generating sectors in small island states is necessary.

66. Sea-level rise and accelerated beach erosion, degradation of coral reefs (including bleaching), and the loss of cultural heritage on the coasts through inundation and flooding will most likely reduce the attractiveness of small island states to tourists. Increases in the frequency or intensity of hurricanes and cyclones will also strongly effect the tourism industry. For example, in Barbados 70 per cent of the hotels are located within 250 m of the high water mark. This suggests that many hotels are almost exclusively within the 1 in 500 and 1 in 100 inundation zones, placing them at risk of major structural damage.[22]

67. Shortage of water and increased danger of vector-borne diseases may also steer tourists away from small islands, and warmer climate in the northern countries could reduce the number of tourists who visit small islands in the tropical and subtropical regions.

68. In addition, future action to address climate change, such as environmental taxes on fuels used in air transportation, may also affect the tourism industry in small island developing States.[23]

V. Adaptation to climate change

A. Current experiences on community-based adaptation

69. Adaptation has been taking place through individual, ad-hoc actions on a local scale. For example, placing concrete blocks on the top of zinc roofs to prevent the roofs from being blown away during hurricanes has become common practice in Jamaica since Hurricane Ivan.[24] In Vanuatu, SPREP, with funding from the Canadian government, has moved 100 villagers living in the Lateu settlement to higher ground 600 m from the coast and 15 m above current sea level. Frequent flooding and erosion were making the original location of the settlement uninhabitatable.[25]

70. One of the key parameters of resilience on small islands has been the use of traditional knowledge including institutions and technologies, land and shore tenure regimes, the subsistence economy and customary decision-making processes. However, this resilience may be undermined as the SIDS become increasingly integrated into the world economy, through for example, negotiations for fishery rights in the Exclusive Economic Zone, international tourism and economic globalization. This raises the issue of setting priorities between modern and traditional economic practices.

71. Adaptation has also involved applying traditional coping strategies to new climate conditions. For example, on Timor Island farmers have developed their own varieties of major staple crops to adapt to erratic rainfall and cyclones and to ensure food security.[26]

72. Practices for coping with coastal erosion can be useful in adapting to rising sea level. For example, at Playa Rosaria, Havana Province, Cuba, the community has been relocated five kilometres inland because of coastal erosion. Other less disruptive activities such as reconstructing groynes, building sand dune fences, and planting trees along the coast can also reduce the impact of coastal erosion on communities.[27]

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[22] "Preliminary review of the economic impact of climate change on Caribbean Tourism: what is at risk and adapting for sustainable tourism development", presentation given by Ms. Marlene Attzs at the Organization of American States Meeting on Adaptation to Climate Change in the Caribbean, Tourism Sector Workshop held in Grenada, in May 2002.

[23] FCCC/SBI/2006/18, paragraph 5.

[24] Jamaica Gleaner, online article, posted 25 July 2006.

[25] Port Villa Presse, online article, posted 21 December 2005.

[26] UNFCCC database on local coping strategies <http://maindb.unfccc.int/public/adaptation/>.

[27] <www.unesco.org/csi/smis/siv/Caribbean/cubact2_com.htm>.

B. Possible adaptation options

73. Most adaptation initiatives in SIDS have involved enabling activities (including those for vulnerability and adaptation assessments) and, more recently, mainstreaming of climate change into government policies that being consistent with sustainable development would increase adaptive capacity to future climate change. In recent years more projects have included researching and implementing specific pilot adaptation measures (see section VI.C for examples). Some possible adaptation options available for vulnerable sectors in SIDS are highlighted below; many of these, such as improved water resources management, the development of hazard maps and the development of more appropriate building codes and land use policies, can also be considered sustainable development practices.

74. Measures to address the impacts of climate change on biodiversity and land degradation, include: creating land use plans and corresponding enforcement strategies; rainwater harvesting, water demand management, provision of water storage and water efficient household appliances; flood risk analysis with land zoning and flood mitigation actions; strengthening of institutional capacity to enforce land zoning restrictions, including the application of beach setbacks for construction; the use of land use models in order to make farming more efficient and less destructive to the environment and training fishermen and women in sustainable fishing practices.

75. Possible measures to address impacts on infrastructure and settlements include: providing for the scientific and engineering services required to assess vulnerabilities and define priorities, then retrofitting buildings; integrating adaptation into population and resettlement programs; improving the planning and permitting processes to guide coastal zone activities, including regulatory adjustments, awareness raising and enforcement; producing design and construction guidelines and applying them in pilot investments.

76. Measures that have been suggested to respond to projected decreases in water resources include: incentives to encourage the use of water saving devices; selecting appropriate drought tolerant vegetation; establishing river buffer zones to enhance the resilience of the river and catchment area; updating national water policies, improving water resources management; revising building codes to increase opportunities for rainwater catchment and storage; preparing water resource master plans for islands; and assessing and improving the water supply system.[28]

77. Adaptation can also occur through the prevention and removal of maladaptive practices. Maladaptation has been defined by the IPCC as "Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli" or as "an adaptation that does not succeed in reducing vulnerability but increases it instead".[29]

78. Examples of laws and practices that can 'inadvertently increase vulnerability' include: policies that lead to the destruction of mangroves; relaxation of coastal setback regulations; absence of comprehensive coastal zone management and planning; laws preventing the use of recycled water by hotels.[30] Individuals can carry out maladaptive practices by deliberately ignoring the risks posed by climate change (such as repeatedly rebuilding property in a vulnerable zone).

79. Responses to climate change may inadvertently increase, instead of decrease, vulnerability (the second definition of maladaptation). Maladaptation can occur because of underestimating, overestimating or mis-estimating the climate impact (adapted from Tompkins et al[30]):

(a) Underestimating: money is wasted as the action is inadequate, for example building sea defences with an expected life of 50 years that are over-topped within 5 years;

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[28] Above examples taken from project documents for: *Implementation of pilot adaptation measures in coastal areas of Dominica, St. Lucia and St.Vincent & the Grenadines* and *Kiribati Adaptation Program, Phase II.*

[29] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[30] Tompkins, E.L., et al, 2005, Surviving Climate Change in Small Islands - A guidebook, produced by the Tyndall Centre for Climate Change Research, United Kingdom.

(b) Overestimating: money is wasted as the action is overzealous, for example building sea defences that undermine natural beach processes and that are unnecessary during their 50 year life;

(c) Mis-estimating: for example sea defences are built but the most critical impacts from climate change manifest themselves as more intense rainfall events, so that inland flooding rather than coastal flooding is the problem.

80. Adaptation actions can occur within the range of projected changes, with flexibility built in so that they can respond to new information on expected impacts, avoiding maladaptation.

C. Adaptation policy processes and projects

1. National adaptation programmes of action

81. National adaptation programmes of action (NAPAs) provide a process for LDCs to identify priority activities that respond to their urgent needs with regard to adaptation to climate change. The rationale for NAPAs was based on the limited capability of LDCs to adapt to the adverse effects of climate change. Twelve of the LDCs are SIDS and are in the process of preparing their NAPAs; Samoa and the Union of Comoros have already completed the process (see box II).

82. NAPAs were launched after the seventh session of the Conference of the Parties (Marrakech, 2001) and focus on enhancing adaptive capacity to climate variability, which itself helps address the adverse effects of climate change. They are prepared through a participatory process, involving, in particular, local communities. After consultations, a national NAPA team develops prioritized proposals for urgent adaptation activities which will subsequently be funded from the LDC Fund and other sources.

