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UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
Twenty-seventh session
Bali, 3–11 December 2007

Item 3 of the provisional agenda
Nairobi work programme on impacts, vulnerability and adaptation to climate change

Information on methods and tools for impact, vulnerability and adaptation assessments

Submissions from relevant organizations

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its twenty-sixth session, invited relevant organizations to submit to the secretariat, by 15 May 2007, information on existing and emerging assessment methodologies and tools; and views on lessons learned from their application; opportunities, gaps, needs, constraints and barriers; possible ways to develop and better disseminate methods and tools; and training opportunities. It requested the secretariat to compile these submissions into a miscellaneous document to be made available to the SBSTA by its twenty-seventh session. (FCCC/SBSTA/2006/11, para. 33).

2. The secretariat has received seven such submissions. In accordance with the procedure for miscellaneous documents, the five submissions received from intergovernmental organizations are attached and reproduced[*] in the language in which they were received and without formal editing. In line with established practice, the two submissions from accredited non-governmental organizations have been posted on the UNFCCC website at <http://unfccc.int/3689.php>.

[*] These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

FCCC/SBSTA/2007/MISC.13

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CONTENTS

Page

1. SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY (Submission received 31 May 2007).. 3

2. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (Submission received 6 June 2007).. 10

3. SECRETARIAT OF THE UNITED NATIONS INTERNATIONAL STRATEGY FOR DISASTER REDUCTION (Submission received 31 May 2007)... 24

4. WORLD METEOROLOGICAL ORGANIZATION (Submission received 20 July 2007) 47

5. SECRETARIAT OF THE PACIFIC REGIONAL ENVIRONMENT PROGRAMME (Submission received 11 June 2007).. 54

PAPER NO. 1: SECRETARIAT OF THE CONVENTION ON BIOLOGICAL DIVERSITY

SUBMISSION OF THE CONVENTION ON BIOLOGICAL DIVERSITY TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE: ASSESSMENT METHODOLOGIES AND TOOLS

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC) invited Parties and relevant organizations to submit to the UNFCCC secretariat, by 31 May 2007, information on existing and emerging assessment methodologies and tools; and views on lessons learned from their application; opportunities, gaps, needs, constraints and barriers; possible ways to develop and better disseminate methods and tools; and training opportunities.

2. Since climate-change adaptation is integrated into all of the programmes of work of the Convention on Biological Diversity (CBD), with the exception of the programme of work on technology transfer, in response to the request from SBSTA, the Executive Secretary of the CBD prepared this document on assessment methodologies and tools for climate-change adaptation planning.

3. This document specifically addresses the following methodologies and tools: the ecosystem approach (section I), impact assessments (section II), risk-management approaches (section III), value and valuation techniques (section IV), and monitoring and evaluations tools which link biodiversity and climate change (Section V). Additional resources available from the CBD are provided at the end of the document (Section VI).

4. Information for inclusion in this document was derived from national reports submitted by Parties to the CBD, the reports of the Ad Hoc Technical Expert Group on biodiversity and climate change, and a review of the implementation of relevant programmes of work on thematic areas and cross-cutting issues under the Convention on Biological Diversity.

I. THE ECOSYSTEM APPROACH

5. The ecosystem approach (also known and integrated land and water management, landscape management, etc.) is a strategy for the integrated management of land, water and living resources that promotes the conservation and sustainable use of biodiversity in an equitable way.

6. The main principles of the ecosystem approach focus on capacity building; participation; information gathering and dissemination, research; comprehensive monitoring and evaluation; and governance.

7. As such, advantages of the ecosystem approach include: stakeholder participation; consideration of scientific, technical and traditional knowledge; and the achievement of balanced ecological, economic and social costs and benefits.

8. Since the ecosystem approach takes a broad perspective to management, it is an ideal methodology through which the multiple impacts from climate change, including on biodiversity, can be reflected in comprehensive and responsive adaptation planning.

9. The implementation of the ecosystem approach will be the subject of an in-depth review at the twelfth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) of the Convention on Biological Diversity, in July 2007, and at the ninth meeting of the Conference of the Parties, in May 2008. Preparatory work for this review would indicate that opportunities to strengthen ongoing efforts include *inter alia*:

- Developing standards for application of the ecosystem approach;
- Simplified and improved marketing approaches to appeal to a wider audience; and
- Capacity-building at all levels by developing a strategic approach through enhanced partnerships.

10. In response to the in-depth review of implementation four key obstacles to the application of the ecosystem approach were identified:

- The need to simplify the description of ecosystem approach and make it more attractive to, and comprehensible for, key target audiences;
- The need to improve the "marketing" of the ecosystem approach, chiefly by promoting it as a planning tool to achieve enhanced economic benefits;
- The need to enhance the availability of tools to implement the ecosystem approach; and
- The need ensure that the application of the ecosystem approach goes beyond the biodiversity sector to all sectors whose actions impact on the delivery of ecosystem goods and services (positive and negative) across different levels (e.g. internationally, nationally and locally).

II. IMPACT ASSESSMENTS

11. Environmental impact assessment and strategic environmental assessments can be used to evaluate the environmental and socio-economic implications of various projects including climate change adaptation plans and the impacts of adaptation activities on biodiversity.

12. Environmental impact assessments typically consist of seven steps:

(i) Developing the project concept;
(ii) Screening the project concept to identify potentially significant impacts;
(iii) Scoping project activities to establish whether or not an impact assessment is needed;
(iv) Information gathering to establish baselines;
(v) Prediction of impacts;
(vi) Mitigation measures and management plans to minimize negative impacts; and
(vii) Monitoring and supervision.

13. Article 14 of the Convention on Biological Diversity explicitly encourages the use of environmental impact assessments in order to avoid or minimize adverse effects of a diverse set of activities on biodiversity and to allow public participation in such procedures.

14. In order to support Parties in the application of impact assessments, the annex to decision VI/7 of the Conference of the Parties to the CBD provides guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation.

15. The Secretariat of the CBD also published "Voluntary Guidelines on Biodiversity-Inclusive Impact Assessments" (CBD Technical Series No. 26), which includes case studies, background

material and practical examples of the application of impact assessments. The voluntary guidelines explore both direct drivers of change through impact assessments and the review of indirect drivers of change carried out within the framework of the Millennium Ecosystem Assessment.

16. Lessons learned from the application of environmental impact assessments reveal the importance of public participation and the need to ensure that, to the extent possible, environmental impact assessments are applied as early in the project cycle as is feasible.

17. Strategic environmental assessments differ slightly from environmental impact assessments in so far as they can be applied to broader policy decisions regarding climate change adaptation planning. They serve to facilitate the integration of environmental considerations within policy planning and to inform decision-makers of uncertainty and consistency in objectives.

18. The process of completing strategic environmental assessments is very similar to an environmental impact assessment except that strategic environmental assessments:

- Place increased importance on baseline surveys;
- Conduct an options analysis; and
- Present information specifically for use in policy decisions.

19. Lessons learned from the application of strategic environmental assessments reveal the value-added from public participation and quality control through, for example, an audit committee.