Box II: National adaptation programmes of action

Samoa[31]

The National adaptation programme of action (NAPA) for Samoa was based on the results of a climate synthesis report produced by Samoa.

Samoa analysed 13 sectors, nine of which were identified as being highly vulnerable to climate change: agriculture and food security; water; biological diversity; health; forestry; coastal infrastructure and environment; tourism; urban settlement and village settlements. The NAPA team also looked in depth at causes of vulnerability for village community livelihoods. The activity that was identified as being of the highest priority for Samoa was securing community water resources. The NAPA for Samoa is unique in that it uses a "consensus approach" to prioritize the proposed actions, rather than the usual multicriteria analysis.

The framework for adaptation was based on the 2005–2007 Strategy for the Development of Samoa, along with four national environmental management strategies and other action plans which gave the NAPA a country-driven, complimentary approach.

Insights from and advantages to the NAPA process:

- The climate synthesis report has allowed synergies with other Rio Conventions.
- A nationally driven set of criteria was developed and utilized to prioritize the adaptation actions in the national programme.
- The process was an "exceptional learning experience" for the national climate change country team and the national task team.

[31] Information taken from the National adaptation programme of action for Samoa submitted to the UNFCCC in December 2005.

- An integrated approach ensured that all the relevant government and non-government stakeholders could provide input and that "those whose livelihoods are most vulnerable to adverse impacts of climate change impart the urgency and immediacy of the adaptation needs".[32]

Union of the Comoros[33]

The NAPA for the Comoros was the result of a participatory approach that took into consideration basic studies, field investigations, consultations and numerous working meetings and workshops. It was based on a prior analysis made on climate. The NAPA contains four main sections:

(1) Presentation of the characteristics of the physical environment, the pressures on environment, population and economy of the Comoros;

(2) Analysis of the vulnerability of the country to climate change by underlining impacts on the key sectors, including inventory of the potential risks and climate impacts on population and the economy, analysis of the sensitivity of resources, sectors, and the most vulnerable human groups.

(3) Analysis of links between the NAPA and development programmes and multilateral environment agreements.

(4) Review of the actions undertaken in the past to face climate change and identification of conditions for successful adaptation.

Challenges in the NAPA process included:
- Limited knowledge of the communities and development stakeholders in terms of climate change;
- Unpredictability of climate change effects;
- Reliability of the adaptation measures advocated in the face of possible evolution scenarios;
- Institutional weaknesses;
- Possible difficulties in obtaining the necessary financial resources for implementation;
- Concern about the daily life of the particularly vulnerable populations.

The activity that was identified as being of the highest priority for the Comoros was the introduction of plant varieties more adapted to drought.

2. Programmes and projects

83. SIDS have ongoing projects and projects in the pipeline which will implement adaptation measures to help increase resilience to the impacts of climate change. These projects involve strengthening of institutions, policy and regulations, but also ground-level tasks such as water storage and drought resistant crops. Many follow on from, or are acting in synergy with, projects for the mainstreaming of adaptation.

84. The projects and programmes on issues relating to impacts, vulnerability and adaptation in SIDS are diverse. They are being implemented within the UNFCCC process by UN agencies which also serve as Global Environment Facility (GEF) implementing agencies (activities include projects sponsored by GEF and non-GEF funded projects), by other UN agencies and by multilateral financial institutions and bilateral development assistance agencies. Some activities focus on enabling activities and were therefore eligible for agreed full cost funding by the GEF. Others have been or are sponsored by other sources, including the newly created LDC Fund, international intergovernmental agencies in the United Nations system and several development assistance agencies.

85. The activities vary in scope and magnitude. Some projects provide support for multiple countries; including the GEF-UNDP project "Piloting Climate Change Adaptation to Protect Human Health" and the GEF-World Bank project on mainstreaming adaptation to climate change in the Caribbean region (MACC).

[32] National adaptation programme of action for Samoa, page 2.
[33] Information taken from the national adaptation programme of action for the Comoros submitted to the UNFCCC November 2006.

86. Planned, pipeline and ongoing adaptation projects are described below. The projects can be national, regional or global in their scope and range in terms of funding requirements from less than USD one million to more than USD 70 million.

(a) **Implementation of Pilot Adaptation Measures in coastal areas of Dominica, St. Lucia and St. Vincent and the Grenadines, Regional (2006–2010)**
GEF Fund: SPA; Implementing Agency: IBRD; Total project cost: USD 6.4 million. This project aims to support efforts of participating countries in implementing pilot adaptation measures, where climate change mainstreaming activities have already occurred. Activities will specifically address the impacts of climate change on biodiversity and land degradation at the coast.

(b) **Kiribati Adaptation Program, Phase II (KAP–II), National (2006–2009)**
GEF Fund: SPA; Implementing Agency: WB Total project cost: USD 6.58 million. This three-year, SPA-funded project aims to develop and demonstrate the systematic diagnosis of climate-related problems and the design of cost-effective adaptation measures. It will build on KAP Phase I activities and NAPA preparation and continue to integrate climate risk awareness and responsiveness into economic and operational planning. Phase I of this project involved capacity-building and mainstreaming adaptation into national development plans and strategies.

(c) **Mainstreaming Adaptation to Climate Change, Regional (2002–2007)**
GEF Fund: Trust Fund; Implementing Agency: WB; Total project cost: USD 9.64 million. The aim of MACC is to create an enabling environment for climate change adaptation in participating CARICOM states and to integrate climate change and variability into the agendas of the tourism, agriculture, fisheries and infrastructure sectors. Activities include developing impact scenarios; sectoral, country-level studies on mainstreaming adaptation into sectoral planning; and developing disaster prevention through infrastructure norms. This project succeeds the Adaptation to Climate Change in the Caribbean (ACCC) project.

(d) **Coastal Resilience to Climate Change: Developing a Generalizable Method for Assessing Vulnerability and Adaptation of Mangroves and Associated Ecosystems, Global**
GEF Fund: MSP; Implementing Agency: UNEP; Total project cost: USD 2 million. This GEF funded project aims to build and strengthen the capacity of conservation practitioners to promote effective vulnerability assessment and climate change adaptation projects and policies. This will be done by developing a generalizable methodology for vulnerability assessment and climate change adaptation which can be applied to mangrove and associated coral reef, seagrass and upland ecosystems. Four focused projects in four different countries will be used to form the methodology; Fiji is one of these countries.

(e) **Adaptation to Climate Change in the Tourism sector in Fiji Islands, Regional**
GEF Fund: SCCF; Implementing Agency: UNEP; Total project cost: USD <1 million. Fiji has received funding to develop a demonstration project which will reduce the vulnerability of the tourism sector to the impacts of climate variability and change.

(f) **Pacific Islands Adaptation to Climate Change Project, Regional**
GEF Fund: SCCF; Implementing Agency: UNDP; Total project cost: USD 72.4 million. This project will implement long-term adaptation measures to increase resilience of a number of key development sectors to the impacts of climate change in ten different Pacific islands. The project will focus on water resources management, food production and food security, coastal zone and associated infrastructure along with the development of regional and national adaptation financing instruments to ensure the sustainability of the project.

(g) **Piloting Climate Change Adaptation to Protect Human Health, Global**
GEF Fund: SCCF; Implementing Agency: UNDP; Total project cost: USD 24.47 million. This project aims to select, prioritize and implement a range of strategies, policies and measures to increase resilience of human health to current climate variability and future climate change in a range of vulnerable countries; The project includes Barbados as an example of a low-lying developing country.

87. There are also many completed projects which now have reports available in the public domain, for example on project websites, some of which are highlighted below:

(a) **Wise Practices for coping with Climate Change in Mauritius, National (2006)**
This project involved the local community in investigating, planning, preparing and implementing an adaptation strategy plan in selected coastal villages (with a focus on the more immediate impacts such as extreme weather). Through this process, awareness of climate change science was raised and the local community will given an understanding of the impacts of climate change and how to verify that they are taking place.

(b) **Assessments of Impacts and Adaptations to Climate Change (AIACC) in Multiple Regions and Sectors, 2001–2006**
AIACC was designed to overcome capacity deficiencies and strengthen the information base for adaptation decisions in developing countries by taking a research-based approach to capacity building. This involved advancing the scientific understanding of climate change, adaptation and vulnerability in developing countries through enhancing the scientific and technical capacity among researchers within these countries. The website also contains 13 final project reports from the regional assessments carried out, three of which were in SIDS <www.aiaccproject.org/aiacc.html>.

(c) **Capacity building for Stage II adaptation to climate change, Regional (2003–2005)**
Central America, Mexico and Cuba serve as the pilot region for elaborating and applying an adaptation policy framework for preparing adaptation strategies, policies and measures. The application of this framework will demonstrate how policy for adaptation can be integrated into national sustainable development for at least three human systems: water resources, agriculture and human health. This demonstration project builds upon the Stage I vulnerability and adaptation assessments of the initial national communications of the eight participating countries of the region and will prepare them to move to Stage III Adaptation. The outputs of the project, Stage II adaptation strategies, may be used for preparing the second national communications.

(d) **South Pacific Sea Level and Climate Monitoring Project (SPSLCM), 2000–2005**
The SPSLCM was developed in 1991 in response to concerns by Pacific island countries with regard to climate change, climate variability and sea-level rise. The project assembled an archive of sea level and related climate data that provide information about sea-level variability and change. The third phase of the project was completed in 2005 and is now undergoing a review with a view to implementing the fourth phase. <www.bom.gov.au/pacificsealevel/index.shtml>.

(e) **Capacity building for the development of adaptation measures in the Pacific island countries (CBDAMPIC), 2002–2005**
The project supported the Cook Islands, Fiji, Samoa and Vanuatu in carrying out community vulnerability assessments and identify concrete adaptation measures to be implemented. It also enabled effective participation of all relevant stakeholders in the identification of adaptation measures and procedures for implementation at the community level. Funding was provided for the project by the Canadian International Development Agency and implemented by SPREP <www.sprep.org.ws/climate>.

(f) **Adaptation to Climate Change in the Caribbean (ACCC), 2001–2004**
This project succeeded and built upon CPACC by further increasing capacity for adaptation, especially though addressing areas not addressed by CPACC. Activities included planning for a regional climate centre, public education and outreach, the integration of climate change into the physical planning process and environmental assessments, the strengthening of regional technical capacity, the formulation of adaptation strategies for the health and agriculture sectors, and the implementation of strategies for adaptation in the water sector. In addition, ACCC tried to foster collaboration and cooperation with non-CARICOM countries.

(g) **Caribbean Planning for Adaptation to Climate Change (CPACC), 1997–2001**
The goal of this regional project was to increase capacity within the Caribbean for adaptation to climate change impacts, especially sea-level rise. It involved vulnerability assessments, adaptation planning and capacity building activities. Sea-level and climate monitoring systems were installed, databases and information systems established, and an inventory of coastal resources taken for the region. Specific measures such as coral reef monitoring, economic valuations and the formation of economic/regulatory proposals were also carried out.

(h) **Pacific Islands Climate Change Assistance Programme (PICCAP), 1997–2000**
This was a multi-country three-year enabling activity project of the GEF for the preparation of initial national communications of ten Pacific island countries. The main output was the submission of the initial national communications of Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Republic of Marshall Islands, Nauru, Samoa, Solomon Islands, Tuvalu and Vanuatu <http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php> for national communications.

(i) **Climate Adaptation in the Pacific, 2001–2003**
The goal of this regional technical assistance project was to assist ADB's Pacific developing member countries to work towards integrating climate change and variability adaptation measures into their development programs and projects through a risk reduction approach. The project has been completed with the publication of the document *Climate Proofing A Risk-based Approach to Adaptation* <www.adb.org/Documents/Reports/Climate-Proofing/main-report.asp>.

VI. Risk management, risk reduction and the role of insurance

88. Risk management practices have the potential to greatly help SIDS in preparing for climate change impacts and many activities are already ongoing with regard to disaster risk reduction. The Caribbean Disaster Emergency Response Agency of CARICOM is implementing the Caribbean Hazard Mitigation Capacity Building Programme, insurance companies are offering financial incentives for individuals to climate-proof their homes, and the World Bank is testing a Catastrophic Risk Insurance Facility (CRIF) to allow small States to buy parametric insurance coverage against natural disaster risk.

89. Many SIDS have disaster preparedness and management policy and legislation. for example, the Jamaica Office of Disaster Preparedness and Emergency Management, and the British Virgin Islands' Disaster Management policy framework. Other SIDS, such as Tonga, are working to prepare disaster risk reduction legislation to strengthen current disaster management departments. Much of this work has been prompted or supported by the *Hyogo Declaration* and *the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters* which was adopted at the World Conference on Disaster Reduction (WCDR) in 2005 in Hyogo, Japan. The International Strategy for Disaster Reduction is examining ways in which the work of the disaster risk reduction community and the work of the adaptation community may be complementary and synergetic (see Sperling and Szekely).[34]

[34] Sperling and F. Szekely (2005). Disaster Risk Management in a Changing Climate. Discussion Paper prepared for the World Conference on Disaster Reduction on behalf of the Vulnerability and Adaptation Resource Group (VARG). Reprint with Addendum on Conference outcomes. Washington, D.C.

90. However, the formulation and implementation of risk reduction strategies has been hindered in SIDS by institutional reforms associated with reductions in services and support from central governments. Local governments have limited resources to develop local public-sector alternatives to the private insurance market, or to provide adequate preparedness and protection. This does not necessarily mean that they cannot cope, as they have been historically resilient in developing other coping mechanisms. But the question is whether climate change might go beyond what traditional coping mechanisms can cope with.

91. It has been suggested that for developing countries, including SIDS, funding catastrophic damage through *ex-ante* measures in the form of insurance is far more beneficial for the affected community and the country's economy than through *ex-post* mechanisms such as credit, government subsidies or private donations. The *ex-ante* approach offers the potential to influence the level of risk, through linking insurance prices and conditions with government policy on hazard mitigation, implementation and supervision of building codes, which in turn can reduce a country's financial vulnerability and give improve prospects for investment and economic growth. Thus the promotion of 'micro-insurance' to reduce people's financial vulnerability when linked with the broader agenda of risk reduction is useful in assisting communties to manage the various levels of risk.

A. Risk assessment

92. In order to reduce its vulnerability, a country needs to understand the risks to which it is exposed and the potential damage such risks can cause. With this knowledge, a combination of legislation (such as land-use controls and building codes) and other risk reduction measures such as cooperation between government, the insurance industry, donors and civil society will be required to share the burden when disasters strike. To some extent this is already being done in many SIDS.

93. The IPCC Third Assessment Report concluded that climate change will increase actuarial uncertainty in risk assessment, placing upward pressure on insurance premiums and possibly leading to changes in risk coverage and thereby increasing demands for governments to take more active roles in risk management.

Box III: Risk assessment under CARICOM

The Caribbean Disaster Emergency Response Agency (CDERA) is the agency of the Caribbean Community and Common Market (CARICOM) responsible for disaster response in any of the 16 participating states. However, CDERA has been working to create a methodical and preventative approach for disaster management programmes through the assessment of vulnerability (ISDR, 2004).