III. RISK-MANAGEMENT APPROACH

20. A number of planning tools have been developed using risk-management approaches including:

- The Ramsar Wetland Risk Assessment Framework[1];
- Various disaster risk indices[2],[3],[4]; and
- A number of early warning systems[5].

21. Based on such diverse experiences, the Ad Hoc Technical Expert Group on Biodiversity and Climate Change, convened under the Convention on Biological Diversity with financial support from the Government of Finland, created a framework for adaptation integrating biodiversity concerns consistent with risk management approaches as presented in figure 1 below.

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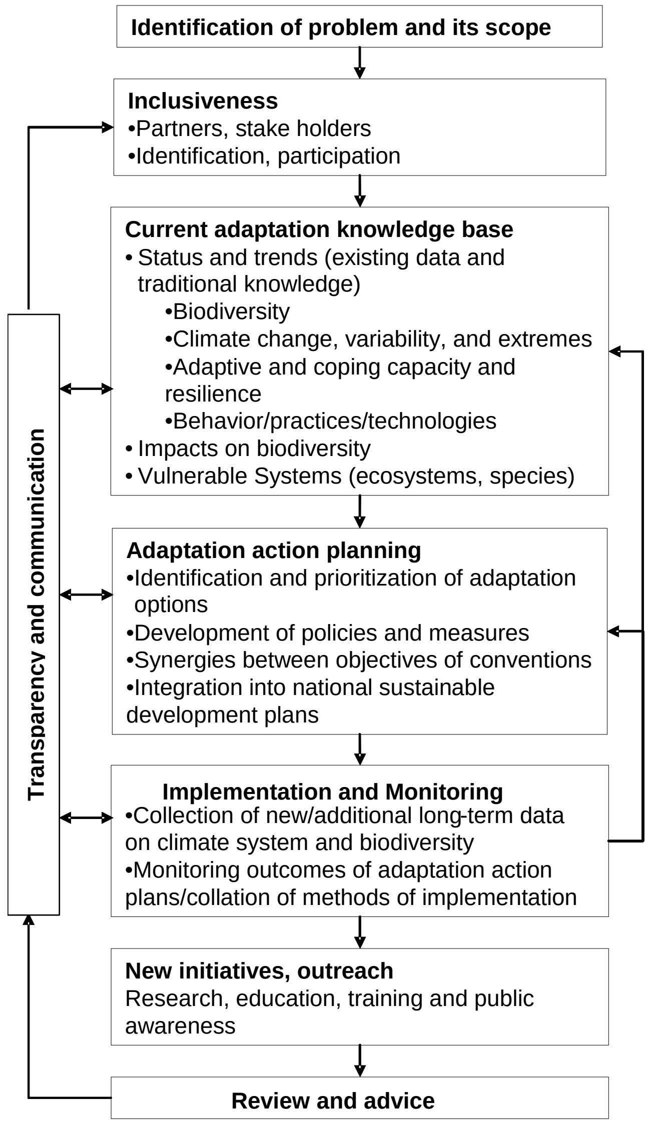
[1] http://www.ramsar.org/key_guide_risk_e.htm
[2] http://www.undp.org/bcpr/disred/english/publications/rdr.htm
[3] http://www.iadb.org/exr/disaster/rmi.cfm?language=en&parid=5
[4] http://siteresources.worldbank.org/INTDISMGMT/Resources/9environment.pdf
[5] http://www.fao.org/GIEWS/english/index.htm

Figure 1: Applying a Risk Management Approach to Adaptation Planning



IV. VALUE AND VALUATION TECHNIQUES

22. Environmental assets, including biodiversity resources, have both use and non-use values. Use values include products for consumption (such as food, clean water and biomass), outputs that are not consumed (such as recreational and aesthetic values), functional benefits based on the provision of ecosystem services an options for future use. Non-use values include existence and bequest values including the value derived from knowledge of continued existence.

23. The valuation of biodiversity resources in adaptation planning can be used to assign a monetary value to the services provided by biodiversity including, for example, coastal protection (e.g. mangroves and coral reefs) and the provision of alternative livelihoods (e.g. non-timber forest products and the harvesting of medicinal plants). As such, valuation techniques allow adaptation project planners to fully consider the current and future economic, environmental and social impacts of change.

24. Techniques for the valuation of biodiversity services are numerous and include willingness to pay and willingness to accept compensation. These techniques are based on observed or hypothetical behaviour including:

- Market prices;
- Contingent valuation;
- Choice experiment tests;
- Avoidance cost method; and
- Opportunity cost method.

25. The Secretariat of the CBD recently published “An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions” (CBD Technical Series No. 28), which provides additional information on tools and practical examples.

26. The publication examines valuation and decision-making in economic and non-economic frameworks and concludes that while valuation techniques are increasingly being integrated into decision making, there remains a need to:

- Ensure broad participation in valuation, especially when social impacts are significant or traditional knowledge is used to capture values;
- Build capacity in valuation studies including the collection of primary research; and
- Establish best practices or commonly accepted guidelines for valuation.

27. It also explores options for strengthened international collaboration for valuation including for: capacity-building, fostering research, and building appropriate institutional enabling environments.

V. MONITORING AND EVALUATION TOOLS

28. Ongoing monitoring and evaluation is critical for: (i) the evaluation of the vulnerability of biodiversity and ecosystems to the impacts of climate change; and (ii) the assessment of the effectiveness of climate change adaptation plans.

29. Monitoring tools can be employed in adaptation planning to assess either the direct physical impacts of climate change (e.g. sea level rise, changes in precipitation, changes in temperature) or the results of these impacts on ecosystems, people and livelihoods.

30. Examples of some tools and methods are presented in table 1 below. The tools and methods presented below do not represent all possibilities; rather they provide examples of some of the more commonly implemented tools and methods as identified through research conducted by the Secretariat of the Convention on Biological Diversity.

Table 1. Examples of tools and methods to assess vulnerability

Impacts of climate change	Tools and Methods	
	Physical Processes	**Vulnerability**
Sea-level rise	Sea level Fine Resolution Acoustic Measuring Equipment (SEAFRAME)[6]	Coastal Vulnerability Index (CVI)[7]
	Continuous Global Positioning System[8]	
Increased air / ocean temperatures	Ocean Monitoring (e.g. Global Ocean Data Assimilation System [9], National Oceanographic Data Center [10])	Coral reefs monitoring protocols (e.g. reef resilience toolkits[11])
	Meteorological Stations (e.g. National Climate Data Center[12], Climate Anomaly Monitoring System[13])	Glacial lake outburst vulnerability assessment
Changing precipitation regimes	Meteorological Stations (e.g. Global Precipitation Measurement[14])	Fire risk assessment
	Satellite Monitoring (e.g. International Satellite Land Surface Climatology Project[15])	Drought vulnerability assessment
	Palmer Drought Severity Index[16]	Global Information and Early Warning System[17]
Increased frequency of extreme events	Global Hazards / Extremes Monitoring (e.g. Tropical Atmosphere Ocean Project[18])	Household vulnerability assessments
		Disaster Risk Index[19]