CDERA is implementing a three-year project, funded by the Canadian International Development Agency and executed by the Organization of American States entitled the Caribbean Hazard Mitigation Capacity Building Programme (CHAMP).

CHAMP aims to help Caribbean countries in the development of comprehensive, national hazard vulnerability reduction policies and associated implementation programs; and the development and implementation of safer building training and certificate programs. Part I of the project involves mitigation planning. Activities include:

- Increasing geographic information system and data collection resources, e.g. coastal resources inventory system, hazard assessment data and critical facilities inventories.
- Hazard mapping for hazards such as storms, coastal and beach erosion, floods, landslides, drought (as well as non-climate related hazards such as earthquakes).
- Sectoral assessments, e.g. in the electrical utilities sector as in the report, *Hurricane Vulnerability and Risk Analysis of the VINLEC transmission and distribution system* (St. Vincent).

These activities, along with other vulnerability assessments, were combined with marketing for the mitigation of hurricane impacts and for policy development.

94. The Havana 2001 Risk Management Network is an example of a network established to assist in effective risk management, with the specific aim of supporting the initiatives of the various regional institutions working in the area of risk management and adaptation to climate change.

B. Possible options for insurance and risk transfer

95. Based on Article 4, paragraph 8, of the Convention, the international climate regime can provide a framework for insurance related activities, which might help countries to cope better with the risks and impacts of the adverse affects of climate change.

96. While the development of an insurance scheme has the potential to help SIDS manage disaster risk and reduce losses. Minimizing risk can result in a reduction of the rates for insurance, which thereby become more affordable. Rates could also reflect the mitigation measures, such as implementation of hazard plans, forecasting and warning systems, undertaken by a community, individuals, governments, and other stakeholders.

97. In order to diversify the financial burden it is important to coordinate among national institutions for the planning and implementation of disaster reduction strategies and activities. The involvement and collaboration of all stakeholders, decision-makers, disaster risk managers, the scientific community, civil society and local communities is needed to effectively manage risk assessment, monitoring and dissemination of information. Governments should integrate pre-planning, risk assessment, reconstruction and rehabilitation programmes, based on disaster scenarios, into their development plans, environmental policies and poverty reduction strategies in order to support disaster-resilient communities. It will be important for the governments of SIDS to review existing plans, particularly in the light of the effects of climate change.

98. Traditionally, inhabitants of small island states have coped with hazards such as earthquakes, cyclones, floods, tsunamis and volcanoes, as well as more recent, anthropogenic hazards. In this context SIDS base their responses to various levels of risk on diversification of their livelihoods or on remittances and other social assets because climate risk financing is either non-existent or significantly restricted.

99. Microfinance can provide a valuable alternative to insurance for poor households and at a community level. Community-based disaster prevention and risk management through mitigation programmes is essential, since communities are the most seriously affected by disasters. Therefore it is important for governments to cooperate closely with local communities in risk management and disaster preparedness.

1. Discussion of possible options

100. A number of mechanisms of risk transfer currently exist that could be considered in the context of SIDS. These include a concept of reinsurance either through the private market or from the state, whereby the re-insurer assumes responsibility for covering a portion of the risk, especially for rare but extreme event losses. This enables insurers to access capital in a cost-effective way, and assist in managing liquidity following a large claim event. A number of instruments could be considered: catastrophe bonds which pay out on a trigger condition rather than on proof of loss, and weather derivatives used by companies to hedge against the risk of weather-related losses. Weather derivatives pay out on a specified trigger, for example, temperature over a specified period rather than proof of loss. The provider of a weather derivative charges the buyer a premium for access to capital. If nothing happens, then the provider makes a profit.

101. Recognition of the apparent vulnerability of entire small island states to damage from sea-level rise led AOSIS to propose, in 1992, that an international insurance pool be instituted under the UNFCCC. In the AOSIS proposal it was suggested that payments into the pool would be a form of compensation linked to responsibility or liability for the impacts of climate change.

102. At a UNFCCC workshop in held May 2003 on the role of insurance, a number of proposals were put forward either to advance the AOSIS proposal or to follow a new system of risk sharing. One consideration was that a liability-based scheme would be useful for climate change, given that mandatory insurance requirements and tier of liability are already in use by a variety of international compensation and liability schemes for transboundary pollution to make otherwise uninsurable exposures insurable.

103. However, it was pointed out that such a scheme would have difficulties in apportioning causation (climate change versus climate variability) and difficulties in the application of the polluter pay principle. For example, how would contributions from 'polluters' from large emitting developing countries be calculated and who would adjudicate on the claims to ensure that the scheme worked? Another emerging problem is that extreme weather events place significant demands on the financial capacity of the insurance industry and, hence potential loss can be enormous. For example, after Hurricane Andrew hit Florida in 1992 causing USD 22 billion worth of insured damage (in 2004 prices), 11 insurers went into receivership. Therefore any insurance scheme for climate change in SIDS has to take into consideration the problems of liability, magnitude and intensity of climate extremes and the size of the risk pool.

Box IV: United Insurance Company Limited Hurricane Mitigation Programme

In 1997, the United Insurance Company of Barbados initiated its international Hurricane Mitigation Programme with an aim to reduce the vulnerability of Caribbean property to hurricanes. It has done this by producing the document entitled ***Guide to making your home hurricane resistant***, and by providing the financial incentives to put in place the preventative measures presented in this document.

The Hurricane-Resistant Safeguard Compliance Checklist has seven different sections: external sides, roofs, windows, doors, other apertures, solar water heaters and air conditioners and roof shapes. Compliance with measures under the first five categories leads to a reduction in the insurance premium of 17.5 per cent. Compliance with all safeguards results in a 25 per cent discount on the insurance premium.

The United Insurance Company operates in 14 Caribbean countries.

2. Needs and constraints

104. Further groundwork is required which includes an expansion of early warning systems and information dissemination systems, and improvement in forecasting and disaster related decision-making. In the case of SIDS it is important to reinforce local broadcasting systems to help outer-island communities during a disaster.

105. Transfer of the financial risk can only be implemented when all stakeholders including governments, technical agencies, bilateral and multilateral organizations and the private sector, including insurers and re-insurers, are engaged and involved in risk-bearing activities (thereby diversifying the financial burden of a disaster away from the affected economy). For SIDS, the funding of an insurance scheme is one of the foremost and most difficult issues.

106. A major constraint for efficiency of transferring or sharing risk in SIDS (and also many developing countries) is that the size of the risk pool and availability of financial instruments and services for risk management are small, with inadequate insurance coverage and pay off. Thus the implementation of specific instruments and services for risk sharing at different levels is needed, as most SIDS cannot afford fully domestic insurance services and rely to a large extent on adjacent developed country insurance companies. Perhaps recent initiatives on financial risk transfer mechanisms through traditional insurance structures and new financial instruments, such as catastrophe bonds, weather derivatives and micro-insurance, might provide the flexibility to adapt to an individual country.

107. National governments need to support local governments through transfer of resources based on risk assessments by subregion. It is important to link these transfers to capital investment in prevention and mitigation. In this regard, creating partnerships with financial institutions for promoting preparedness and mitigation, and short-term training programmes for community-based organizations can be of great assistance in building capacity at local level. Governments can help reduce risk through innovative risk transfer mechanisms such as the "Small States Catastrophe Risk Insurance Facility" (see box V).

108. Any measures taken in this context could also be beneficial for many countries from the perspective of sustainable development. A number of ways have been proposed for transferring risk from climate change.