[6] http://www.icsm.gov.au/icsm/tides/SP9/PDF/IOCVIII_acoustic_errors.pdf
[7] http://cdiac.ornl.gov/epubs/ndp/ndp043c/sec9.htm
[8] http://www.bom.gov.au/pacificsealevel/cgps/cgps_fact_sheet.pdf
[9] http://www.cpc.ncep.noaa.gov/products/GODAS/
[10] http://www.nodc.noaa.gov/
[11] The Nature Conservancy and Partners R2- Reef resilience: building resilience into coral reef conservation; additional tools for managers: Volume 2.0. CD ROM Toolkit, 2004.
[12] http://www.ncdc.noaa.gov/oa/ncdc.html
[13] http://www.cpc.noaa.gov/products/global_precip/html/wpage.cams_opi.shtml
[14] http://gpm.gsfc.nasa.gov/
[15] http://www.gewex.org/islscp.html
[16] http://www.drought.noaa.gov/palmer.html
[17] http://www.fao.org/giews/english/index.htm
[18] http://www.pmel.noaa.gov/tao/
[19] http://gridca.grid.unep.ch/undp/

31. Lessons learned from the application of monitoring and assessment tools reveal the need for:

- A flexible framework to facilitate adaptive management and learning by doing;
- The pairing of technical, human and institutional capacity building;
- Links between technical experts, decision-makers, and project managers; and
- The inclusion of traditional and local knowledge in monitoring and evaluation.

VI. ADDITIONAL RESOURCES

Ecosystem Approach Sourcebook: http://www.cbd.int/ ecosystem/sourcebook

Technical Series No. 10 – Interlinkages Between Biological Diversity and Climate Change: http://www.cbd.int/doc/publications/cbd-ts-10.pdf

Technical Series No. 25 – Guidance for Promoting Synergy Among Activities Addressing Biological Diversity, Desertification, Land Degradation and Climate Change: http://www.cbd.int/doc/publications/cbd-ts-25.pdf

Technical Series No. 26 – Voluntary Guidelines on Biodiversity – Inclusive Impact Assessment: http://www.cbd.int/doc/publications/cbd-ts-26-en.pdf

Technical Series No. 28 - An Exploration of Tools and Methodologies for Valuation of Biodiversity and Biodiversity Resources and Functions: http://www.cbd.int/doc/publications/cbd-ts-28.pdf

PAPER NO. 2: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Methods and Tools

FAO Contribution to

"The Nairobi Work Programme (NWP) on impacts, vulnerability and adaptation to climate change"

On invitation of SBSTA to submit to the secretariat, by 31 May 2007, information on the relevant programmes, activities and views on the issues listed under item 21 of the Conclusions of the Nairobi work programme on impacts, vulnerability and adaptation to climate change

Context and mandate of FAO to work on methods and tools for climate impact, vulnerability and adaptation assessments

One of the Governing Bodies of FAO, the Committee on Agriculture (COAG), has stressed the need for the Organization to continue to be a neutral and technical forum on the issue of Climate Change and to contribute to the debate, focusing on such issues as data, definitions and methodologies related to agriculture and climate change.

COAG supported the development of an integrated climate change programme based on current activities, within FAO Regular Budget provisions, and consistent with the legal and political framework of the UN Framework Convention on Climate Change (UNFCCC) and the technical work of the IPCC. This includes the promotion of practices for climate change mitigation, the adaptation of agricultural systems to climate change, the reduction of emissions from the agricultural sector as far as it is carefully considered within the major objective of ensuring food security, the development of practices aimed at increasing the resilience of agricultural production systems to the vagaries of weather and climate change, national and regional observing systems, as well as data and information collection and dissemination.

The Committee called on FAO to assist Members, in particular developing countries, which are vulnerable to climate change, to enhance their capacities to confront the negative impacts of climate variability and change on agriculture. In 1998, an Interdepartmental Working Group on Climate Change was established and mandated to coordinate FAO's cross departmental, multi-disciplinary work on climate change.

The issues of climate change mitigation and adaptation has been specifically addressed and prioritized as a key area of future work by FAO's governing bodies at the Committee on Agriculture (COAG), the Committee on Food Security (CFS), the Committee on Forestry (COFO). In the context of FAO's internal reform 2006/2007, a new division "Environment, climate change and bioenergy" (NRC) was created reflecting the importance given to the subject.

NRC, under the Natural Resources Management and Environment Department, plays a central role in coordinating, together with the Interdepartmental Working Group on Climate Change, FAO climate change related programmes and activities. The main mandate of NRC is to contribute to and promote environmental and natural resources management and conservation in the context of sustainable agriculture, including forestry and fisheries, rural development and food security. NRC provides advisory services, formulation, backstopping and evaluation to FAO's field projects and Headquarter's programmes, including some 50 countries in Africa, Asia, Latin America, the Caribbean, Central and Eastern Europe. The main technical orientation of NRC is aimed at:

- promoting and optimizing, within the FAO network, the use of remote sensing, GIS and agrometeorology tools, for the collection, archiving and processing of data on renewable natural resources and food security;
- to transfer and integrate the use remote sensing, GIS and agrometeorology tools into Member Nations' activities, for the specific purposes of:
  - early warning, environmental monitoring and rapid assessment of crop growing conditions;
  - inventory, monitoring and management of natural resources at various levels: local, national, regional and global;
  - integration of various types of data in local or national environment information systems;
  - coordination of FAO's remote sensing, agrometeorology, early arning and natural resource monitoring activities, and to follow and initiate new technological developments.

NRC recently began a process aimed at developing a climate change adaptation strategy and workplan. A central component of this strategy involves a screening of FAO's data and information resources in order to identify those tools that will assist climate change adaptation. That process is not complete yet. As a result, the tools and methodologies listed below represent the set of possible options available to FAO. How these tools and methodologies FAO applies, it will become clearer as the climate change adaptation strategy and workplan develops. A further focus of the strategy regards how FAO combines these tools and information resources. Whilst data are essential for effective adaptation, it is anticipated that FAO will use its traditional data and information tools in novel and more coordinated ways – that are not fully captured in this submission - in supporting climate change adaptation.

More specifically it is anticipated that FAO will use and combine its existing information resources to establish vulnerability baselines, identify adaptation options, screen those options and monitor the impact of implemented adaptation.

It should be noted that this submission is among others FAO's submissions to SBSTA, and as such it highlights a very specific component of FAO's contribution to climate change adaptation.

FAO submission to SBSTA

According to the outline provided by UNFCCC this submission reports on FAO programmes and activities relating to the SBSTA sub-heading "Methods and Tools", with the objective of contributing to the sub-themes:

(i) "Promoting development and dissemination of methodologies and tools for impact and vulnerability assessments, such as rapid assessments and bottom-up approaches, including as they apply to sustainable development", and

(ii) "Promoting the development and dissemination of methods and tools for assessment and improvement of adaptation planning, measures and actions, and integration with sustainable development".

The aim of the activities in this area is to:

1. Apply and develop methodologies and tools for impact, vulnerability and adaptation assessments;
2. Develop methodologies and tools for adaptation planning, measures and actions, and integration with sustainable development;
3. Disseminate existing and emerging methods and tools;
4. Facilitate the sharing of experiences and lessons learned, including those contained in the UNFCCC Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change[1], including the assessment of costs and benefits.