(a) Supporting public private partnership: the climate regime could transfer (or arrange for the transfer of) the risks of national or regional public-private insurance systems in the capacity of re-insurer or consider subsidizing the costs of alternative hedging instruments.

(b) Supporting relief and reconstruction: the international community could assist governments in transferring their risks of public infrastructure damage either through private insurers or directly to the capital markets through alternative risk-transfer instruments.

(c) Supporting micro insurers: the international community could also play a role in supporting and transferring the risks of micro-insurers, for example those offering weather hedges, possibly by acting as reinsurer or assuming the interest payments of catastrophe bonds.

(d) Supporting data collection and analytical capacity-building: since any insurance or insurance-related system requires knowledge of the risks, the international community could provide support to developing countries in collecting the requisite data and in building analytical capacity.

(e) Supporting new risk hedging instruments: creation of national-level market incentives, for example tax reductions to individuals or institutions for purchasing developing country catastrophe bonds at lower interest.

Box V: Small States Catastrophe Risk Insurance[35]

Following the devastation caused by natural hazards in the Caribbean in 2004, the CARICOM governments asked the World Bank for assistance with gaining access to affordable and effective disaster risk financing arrangements. The World Bank has since obtained assistance from the Japanese Government to finance studies that should allow the establishment of a pilot phase in the Caribbean Region. The Catastrophic Risk Insurance Facility (CRIF) within the World Bank would allow small States to buy parametric insurance coverage against natural disaster risk. The facility would have the following characteristics:

- The CRIF would provide client governments with immediate liquidity in case of an adverse natural event. The facility would essentially allow small states exposed to adverse natural events to pool their risk in order to lower cost of coverage. The ultimate cost of coverage will depend on the extent of the risk spreading effect, economies of scale and the amount of initial capital provided to start the programme.
- The CRIF would be created with assistance from donor countries which would contribute to its initial capitalization, which would depend on donor contribution.
- The CRIF would gain access to additional risk capital through (multi-year) re-insurance or issuance of its own financial coverage instruments (e.g. catastrophe bonds). The CRIF would purchase additional coverage on behalf of the client countries.
- Claims payments would depend on parametric triggers through index-based insurance pay claims based on the measurement of the intensity of a pre-determined natural event in a pre-defined area over a pre-defined period, up to a certain pre-determined limit per year.
- The insured countries would pay an annual premium based on their own specific exposure, for example, coverage for risks related to a specific return period (i.e. 20 years, 30 years or 50 years or more). This risk will be calculated using probabilistic risk modelling techniques and would be specific to each country's location and size.

[35] World Bank Group/International Monetary Fund, 2005, Small States Catastrophe Risk Insurance Facility: Draft Concept Note, Background information for the intervention by the World Bank Group in Session II, Annual Meetings, Washington, D.C.

- The CRIF would be managed by a captive manager with expertise in insurance. The captive manager would collect premium from participating countries, purchase necessary reinsurance, pay reinsurance fees from the pool, manage the portfolio and ensure that claims are paid in a timely fashion.
- The main advantages of using parametric triggers would be immediate claims payments to the country, efficient risk transfer mechanisms, optimal pricing from reinsurance through risk-pooling and economies of scale, and sharing of administrative and operational costs of the insurance business.

VII. Climate change and sustainable development goals in SIDS: the Mauritius Strategy

109. Climate change has the potential to delay or prevent the achievement of sustainable development objectives as well as affect the achievement of the Millennium Development Goals in SIDS, as in other countries particularly vulnerable to climate change.

110. Sustainable development objectives, challenges and constraints that face SIDS specifically were first described in the Barbados Programme of Action for the Sustainable Development of Small Island States (BPoA) which was adopted in Bridgetown, Barbados, in 1994 at the Global Conference on the Sustainable Development of Small Island Developing States.[36] The BPoA explicitly recognized climate change as an additional obstacle to achieving sustainable development.

111. In response to climate change and at a national level, within the BPoA countries agree to: ratify or accede to the UNFCCC and Montreal Protocol; increase observation of sea-level rise and climate change; use integrated coastal zone management to mitigate the impacts of sea-level rise; assess the socio-economic implications of the impacts of climate change; try to improve public and political understanding of the potential impacts of climate change; develop strategies to create methodologies for adequate adaptation; use energy resources efficiently; and finally, increase their participation in bilateral, regional and global efforts on climate change. Regional actions involve increasing cooperation and the exchange of experiences among SIDS, providing technical assistance for ratification or accession to the UNFCCC and supporting national efforts in developing adaptation strategies. Countries also agree to take part actively in international climate change activities.

112. In 2004, the Secretary General of the United Nations Commission on Sustainable Development released a review of the progress of implementation of the BPoA, concluding that progress had been "mixed".[37] This led to a high level United Nations meeting in Mauritius in 2005 not only to review the implementation of the BPoA but to refine its priorities and incorporate areas that had emerged as important for sustainable development. The resulting, Mauritius Declaration and Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States are the new definitive documents for implementing sustainable development in SIDS.

113. The actions for the international community which are outlined in the Mauritius Strategy to address the threat climate change poses to SIDS reinforce those contained in the BPoA. Actions include the development, transfer and dissemination to SIDS of appropriate technologies and practices to address climate change; building and enhancing scientific and technological capabilities (including in SIDS) and enhancing the implementation of national, regional and international global atmospheric observing systems.

114. The Mauritius Strategy contains twenty chapters, each covering an area of importance for sustainable development SIDS. Themes range from climate change and natural disasters, to trade and culture. All the themes are linked directly or indirectly to climate change, particularly through the impacts climate change will have upon them.

115. Chapter 20, on implementation, is cross-cutting and commits the SIDS, with support from the international community, to implementing key areas of the Strategy. Specifically, the strategy calls on the international community to*:*

[36] This conference was called for by General Assembly resolution 47/189 as a follow-up to the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992.

[37] Economic and Social Council of the United Nations, document E/CN.17/2004/8, page 1.

(a) "Fully implement the United Nations Framework Convention on Climate Change and further promote international cooperation on climate change;

(b) Continue to take, in accordance with the Convention and the Kyoto Protocol, as applicable, steps to address climate change, including through: adaptation and mitigation in accordance with the principle of common but differentiated responsibilities and respective capabilities; and the effective implementation of the Kyoto Protocol by those countries that have ratified it;

(c) Promote increased energy efficiency and development and the use of renewable energy as a matter of priority, as well as advanced and cleaner fossil fuel technologies, inter alia, through public and/or private partnerships, market-oriented approaches, as well as supportive public policies and international cooperation, and support their use in small island developing States, where appropriate and in accordance with their national policies;

(d) Implement the Buenos Aires programme of work on adaptation and response measures, in particular those elements that are relevant to small island developing States;

(e) Work to facilitate and promote the development, transfer and dissemination to small island developing States of appropriate technologies and practices to address climate change;

(f) Build and enhance scientific and technological capabilities, including in small island developing States, inter alia, through continuing support to the Intergovernmental Panel on Climate Change for the exchange of scientific information and data, including where relevant to small island developing States;

(g) Enhance the implementation of national, regional and international strategies to monitor the Earth's atmosphere, including as appropriate, strategies for integrated observations, inter alia, with the cooperation of relevant international organizations; and work with small island developing States to strengthen their involvement in monitoring and observing systems and enhance their access to and use of information."

116. Adaptation measures and sustainable development have benefits that are manifold. They can reduce the pressure on natural resources, improve environmental risk management, and increase living conditions of the poor, not only reducing vulnerability, but also putting those in developing countries on a solid path towards sustainable development. Climate change solutions will need to identify and exploit synergies, as well as seek to balance possible trade-offs, among the multiple objectives of development, mitigation, and adaptation policies.

VIII. Cooperation and opportunities for adaptation

A. Available multilateral funding for adaptation

117. There are a number of sources which can provide support for adaptation, including:

(a) **The Global Environment Facility (GEF) Trust Fund**
The GEF, as an entity entrusted to operate the financial mechanism of the UNFCCC, established the Strategic Priority on Adaptation (SPA) under its Trust Fund. The objective of the SPA is to reduce vulnerability to and increase adaptive capacity to the adverse effects of climate change in the focal areas in which the GEF works. The SPA supports pilot and demonstration projects that address local adaptation and at the same time generate global environmental benefits.

(b) **The Special Climate Change Fund (SCCF)**
The SCCF aims at supporting activities in the following areas: (i) adaptation; (ii) technology transfer; (iii) energy, transport, industry, agriculture, forestry and waste management; and (iv) economic diversification. Adaptation activities to address the adverse effects of climate change have top priority for funding under the SCCF.

(c) **The Least Developed Countries Fund (LDCF)**
The LDCF was established to support a work programme to assist LDC Parties carry out, inter alia, the preparation and implementation of NAPAs.

(d) **The Adaptation Fund under the Kyoto Protocol**
The Adaptation Fund was established to finance concrete adaptation projects and programmes in developing countries that are Parties to the Kyoto Protocol and will be financed from the share of proceeds of the clean development mechanism (CDM) and other sources.

118. In addition, some funding is also available under other multilateral environmental agreements whose areas of work could be synergetic with adaptation, including the Convention on Biological Diversity, the United Nations Convention to Combat Desertification and the Ramsar Convention on the Conservation of Wetlands.

B. Opportunities for cooperation

1. Regional organizations, groups and networks

119. The examples of regional organizations contained in this section aim to highlight how past efforts to mainstream climate change have succeeded as organizations have incorporated climate change into their strategies and activities. However, opportunities remain to be exploited and networks and organizations that could be co-opted for the achievement of adaptation goals are also mentioned below. Finally, this section broaches some of the research centres and think tanks carrying out pertinent research of which advantage should be taken.

120. Highlighted below are some examples of the range of regional organizations, groups and networks which are already taking an active role in increasing adaptation to climate change or which could be used as an effective way of cooperating on adaptation.

(a) **Alliance of Small Island States**
The Alliance of Small Island States (AOSIS) is a coalition of Small Island and low-lying coastal countries that share similar development challenges and concerns about the environment, especially their vulnerability to the adverse effects of global climate change. It functions primarily as an ad hoc lobby and negotiating voice for SIDS within the United Nations system. AOSIS has a membership of 43 States and observers, drawn from all regions of the world: Africa, Caribbean, Indian Ocean, Mediterranean, Pacific and South China Sea. Thirty-seven are members of the United Nations, close to 28 per cent of developing countries, and 20 per cent of the total membership of the United Nations. Together, SIDS communities constitute some 5 per cent of the global population <www.sidsnet.org/aosis>.

(b) **Association of Caribbean States**
The objectives of the Association of Caribbean States, formed in 1994, are to strengthen regional cooperation and the integration process in order to enhance economic capacity, preserve environmental integrity and promote sustainable development among its members. Of relevance to adaptation to climate change are the special committees on sustainable tourism and natural disasters <www.acs-aec.org>.

(c) **CARICOM**
All of the objectives of CARICOM,[38] established in 1972, are threatened by the impacts of climate change. It provides an important framework through which adaptation to climate

[38] To improve standards of living and work; the full employment of labour and other factors of production; accelerated, coordinated and sustained economic development and convergence; expansion of trade and economic relations with third States; enhanced levels of international competitiveness; organization for increased production and productivity; achievement of a greater measure of economic leverage and effectiveness of Member States in dealing with third States, groups of States and entities of any description and the enhanced coordination of Member States' foreign and foreign economic policies and enhanced functional cooperation.

change can take place <www.caricom.org>. In 2000, CARICOM established the Caribbean Community Climate Change Centre, which aims to protect the climate system in the region, enhance capacity of member governments to coordinate national responses to climate change, provide policy and technical support on climate change issues and act as an executing agency for regional projects relating to climate change. In December 2006, the Caribbean Community Climate Change Centre hosted a workshop on regional downscaling in Havana, Cuba <www.caricom.org/jsp/community/ccccc.jsp>.

(d) **Global Islands Network**

The GIN aims to serve as a hub that connects and coordinates efforts to help ensure a healthy and productive future for islanders. GIN brings together islanders and partner organizations, borrowing as well as replicating best practices to tackle sustainable development problems, and problems such as sea-level rise, the cause of which is beyond the control of small island states <www.globalislands.net>.

(e) **Indian Ocean Commission (Commission de l'Océan Indien)**

The IOC is an inter-governmental organization that brings together the Comoros, France (Réunion Island), Madagascar, Mauritius and Seychelles, with the objective of promoting sustainable development in the Western Indian Ocean Islands. The IOC also represents the island states in international forums and defends their interest with regard to specific environmental and economic issues. It also facilitates regional cooperation and integration (<http://www.coi-info.org>; World Bank Regional Institutions website).

(f) **Organization of Eastern Caribbean States**

The Environment and Sustainable Development Unit of the OECS, has brought the member governments together to create the St. Georges' Declaration Of Principles for Environmental Sustainability in the OECS. The Declaration contains 21 principles that were formed by peoples and governments of member states as a guide for environment management within their countries. Importantly, principle eight is called *Preparation for Climate Change* and states that: "Governments will enact laws, create organizations and institutions and provide money to assist people and communities to adapt to the impact of climate change" <www.oecs.org/ESDU>.

(g) **Pacific Islands Forum**

The Pacific Islands Forum, founded in August 1971, comprises 16 independent and self-governing states in the Pacific. The Forum is the region's premier political and economic policy organization. Forum Leaders meet annually to develop collective responses to regional issues <www.forumsec.org.fj>.

(h) **Pacific Regional Environment Programme**

The mandate of SPREP is to promote cooperation in the Pacific Islands region and to provide assistance to protect and preserve the environment while ensuring sustainable development. SPREP is highly active in terms of climate change, for example through initiatives such as the Pacific Islands Framework for Action on Climate Change 2006–2015 and Capacity Building for the Development of Adaptation Measures in Pacific island countries (CBDAMPIC) <www.sprep.org/climate_change>.

(i) **Secretariat of the Pacific Community**

The SPC cooperates with member countries, donors and other organizations to deliver work programmes to members that aim to develop technical assistance, professional, scientific and research support, and planning and management capability. At the recent thirty-sixth Meeting of the Committee of Representatives of Governments and Administrations (CRGA) (13 to 17 November, 2006), policy agenda item 3.1 addressed *Key issues affecting Pacific Island countries and territories* under which the issue of climate change was highlighted. Specific problems highlighted were alteration and possible irreversible damage to biodiversity, changed and unpredictable weather patterns, sea-level rise and reduced food security <www.spc.org.nc>.

(j) **SIDSnet**
SIDSnet was created in 1998 as a way of facilitating communication among SIDS to assist them in the implementation of the sustainable development goals embedded in the Barbados Programme of Action. It aims to form partnerships through the internet and other information and communication technologies <www.sidsnet.org>.