FAO has a credible track-record in collecting, processing and applying information on natural resources, climate and the potential and actual production of food and fibre. In some instances, most notably fisheries, FAO is the exclusive source of this data. Much of this data will be useful, indeed essential, in the formulation of adaptation baselines and effective adaptation strategies. Information on its own, however, is insufficient to ensure effective adaptation. Only by combining the available data and information tools with FAO's long-standing, country and region-specific, experience in technology transfer, information dissemination via extension and development facilitation will the FAO's information resources prove effective in shaping adaptation processes. FAO has recently articulated its commitment to a "corporate-response" to climate change. Implicit in this approach is an understanding that effective adaptation will require a combination of tools and methodologies with the facilitation, social and institutional expertise that are necessary for their use.

a) Information on existing and emerging assessment methodologies and tools

Reducing vulnerability to current climate variability represents an essential step towards reducing vulnerability to climate change. At the same time climate change may require communities and countries to adapt to new threats if they are to survive. Effective adaptation to climate change involves both social and institutional processes aimed at creating the capacity to cope with a wide-range of future climate scenarios, and the multiple stresses that they will impose. Information on the following FAO methods and tools is given: (i) Agro-ecological Zoning; (ii) Climate Impact Assessment; (iii) AQUACROP; (iv) CLIMWAT; (v) Gender Issues; (vi) Global Land Cover Network.

Agro-ecological Zoning

The Agro-ecological Zoning (AEZ) methodology and related decision support tools allow the analysis of land productivity, crop intensification, food production and sustainability issues. AEZ methodology and supporting software packages can be applied at global, regional, national and sub-national levels. AEZ uses various databases, models and decision support tools which are described below. The AEZ methodology is useful for assessing land resources, and as such

[1] http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/2674.php

provides a tool for better planning and management and monitoring of these resources. AEZ can be used in various assessment applications, including:

- land resource inventories;
- inventories of land utilization types and production systems, including indigenous systems, and their requirements;
- assessment of the impact of climate change on cropping systems and food production;
- potential yield calculations and estimates of how yield will be affected by climate change;
- land suitability and land productivity evaluations, including forestry and livestock productivity;
- estimations of arable areas, mapping of agro-climatic zones, identifying soil problem areas, identifying and mapping agro-ecological zones, identifying the suitability of land for cropping and pastoral activities, quantitative estimates of potential crop areas;
- land degradation assessments, assessments of carrying capacity and how this will be affected by different climate regimes and land use optimization modelling;
- assessing and mapping flood and drought damages to crops;
- monitoring land resources development.

It is anticipated that the AEZ process will be crucial in identifying agricultural and natural resource baselines, and in monitoring how these baselines are being altered. FAO's AEZ methodology also provides a means of identifying how natural resources and agricultural production is likely to be perturbed under future climate scenarios and in identifying suitable crops and locations under future climate scenarios.

Climate Impact Assessment

FAO has a long tradition in supporting early warning systems through the crop monitoring and forecasting technology based on field data, satellite based indices and application software. Since 1974, FAO has developed and improved its crop forecasting methodology, and has been supplying updated information on crop conditions mainly in sub-Saharan countries through the Global Information and Early Warning System on Food and Agriculture and to the national Food Security Information and Early Warning Systems world-wide. Building on these national systems, which are known and used by countries, represents a more effective starting point than trying to launch new, possibly improved but largely untested, analytical tools for climate impact assessment.

FAO has been a leader in the use of new data types (in particular rainfall, crop phenology and remotely sensed data) and specific software tools such as crop specific water balance, data interpolation in time and space and analysis tools. These data and tools are designed to be scale independent, and can monitor patterns of climate variability at global, continental, regional, national, sub-national and farm level. They have been tested and used extensively by countries and are appropriate for vulnerability risk assessments and to define best practices for climate change adaptation.

By improving theuse of Early Warning and Information Systems and Disaster Information Management Systems, the short- and long-term impact of (extreme) events on agricultural livelihoods can be assessed, and disaster preparedness and risk mitigation enhanced.

Because of the nature of climate change, effective climate change adaptation will require repeated efforts at various spatial scales to develop methodologies that render agriculture more resilient and responsive. FAO's climate impact assessment tools are capable of supporting this process. FAO's track-record and experiences in applying these tools are likely to prove particularly useful in the formulation of adaptation responses. These include:

- Modularity of software and common file formats constitute central issues in the FAO philosophy with regards to the development of climate impact assessment methods and tools.
- In developing and/or applying methodologies, FAO takes an approach that integrates different technical and socio-economic elements, according to location-specific priorities and available resources.
- South-south co-operation is seen as fundamental, and is encouraged by FAO as a means of promoting the transfer of technical capacities and know-how between developing countries.
- Dynamic Farming Optimization (DFO) – the improvement of tactical decision-making at farm level and based on the quantitative observation and analysis of local environmental factors - is seen as an essential component of FAO's climate impact assessment tapproach.
- Applications of methods and tools should begin at on-farm level and be up-scaled to sub-national / national / regional / global level.
- Field activities should inform and strengthen capacity at all levels – that is from farm-level to national institutions involved in agriculture and natural resource management.

A variety of climate impact assessment tools developed or under development by FAO is described below. Table 1 describes the linkages between application, product, tool, data input, tools, spatial scale and audience for climatic information.

Agroclimatic water stress mapping

In order to provide a global, near real-time warning of current and future agricultural emergencies, the agroclimatic water stress mapping tool identifies, through a calibration matrix, areas where excess or deficit rainfall is likely to produce serious damage to rainfed agriculture or pastures. The risk can be weighted with other critical factors, for instance high population density or high soil degradation.

The tool produce water stress maps in a digital form consisting in comparing actual and average monthly precipitation digital maps at 0.5° of resolution during the periods when agricultural activities are more "sensitive" to water stress. The agricultural areas are the zones where the combination of rainfall, mean temperature and potential evapotranspiration average patterns produces an active growing season. Based on a user-selected future time, the maps identify the regions where the agricultural season will be disrupted by adverse water supply conditions. In addition this predictive instrument can use seasonal forecast data to produce maps identifying the probability of water deficit or surplus conditions in the coming months.

AGROMETSHELL

AgroMetShell (AMS) consolidates several food security early warning software packages that have been developed by FAO. It represents an essential tool for assessing the impact of climatic conditions on crops, climatic risk analysis and for regional crop yield forecasting. AMS is a software tool designed to support crop forecasting and the core part of the software is formed by the crop specific water balance calculations. Based on rainfall, evapotranspiration and crop data, AMS can calculate if and when a crop experienced water shortage, eventually leading to reduced crop yields.

AMS includes several modules, such as:

- **ADDAPIX**. Addapix performs a pixel-by-pixel clustering analysis in order to identify areas on a map, or a set of maps, that exhibit similar patterns of weather change. For instance, areas where the rainy season was late and which suffered drought at the time of flowering, could constitute a cluster. It includes a numerical classification at the pixel level, providing a map of homogeneous areas together with the "profiles" that characterise them. The pixel-by-pixel clustering of a set of images (or two related sets, as is the case with monitoring) provides a means of extracting and transmitting the essential information from large data sets in an easy-to-understand way.