(k) **South Pacific Applied Geoscience Commission (SOPAC)**
SOPAC is an intergovernmental regional organization which provides services to aid sustainable development in the Pacific countries it serves. It is introducing adaptation mechanisms to climate change, climate variability and sea-level rise as part of its Oceans and Islands programme <www.sopac.org/tiki/tiki-index.php>.

2. Programmes for SIDS within inter- and non-governmental organizations

121. Many organizations have environmental programmes specifically for SIDS.

(a) **Caribbean Environment Programme (UNEP)**
The CEP is a conglomerate of legislative, programmatic and institutional frameworks and entities working together to assist the nations and territories of the Wider Caribbean Region to protect their marine and coastal environment and promote sustainable development. The work of the CEP is based around the Caribbean Action Plan and is funded through the Caribbean Trust Fund. Although none of the CEP sub-programmes specifically target climate change, the work of the CEP will be threatened by climate change, and adaptation should be a key concern <www.cep.unep.org>.

(b) **Coastal Regions and Small Islands platform of UNESCO**
Concentrating on the mitigation and management of conflicts over coastal resources and values, the Coastal Regions and Small Islands platform works through field based projects, UNESCO Chairs and university twinning and a multi-lingual internet-based forum. With regard to small island states, it focuses mainly on helping implementation of the Barbados Programme of Action. Climate change and sea-level rise is one of the domains of the 1994 Barbados Programme of Action, the implementation of which has now been reinforced through the Mauritius Strategy <www.unesco.org/csi>.

(c) **Regional Offices (UNEP)**
UNEP has a regional office for Latin America and the Caribbean (ROLAC), for Africa (ROA) and for Asia and the Pacific (ROAP). These offices are carrying out many initiatives which contribute towards sustainable development of the region <www.rolac.unep.mx; www.roap.unep.org>.

(d) **Small States Forum (World Bank)**
At the Small States Forum of the Work Bank, representatives of the 45 small developing countries that are members of the World Bank meet to discuss issues of particular interest them.

3. University and think-tank programmes of importance to SIDS

(a) Pacific Islands Development Program (East-West Centre), United States;

(b) International Global Change Institute at the University of Waikato, New Zealand;

(c) University of Malta - Islands and Small States Institute, Malta;

(d) The Universities Consortium of Small Island States, (UCSIS), multi-country;

(e) Tyndall Centre for Climate Change Research, United Kingdom of Great Britain and Northern Ireland.

4. Some examples of cooperation

122. Some examples of cooperation on adaptation, and its mainstreaming into research, policy and development in SIDS are listed below:

(a) In July 2006, the University of the West Indies held a conference entitled "Global Change and Caribbean Vulnerability: Environment, Economy and Society at Risk?" Researchers from a variety of fields came together and tried to take a multi-disciplinary look at climate change in the Caribbean, linking changes in climate with other environmental and socio-economic changes that are occurring.

(b) Climate change is also being incorporated into high level meetings. In 2006, the Regional Meeting of the Heads of Agriculture and Forestry[39] structured their discussions around the theme "Managing Change". Change was considered in the context of biodiversity, health and nutrition, agriculture and forestry commodity trade, atoll agriculture and forestry and climate change and food security.

(c) There are national partnerships to address climate change. For example, in Jamaica the Jamaican Red Cross is joining forces with the National Meteorological Service, the Office of Disaster Preparedness and Emergency Management (ODPEM) and the University of the West Indies to disseminate information on climate change impacts and inform those communities that are most at risk.[40]

(d) Partnerships can also be formed on a global scale and the UNEP-Grid Arendal Many Strong Voices consortium is a good example. Through this consortium SIDS from both the Caribbean and Pacific regions are cooperating with Arctic communities to build capacity, enhance awareness, assess needs and implement adaptation measures. These regions, although geographically and climatically very different, share a high vulnerability to climate change because of their dependence on the natural resource base and geographical and socio-economic isolation. The consortium focuses on the links between the regions and on encouraging education, training and public awareness among their inhabitants so that they take a more active role in the climate change debate. It also aims to increase understanding of needs and solutions and take practical measures on adaptation.

5. Resources

123. The following are examples of the many resources that provide information and guidelines relating to climate change and adaptation.

(a) **Surviving Climate Change in Small Islands, 2005**
This guidebook was prepared by the Tyndall Centre for Climate Change Research and Cayman Islands Department of Environment in collaboration with the United Kingdom Department for International Development and the United Kingdom Foreign and Commonwealth Office. The guide aims to inform government officers about climate change and the risks associated with its impacts and to provide 'ideas, tools and techniques' to take action to prepare for climate change <www.tyndall.ac.UK/publications/surviving.pdf>.

(b) **Climate Proofing: A Risk-based Approach to Adaptation, 2005**
Part of the Pacific Studies Series of the Asian Development Bank (ADB), this report was funded by the Canadian Cooperation Fund for Climate Change, administered by the ADB and the case studies were prepared by consultants. The case studies were based in the Federated States of Micronesia and the Cook Islands and aimed to highlight the range of levels at which adaptation takes place (from project to development planning) and the

[39] The advisory body to the integrated agriculture and forestry programme being implemented by the Land Resources Division of the Secretariat of the Pacific Community.
[40] The Jamaica Observer, online article, posted 25 July 2006.

importance of mainstreaming adaptation <www.adb.org/Documents/Reports/Climate-Proofing/main-report.asp>.

(c) **Climate variability and change and sea-level rise in the Pacific islands region, 2003**
This is a resource book funded by the Global Environment Bureau of the Japan Ministry of the Environment and published in collaboration with SPREP. Its target audience includes policymakers and decision makers, educators and other stakeholders <www.sprep.org.ws/climate/doc/01index.htm>.

(d) **Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making, 2003**
This book was produced by CARICOM as part of the Adapting to Climate Change in the Caribbean (ACCC) Project. The guidelines provide a user-friendly framework for risk management to assist the decision-making process when adapting to climate variability and climate change.

IX. Conclusion and issues for further consideration

124. In comparison with other regions of the world, SIDS have a high awareness of the impacts of climate change and the need to adapt, and are advanced in mainstreaming adaptation into their policy frameworks and development efforts. There are many adaptation projects on the ground with more projects in the pipeline but there are still barriers to adaptation that need to be removed. The avenues for regional cooperation and the sharing of traditional knowledge, project outcomes and technical data are extensive and should be exploited to help identify and remove barriers to adaptation.

125. This paper provides background information on impacts, vulnerability and adaptation within SIDS, and is intended to serve as a starting point for further discussion. In addition to this background material and based on it, the following issues may also be considered:

(a) How can outcomes of completed projects be disseminated effectively so that the information can be used by others?

(b) The decline in the use of local coping strategies and traditional knowledge is suggested as one reason for increased vulnerability of SIDS to climate change. However, does the reverse occur? Are some local coping strategies outdated and perhaps maladaptive? How can a balance be reached between modern technologies and traditional strategies in adapting to climate change?

(c) Is insurance the most suitable mechanism for risk transfer? What needs to be done first in order for insurance schemes to be successful (e.g. comprehensive risk assessment)?

(d) With adaptation being carried out by many different organizations, how can future adaptation projects be coordinated so that it is ensured that vulnerable sectors, areas or communities are not overlooked?

(e) International migration from island countries to other island countries or larger states; or the internal migration of islanders between different islands poses political, socio-economic and ethical questions. How will climate change impact on this issue?

(f) How are the policies of other countries likely to affect adaptation to climate change in SIDS, for example, in terms of ODA, immigration and foreign trade policies?

(g) How can existing networks and organizations be better used to improve cooperation on adaptation and increase adaptation activities?

X. Bibliography

Adger, N., Mace, M.J., Paavola, J., and Razzaque, J., 2003: Justice and equity in adaptation. *Tiempo* 52, 19-22.

Agrawala, S., T. Ota, J. Risbey, M. Hagenstad, J. Smith, M. van Aalst, K. Koshy and B. Prasad., 2003: *Development and Climate Change in Fiji: Focus on Coastal Mangroves*: OECD.

Arnell, N.W., 2004: Climate change and global water resources: SRES emissions and socio-economic scenarios. *Global Environmental Change*, 14, 31-52.

Association of British Insurers, 2005, Financial risks of climate change: Summary report, London, United Kingdom.

Auffret, P., 2003. Catastrophe Insurance Market in the Caribbean Region: Market Failures and Recommendations for Public Sector Interventions, World Bank Policy Research Working Paper 2963.

Barnett, J. 2001. 'Adapting to Climate Change in Pacific Island Countries: The Problem of Uncertainty', *World Development,* 29(6): 977-993.

Briguglio, L. and Cordina, G., (eds), 2004: *Economic Vulnerability and Resilience of Small States.* Commonwealth Secretariat and the University of Malta.

Buddemeier, R.W., J. A. Kleypas and R.B. Aronson, 2004: *Coral Reefs and Global Change.* Pew Center on Global Climate Change, Arlington, VA., 44 pp.

Burgess, S., 2004: Southwest Pacific Tropical Cyclones Summary for 2003/04 Season. The Island Climate Update, 45, 4 pp. Retrieved 12.11.2004 from http://www.niwa.co.nz/ncc/icu/2004-06/

Burns, W.C.G., 2000: The impact of climate change on Pacific island developing countries in the 21st century. In *Climate Change in the South Pacific: Impacts and Responses in Australia, New Zealand, and Small Island States*. A. Gillespie and W.C.G. Burns (eds.), Kluwer Academic, Dordrecht, pp. 233-251.

Burns, W.C.G., 2002: Pacific island developing country water resources and climate change. In *The World's Water (3rd Edition)*. P. Gleick (ed), pp. 113-132, (also available from website http://www.internationalwildlifelaw.org/BurnsChapterPDF.pdf).

Briguglio, L. and Cordina, G., (eds), 2004: *Economic Vulnerability and Resilience of Small States.* Commonwealth Secretariat and the University of Malta.

Buddemeier, R.W., J. A. Kleypas and R.B. Aronson, 2004: *Coral Reefs and Global Change.* Pew Center on Global Climate Change, Arlington, VA., 44 pp.

Burgess, S., 2004: Southwest Pacific Tropical Cyclones Summary for 2003/04 Season. The Island Climate Update, 45, 4 pp. Retrieved 12.11.2004 from http://www.niwa.co.nz/ncc/icu/2004-06/

Burns, W.C.G., 2000: The impact of climate change on Pacific island developing countries in the 21st century. In *Climate Change in the South Pacific: Impacts and Responses in Australia, New Zealand, and Small Island States*. A. Gillespie and W.C.G. Burns (eds.), Kluwer Academic, Dordrecht, pp. 233-251.

Burns, W.C.G., 2002: Pacific island developing country water resources and climate change. In *The World's Water (3rd Edition)*. P. Gleick (ed), pp. 113-132, (also available from website http://www.internationalwildlifelaw.org/BurnsChapterPDF.pdf).

FIELD, 2003. SIDS Workshop on Insurance and Climate-Related Extreme Weather Events United Nations Development Programme, Fondazione Eni Enrico Mattei (FEEM), Magenta Milan, Italy.

Hamilton, K. 2004, Insurance and financial sector support for adaptation, International Development Studies in Yamin, F. and Huq, S. (eds). Vulnerability, Adaptation and Climate Disaster**s,** Institute of Development Studies Bulletins 36(4).

Hay, J., N. Mimura, J. Cambell, S. Fifita, K. Koshy, R.F. McLean, T. Nakalevu, P. Nunn, and N. deWet., 2003: *Climate Variability and Change and Sea-level Rise in the Pacific Islands Region. A Resource book for policy and decision makers, educators and other stakeholders.* South Pacific Regional Environment Programme (SPREP), Apia, Samoa, 94 pp.

Hoffmann, T.G., 2002: The reimplementation of the Ra'ui: Coral reef management in Rarotonga, Cook Islands. *Coastal Manageme*nt, 30, 401-418.

Huq, S. and Reid, H., 2004: *Mainstreaming Adaptation in Development" in Climate Change and Development.* IDS Institute of Development Studies, 35 (3), 40

Herrmann, T. M , Ronneberg, Brewster, M and Dengo, M. 2005. Social and economic aspects of disaster reduction, vulnerability and risk management in small island developing states, Small Island Habitats.

ISDR, 2004, Living with Risk: A global review of disaster reduction initiatives, Geneva, Switzerland

McCarthy, J. J., Canziani, O. F., Leary, N. A. Dokken, D J., and White, K. S. (Eds.) 2001, Climate Change 2001: Impacts, Adaptation & Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, United Kingdom. pp 1000.

Nurse, L., et al, 2001, Small island states, In: *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. J.J. McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

Organization of American States, 1996. Insurance, reinsurance and catastrophe protection in the Caribbean: A working paper prepared in collaboration with the World Bank.

Parakoti, B, and D.M. Scott, 2002: Drought index for Rarotonga (Cook Islands). Case study presented as part of Theme 2, Island Vulnerability, at the Pacific Regional Conference.

Payet, R., 2003: Coral reefs in small island states: status, monitoring capacity and management priorities. *International Journal of Island Affairs,* 12 (1) 57-65.

Pelling, M., and J.I. Uitto, 2001: Small island developing states: natural disaster vulnerability and global change. Environmental Hazards, 3, 49-62.

Rawlins, S.C., A. Chen, M.Ivey, D. Amarakoon and K. Polson, 2005: The impact of climate change/variability events on the occurrence of dengue fever in parts of the Caribbean: A retrospective study for the period 1980-2002.*West Indian Medical Journa Suppl.,* 53 (2) 54.

Raynor, B., 1995. Montane cloud forests in Micronesia: status and future management. In: Hamilton, L.S., Juvik, J.O., Scatena, Ž. F.N. Eds., Tropical Mountain Cloud Forests: Proceedings of an International Symposium. Springer-Verlag, New York, pp.274–283.

Revell, M., 2004: Pacific Island Weather and the MJO. *The Island Climate Update*, 42, p.4. Retrieved 11.11.2004 from http://www.niwa.co.nz/ncc/icu/2004-03/.

Richards, M. 2003, Poverty Reduction, Equity and Climate Change: Global Governance Synergies or Contradictions? Globalisation and Poverty Programme, Overseas Devlopment Institute, London, United Kingdom.

Stratus Consulting (2000). *Economic Implications of Climate Change in Two Pacific Island Country Locations. Case Illustration of Tarawa, Kiribati and Viti Levu.* Prepared under sub-contract to CICERO (Oslo, Norway). Boulder, Colorado.

Swiss Re. 2004. Hurricane Season 2004, *Unusual, but not unexpected, a focus report*, Zurich.

UNDP, 2004. Disaster Risk Management Report, South Pacific Geoscience Commission and Secretariat for the Pacific Regional Environment Programme. Apia, Samoa

Yu X, Taplin R, Gilmour AJ 1997. Climate Convention Implementation: An Opportunity for the Pacific Island Nations to Move Toward Sustainable Energy Systems *Environ Manage*: 21(4):493-504.

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