- **CrowPer**. Crop gROWing PERiod determines the growing season characteristics for a specific crop, i.e. the average ("normal") and actual ("current") beginning, peak and end of the growing season(s) for any geographically defined location (points or maps), in a fully automated fashion based on ground data and satellite imagery. All outputs are accompanied by a reliability index and map inputs and outputs are provided in digital format.

- **Crop Suitability** provides an evaluation of crop suitability at short-time scale and for future-term climate change scenarios. First, individual crop suitability ratings are analyzed and then suitability for various cropping patterns are rated using a database of known and potential cropping patterns (rotations). This suitability modeling takes into account individual crop characteristics, input/management levels, soil physical characteristics, hydrologic and climatic conditions, and seasonal variability. Extrapolations of existing cropping system technologies can also be made to delineate suitable areas on a national scale.

- **Crop Yield Forecast** provides yield forecast of the major food crops at sub-national / national / regional levels, as accurate and timely as possible. Crop yield forecast procedures combine all kinds of input such as historical yield statistics, weather indicators, simulated crop indicators, remote sensing based vegetation indices, additional information sources and expert knowledge. The components of the crop yield forecast routine include::

  - observed meteorological data collection, processing and analysis;
  - simulation of agro-meteorological crop growth parameters;
  - low spatial resolution (and high temporal resolution) satellite data analysis;
  - statistical analysis and regressions.

- **Crop Yield under Climate Change Scenarios**. Climate change has a direct impact on crop yields. However, while coupled global atmospheric and oceanic circulation models (GCMs) are becoming increasingly robust in their efforts to predict pattern of global warming under different scenarios, to date they have not proven suitable for predicting the local changes in meteorological parameters that determine crop growth and yields (e.g. precipitation, surface solar radiation, humidity and wind speed). These variables are, however, observed by national services and are thus available for national investigations under the recent circumstances. The crop yield under climate change scenario' tool bridges the gap between GCM results on the one hand and crop-yield impacts on the other hand by using FAO's crop-specific soil water balance model and the Stochastic Weather Generator (SWG) fit to observed meteorological data and crop yield statistics. As such it allows for the investigation of the sensitivity of different crops in various regions with respect to a broad range of different future climate scenarios.

- **Crop Yield Trend Analysis**. This tool analyses trends in crop yield at the national and/or local level. This is essential in determining the patterns of inter-annual and intra-seasonal variability and probability of extreme weather events. It also ensures that the time period used for the calibration of crop forecasting methods is devoid of any significant trends that can invalidate the results.

- **Extreme Weather Events Risk Analysis**. Based on historical climate data, this tool analyses the daily maximum and minimum temperature and rainfall data in order to derive climate change indices that provide insight into extreme events:
  - percentile-based indices: sample the extreme end of a reference period distribution (e.g. 10th or 90th percentile of min. and max. temperature);
  - absolute indices: represent maximum or minimum values within a season (e.g. maximum 5 day rainfall);
  - threshold indices: number of days on which temperature/rainfall falls above or below a fixed threshold (e.g. frost days, days with rainfall > 10mm);
  - duration indices: define periods of excessive warmth, cold, wetness or dryness (e.g. heat wave duration, growing season length, number of consecutive dry days);
  - other indices: diurnal or inter-annual temperature range, intensity of daily rainfall.

- **Stochastic Weather Generator**. The stochastic weather generator (SWG) simulates possible "future" weather scenarios using the most relevant weather variables from existing daily or monthly records. Daily values of air max/min temperature, precipitation, and wind speed can be generated from random processes based on parameters estimated either on daily data or monthly means. Synthetic values of solar radiation, vapor pressure deficit, and reference evapotranspiration are produced by physically-based relationships. For precipitation, the routines can generate long-term time-series using parameters from existing daily or monthly data and it includes the amount of rainfall and snowfall.

- **Weather-Based Yield Index for Crop Insurance**. Extreme weather hazards such as droughts and floods lead to severe income losses for rural people, especially farmers and poor people. Given their limited ability to offset these losses, many rural people become food insecure and suffer extreme hardships in disaster years. It might be possible to cope with small, localized droughts by transporting food-supplies from other districts of the country that have excess production and by sourcing government budget reserves. In case of a severe regional drought, this reallocation of resources may not be manageable and it would be appropriate to utilize weather–based maize yield indices in the form of insurance. A weather-based crop yield index is developed by evaluating historical weather data and determining the relationship between rainfall and maize yields. If there is a strong correlation between the two, then this index could be used to manage weather risk. AgroMetShell software is used to derive an effective weather-based maize yield index that could be used for crop insurance purposes to monitor crop performance and to produce real-time pixel-based maize yield index maps covering the whole country with a resolution of 0.05° latitude and longitude (approximately 5 km). First estimates of the index can be provided at planting time and updated in real time throughout the season.

- **WINDISP**. It is a software package for the display and analysis of satellite images, digital maps and associated databases which are used for crop forecasting. The tool allows sophisticated analysis at pixel level.

Dynamic Farming Optimization

With subsistence agriculture expanding more and more into marginal areas, and with at least some modernisation taking place, subsistence farmers face the problem of further degrading their environment and increasing variability of their production. There is a need to promote sustainable farming systems at peasant level and to ensure improved food security and income of rural communities, especially in areas suffering from large inter- and intra-seasonal variations of climatic conditions. The Dynamic Farming Optimization (DFO) approach intends to improve cropping strategies specifically tailored to the changing local environment of subsistence farmers in making better use of climate resources, notably rainfall and solar radiation, while at the same time reducing the strain on the environment, notably on soils. DFO represents a set of techniques able to contribute to optimising farming practices, as a function of current environmental conditions, especially to capture uppermost possible benefits from unusually favourable and/or non favourable climatic (rainfall, temperature, radiation, etc.) conditions. The purpose of DFO is to help farmers stabilise their production and income through advices based on local farming practices, historical weather data ("risk assessment"), actual current season weather and future climate conditions ("dynamic farming optimization").

FAOClim

FAO manages a major world-wide database of agro-climatic variables covering more than 32,000 stations and focusing on monthly averages and historical time series, which are essential tools for variability analyses and risk studies. The database management system (FAOClim-Net), linked to real-time daily meteorological data flow, allows browsing and retrieval of basic data to users. It is proposed that FAOClim provides a crucial resource in understanding how climate is changing and in establishing the baselines from which climate is being perturbed. Without historical baselines and an understanding of the magnitude of perturbations, it is very difficult to mobilise appropriate adaptation.

New_LocClim

New_LocClim (Local Climate Estimator) software can estimate climatic conditions at locations for which no observations are available and provides nine different spatial interpolation methods (IDW, kriging, Shepard, thin-plate splines, etc.). It allows for an extensive investigation of interpolation errors and the influence of different settings on the results. Furthermore, statistical analysis of the interpolated spatial fields is provided and detailed analysis for single geographic points can be prepared. New_LocClim aims at the preparation and investigation of climate maps, including the possibility for users to interpolate their own data and to prepare maps (grids) at any spatial resolution, and to determine crop growing season characteristics.

The preparation of climate maps at any spatial resolution allows users to investigate about climate at various level of detail, from point to region. Based on the FAOClim database, New_LocClim can determine the average growing season as defined by the FAO Agro-Ecological Zones project that is the period during a year when precipitation exceeds half the potential evapotranspiration. The tool allows changing this definition by altering the ratio between precipitation and potential evapotranspiration. Furthermore it distinguishes between moist and humid growing seasons.

Rainfall Estimate with Gauge Analysis

The objective of this activity is to develop a method to estimate rainfall amount over a day or a 10-day period, particularly, for certain regions where the coverage of the weather stations is scarce. The algorithm uses the data from the weather stations to calibrate the satellite estimation. The data taken from the weather stations provide accurate cumulate rainfall measurements, and are assumed to be the true rainfall near each station. The method is designed to use data from any weather station network: it can be a local weather station network or the WMO SYNOP messages distributed via WMO Global Telecommunication System (GTS).

The rainfall estimate routine runs at continental / regional / national level. The tool can be also run by regional / national meteorological centers so that they can use local rainfall data and specific meteorological models. Once operational, the routine to estimate the rainfall amount over Africa will be applied to the Indian Ocean area as well. The input data are used to provide rainfall forecast for the coming day and week.

AQUACROP: an irrigation model

AQUACROP, a new version of CROPWAT, is a Windows based software programme designed to simulate biomass and yield responses of field crops to various degrees of water availability. Its application encompasses rainfed as well as supplementary, deficit and full irrigation. It is based on a water-driven growth-engine that uses biomass water productivity (or biomass water use efficiency) as key growth parameter (WP_b). The model runs on daily time-steps using either calendar time or thermal time. It accounts for three levels of water-stress responses (canopy expansion rate, stomatal closure and senescence acceleration), for salinity build up in the root zone and for fertility status. An important peculiarity of the model is that the WP_b parameter is normalized for climatic conditions (specifically, the evaporative demand of the atmosphere –ET_o– and the CO_2 concentration) and it simulates biomass and yield also under various global warming and elevated CO_2 conditions. It allows to evaluate different water-management strategies, the development of recommendations for improved irrigation practices and the planning of irrigation schedules under varying water availability/supply.

AQUACROP is a tool for (i) predicting crop production under different water-management conditions (including rainfed and supplementary, deficit and full irrigation) under present and future climate change conditions, and (ii) investigating different management strategies, under present and future climate change conditions. Appropriate for risk-management and adaptation-capacity studies of cropping systems. It can be applied at all locations; agricultural sector; site-specific, but can be extrapolated to larger scale by GIS applications.

The key inputs to the AQUACROP model are: basic climatic data (temperature, rainfall, and reference evapotranspiration; CLIMWAT 2.0 database, provided with the program as an option); basic soil data (texture for each -1 to many - layer along the depth); crop data (already calibrated crop-parameters are provided with the model); selected management conditions. The key outputs are: canopy development, above-ground biomass, final yield, crop water consumption (with separation between soil evaporation and crop transpiration), and general crop water and irrigation requirements. AQUACROP will be provided with calibrated parameters for all major and underutilized agricultural crops and can be applied worldwide.

It is intended for use by agricultural and extension service professionals with sufficient background and experience in crop and water management. As a means of monitoring changes in crop yields and explaining the impacts of climate change and the need for adaptation, and also in planning appropriate adaptation, AQUACROP has the potential to provide a useful tool.

CLIMWAT 2.0: a climatic database for AQUACROP

Under AQUACROP, calculations of crop water requirements and irrigation requirements are carried out with inputs of climatic and crop data. CLIMWAT 2.0 is a climatic database to be used in combination with AQUACROP and allows the ready calculation of crop water requirements, irrigation supply and irrigation scheduling for various crops for a range of climatological stations worldwide. A database facility CLIMWAT 2.0 has been developed which allows a direct link from AQUACROP to an extensive climatic database of more than 5,000 stations worldwide.

The combination of AQUACROP and CLIMWAT has the potential to provide a measure of climate change thresholds and to provide information on adaptation.

Gender Issues

Climate change is expected to have gender specific impacts and accordingly climate change adaptation should include gender disaggregated approaches. A number of well-developed tools for gender mainstreaming exist within FAO, and are being used in a variety of contexts. Applying these tools to climate change adaptation policy making and implementation will form an integral component of FAOs contribution to clmate change adaptation.

Gender analysis: Making gender disaggregated data available and supporting relevant research; evaluating policies, institutions and programmes for gender specific impacts, gender balance and action on gender issues;

Gender Impact Assessment (GIA): Producing gender analysis of adaptation to climate change and vulnerability to its impacts for more sustainable mechanisms of risk management;

Gender budgeting: apply gender budgeting to climate change funds;

Promoting women in decision-making: institutional mechanisms for the advancement of women, e.g. quota systems; establishing task forces and other organisational development mechanisms; innovative types of outreach to women, including awareness raising, capacity building, education and training for women and men (including changing curricula, public campaigns, gender sensitivity training, guidelines for gender mainstreaming, etc); collecting and sharing good practices at local, national and international levels, including peer group review of good practice and promoting successful strategies; developing and applying such tools successfully depends on the appropriate legislative environment, demonstrated political will and support as well as necessary funding being in place.

Global Land Cover Network

The goal of the Global Land Cover Network (GLCN) is to improve the availability of global information on land cover and its dynamics. Currently available land cover information often lacks the required levels of accuracy, or is collected using a variety of different standards, thus preventing comparison between the regions and compilation of global totals. Land cover mapping and monitoring activities provide information that is essential for the sustainable management of natural resources and environmental protection.

FAO and its partners have developed a broad suite of software and methodologies to allow countries and individual organizations the ability to: gather and acquire land cover and environmental data; undertake photo interpretation and data analysis; generate land cover change analysis products and develop environmental databases with environmental as well as socio economic information. All procedures are undertaken using harmonized methods and standards to ensure a broad stakeholder access to what is generated and to allow the development of regional and global datasets. Land cover and land cover change data are fundamental to the sustainable management of natural resources, environmental protection, food security and humanitarian programmes. They are also essential for climate change monitoring, prediction and adaptation strategies.

b) Views on lessons learned from their application

Information tools are a necessary but insufficient resource to ensure effective climate change adaptation. The success of FAO tools is that they have been developed under various conditions so that they can be applied at any spatial level: from on-farm up to global level. The limited amount of input data required to run most of FAO’s information tools makes them a good compromize to deal with the poor density of the climate observation network in many developing countries. They are also applied by several UN and international Agencies for national / regional and global assessments.

Global Land Cover Network (GLCN) is based on the success of the FAO Africover project which was established in response to a number of national requests for assistance in the development of reliable and georeferenced information on natural resources. These data are needed for: early warning; food security; agriculture; disaster prevention and management; forest and rangeland monitoring; environmental planning; watershed catchments management; statistics on natural resources; biodiversity studies, and climate change monitoring, modelling and adaptation activities.

c) Opportunities, gaps, needs, constraints and barriers

All FAO climate impact assessment tools are freeware and, although most of current versions run under MS Windows environment, future versions will be developed for an “open-source” environment.

In order to utilize gender mainstreaming tools in the climate change adaptation policy process, gender-disaggregated data are needed, as is empirical evidence demonstrating the gender differences of vulnerabilities and adaptive capacities.

The main constraints is the lack of access to raw data (e.g. expensive satellite data) and the lack of standards and common methods which leads to incompatibility and access to datasets, especially historical ones. FAO has developed common standards to overcome this problem including the Land Cover Classification System (LCCS). LCCS is a scale independent method of classifying land cover. The approach supports all types of land cover monitoring and enables a comparison of land cover classes regardless of data source, sector or country.

d) Possible ways to develop and better disseminate methods and tools

The Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP), with the financial and technical support of the Government of Italy through the “Cooperazione Italiana” and the “Instituto Agronomico L’Oltremare”, has created the Global Land Cover Network (GLCN) in response to requests by stakeholders. Specifically the objectives of the initiative is to develop a global collaboration to develop a fully harmonized approach to make the required reliable and comparable land cover and land cover change data accessible to local, national and international initiatives. In particular, GLCN is intended to support the stakeholder community in developing countries that have difficulty in producing and making accessible reliable, consistent and updated information. The GLCN has a major mandate on outreach and tools and data dissemination.

e) Training opportunities

All FAO climate impact assessment tools are intended for use by agrometeorological, agricultural and extension services professionals with sufficient background and experience in climate, crop and water management.

With particular reference to the climate impact assessment tools, FAO has developed the concept of the national *turn-key crop monitoring and forecasting systems*, called “Crop Monitoring Box” (CM Box), which is a training package around the FAO software suite to analyse weather data and to asses their impact (current and future) on crop production. The training covers the principles and the practice of the operation of a national crop yield monitoring and forecasting system in a food security context, in particular the interpretation of the maps and other outputs produced by the various tools. By the end of the training, national experts are expected to be able to operate the software independently, including inputting crop and weather data, and the integration of ground and satellite information. One essential ingredient of the training is the development of the capacity to prepare crop and weather reports for the national food security system. The training makes use of national datasets that are prepared by the trainees themselves before the training actually starts. The CM Box is presented as individual modules of which countries can select only one or more of them.

Training on gender mainstreaming for climate policymakers is an outstanding issue.

A key area to the success and continuity of GLCN activities has been the importance given to training and the development of national capacity in the methodologies and applications required to undertake, maintain, archive and disseminate land cover and environmental data and information. This process has been mainly achieved through regional and national training workshops and programmes and has allowed institutions and individuals to become self sufficient and in-turn provide support and training to other GLCN partners.

GLCN also develops a number of other products to support stakeholders, these include: newsletters, distance learning tools, forums, Web pages, databases, manuals, documents and brochures as well as presentations and seminars at the main international conferences and events.

Conclusion

Many FAO information and data resources constitute an essential ingredient in both :

i. promoting development and dissemination of methods and tools for impact and vulnerability assessments, such as rapid assessments and bottom-up approaches, and
ii. assessing and improving adaptation planning, measures and actions, and integration with sustainable development.

FAO has a track record of applying its information and data resources successfully in country specific development facilitation, including responses to variable weather and natural disasters.

FAO's work on climate change mitigation has been complemented during 2006 by an increasing number of climate change adaptation measures involving agriculture, forestry and fisheries and processes of institutional strengthening within these activities. The multidisciplinary approach of FAO combined with large thematic geo-referenced databases and various software applications allow to FAO contribute to the reduction of agricultural production systems' vulnerability to climate variability and change.

A country's ability to gather, interpret and use data for land cover change is essential for policy makers and decision makers aiming to make informed and appropriate climate change adaptation strategies. The use of agreed methodologies and standards allows data compatibility to develop regional and global data required for modeling, including the identification of climate change vulnerability hotspots. Activities are undertaken by the active collaboration of member countries with the assistance of adequate capacity building programmes. However for some developing countries additional financial support is required to allow their full participation in these programmes.

Application	Product	Tool	Input data	Spatial scale	Target audience
Past and current climate					
Past and current vulnerability risk assessments of agriculture sector. Definition of best practices to adapt to climate change	Climate maps, Rainfall estimate, water stress maps, crop suitability, extreme weather events risk analysis, date of planting, length of growing period	AMS, AWS, CLIM, CROW, CYTA, FRE	Historical, real-time meteorological data and satellite imagery	Regional, National, sub-National, On-farm	Extension services, farmers, international disaster agencies, insurance companies
Short-term forecasts (1-5 days)					
Shor-term vulnerability risk assessments of agriculture sector. Definition of best practices to adapt to climate change	Rainfall estimate, water stress maps, crop suitability, extreme weather events risk analysis, yield forecast, date of planting, length of growing period	AMS, CLIM, CYTA, DFO, INS, SWG	Real-time meteorological data and satellite imagery, short-term forecasts	Regional, National, sub-National, On-farm	Early warning systems for food security and for disease outbreaks, emergency response networks, extension services, farmers, international disaster agencies, insurance companies
Medium range forecast (5-20 days)					
Medium range vulnerability risk assessments of agriculture sector. Yield index for crop insurance. Definition of best practices to adapt to climate change	Rainfall estimate, water stress maps, crop suitability, extreme weather events risk analysis, yield forecast, date of planting, length of growing period	AMS, CLIM, CYTA, DFO, INS, SWG	Real-time meteorological data and satellite imagery, short-term forecasts	Regional, National, sub-National, On-farm	Early warning systems for food security and for disease outbreaks, emergency response networks, extension services, farmers, international disaster agencies, insurance companies
Seasonal climate projections (1-6 months)					
Seasonal predictions of vulnerability risk assessments of agriculture sector. Yield index for crop insurance. Definition of best practices to adapt to climate change	Water stress maps, crop suitability, extreme weather events risk analysis, yield forecast, date of planting, length of growing period	AMS, AWS, CLIM, CYTA, DFO, SWG	Historical meteorological data, seasonal climate forecasts	Regional, National, sub-National	Early warning systems for food security and for disease outbreaks, emergency response networks, extension services, farmers, international disaster agencies, insurance companies
Climate change scenarios (2015, 2030, 2050, 2070)					
Long term vulnerability scenarios for communities and regions. Future-term vulnerability risk assessments of agriculture sector. Definition of best practices to adapt to climate change	Future weather, water stress maps, crop suitability	AMS, AWS, CLIM, CROW, CYTA, SWG	Historical meteorological data, global and regional climate models	Global, Regional, National, sub-National	Strategic planners at regional and national level, decision-makers at all levels of government, NGOs, and communities, insurance and financial markets

Table 1. Link between Application, Product, Tool, Input data, and users of climate information.

Acronyms: AMS = AgroMetShell; AWS = Agroclimatic Water Stress Maps; CLIM = FAOClim database; CROW = Crop Growing Period; CYTA = Crop Yield Trend Analysis; DFO = Dynamic Farming Optimization; FRE = FAO Rainfall Estimate; INS = Weather-based Yield Index for Crop Insurance; LOC = New_LocClim; PCA = Pixel Clustering Analysis; SWG = Stochastic Weather Generator.

PAPER NO. 3: SECRETARIAT OF THE UNITED NATIONS INTERNATIONAL STRATEGY FOR DISASTER REDUCTION

Disaster Risk Reduction Tools and Methods for Climate Change Adaptation

Inter-Agency Task Force on Climate Change and Disaster Risk Reduction

"*The view that disasters are temporary disruptions to be managed only by humanitarian response, or that their impacts will be reduced only by some technical interventions has been replaced by the recognition that they are intimately linked with sustainable development activities in the social, economic and environmental fields. So-called 'natural' disasters are increasingly regarded as one of the many risks that people face.*"[1]

I. Introduction

Floods, storms, droughts, and extreme temperatures strike communities around the globe each year. The top ten disasters of 2004, in terms of the number of people affected, were all weather and climate-related. These types of disasters have occurred throughout history but with total damages amounting to US$130 billion from just these ten events, it is clear that the necessary steps to reduce disasters have not yet been taken.[2] As climate change begins to manifest itself—in the form of increased frequency and intensity of hazards such as floods, storms, heat waves, and drought—the need for communities to address climate risks is becoming urgent. The coming decades are likely to bring, among other changes, altered precipitation patterns so that many areas will experience more frequent floods and landslides, while others will experience prolonged drought and wildfires.[3]

As many communities are not prepared to cope with climate disasters facing them today, an ongoing challenge is to build their resilience. In answer to this challenge, disaster risk reduction (DRR)[4] aims to address a comprehensive mix of factors contributing to communities' vulnerabilities. There are numerous tools and methodologies that have been developed to put this approach into practice. The value of DRR and the experiences gained by DRR practitioners have been increasingly tapped by organizations active in climate change adaptation. For example, UNDP, OECD, the World Bank, and others have recently explored linkages between the two (see references).

This paper provides a brief description of DRR and then reviews a selection of tools that can provide an effective framework for combining the knowledge and experiences from the disaster management and climate change communities to build adaptive capacity.

II. The Disaster Risk Reduction Approach

The disaster management community has been evolving. Until the 1990s, disaster management was primarily focused on the response of governments, communities, and international organizations *after*

[1] ISDR, 2004
[2] www.cred.be, see 2004 statistics
[3] IPCC, 2001
[4] The International Strategy for Disaster Reduction, 2004, defines disaster risk reduction as: "The systematic development and application of policies, strategies and practices to minimise vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) adverse impact of hazards, within the broad context of sustainable development."

disasters. This included the humanitarian aspects of relief, such as providing medical care, food and water, search and rescue, and containing the secondary disasters (e.g. fires that occur following an earthquake). Even now, only a tiny amount of humanitarian funding is spent on disaster risk reduction. Although the international community has increasingly realized that countries experience disasters differently, the unfortunate truth is that poorer countries are hit hardest, as they do not have sufficient resources to prepare for disasters. In addition, the socio-economic impacts following a disaster may linger far longer in poorer nations. A UNDP report states, "*In 1995, Hurricane Luis caused US$ 330 million in direct damages to Antigua, equivalent to 66 percent of GDP. This can be contrasted with the larger economy of Turkey that lost between US$ 9 billion and US $13 billion in direct impacts from the Marmara earthquake in 1999, but whose national economy remained largely on track.*" The same report found that "*while only 11 percent of the people exposed to natural hazards live in countries classified as low human development, they account for more than 53 percent of total recorded deaths.*"[5]

Disaster risk reduction is increasingly recognized as a major factor in achieving sustainable development, although the systematic integration of DRR into development planning and activities remains a challenge. Time and again, investments in development have been wiped away by disasters, and these damages have only increased as countries grow. According to Munich Re, the recorded economic value of disaster damage has increased from US$ 75.5 billion in the 1960s to US$ 659.9 billion in the 1990s.[6] These figures do not account for the losses suffered by communities in terms of lost lives and livelihoods.

To reduce human and economic losses, the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, commits countries and agencies to: integrate DRR into sustainable development; develop and strengthen institutions, mechanisms and capacities to build resilience; and systematically incorporate DRR into emergency preparedness, response and recovery programmes. States have agreed to taking the lead in achieving these goals by:

- Strengthening policies and institutions
- Identifying, assessing ad monitoring risk and enhancing early warning
- Using knowledge, innovation and education to build a culture of safety
- Reducing underlying risk factors, such as environmental degradation
- Strengthening preparedness for effective response

Focus on communities and vulnerability

One of the underlying principles of DRR is to consider disasters as a result of a community's vulnerability. Vulnerability has been defined as "*a set of conditions and processes resulting from physical, social, economical, and environmental factors, which increase the susceptibility of a community to the impact of disasters.*"[7] Taken from this standpoint and incorporating the resources within the community, risk can be defined as follows:

$$\text{RISK} = \text{HAZARD} \times \text{VULNERABILITY}/\text{CAPACITY}$$

By analyzing vulnerabilities and capacities, a fuller picture emerges of how to reduce disaster risks. The DRR approach considers a comprehensive range of vulnerability factors and aims to devise strategies that safeguard life and development before, during, and after a disaster. This approach is useful to the climate change community because, whereas the climate change debate and work has largely taken place at the

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[5] UNDP, 2004
[6] UNDP, 2004. Amounts in 2002 US dollars.
[7] *Ibid*

international and national levels and focused on impacts/hazards, disaster managers have long experience working at the local level on the vulnerabilities that turn an impact into a disaster. Although a national disaster reduction strategy should be in place, DRR activities are often focused on specific locations, addressing the particular vulnerabilities and capacities of the community, its culture and processes. The rationale behind any action and how it is implemented should be firmly rooted in the beneficial impacts that can be realized for the community, and for the most part, these benefits should be measurable. The success of disaster risk reduction activities depends to a large extent on the participation of community members. Adaptation to climate change risks may require effecting changes within local communities—by combining local knowledge and know-how with external information. Or adaptation may simply require increasing the scale of current climate risk reduction efforts by intensifying today's efforts or expanding to other areas practices to deal with well-known hazards. By adopting the DRR focus of vulnerability reduction and making use of the specific tools developed for DRR, the climate change community can benefit from the vast experience gained in the reduction of hydro-meteorological risks.

III. Disaster Risk Reduction Tools

One common characteristic of DRR tools, as shown in the examples in the annex, is the emphasis on taking a holistic view of disaster risk reduction and the importance of linking with diverse stakeholders. Even for those tools with a narrower target group (e.g. climate forecasters or water utilities), the process requires drawing on wide-ranging sources of knowledge for successful risk reduction in the community. This attempt to analyze risk from diverse perspectives makes the tools suitable for climate change adaptation as impacts will affect various sectors and communities.

DRR tools have been developed by a range of institutions, including research centers, government agencies, the UN, NGOs, and IGOs. These include tools targeted for use at the international to the local levels, implemented in cooperation with diverse partners, and in response to numerous hazards. This paper does not attempt to catalogue the abundance of tools on offer.[8] Instead, it looks at one or two specific examples for each aspect of DRR and briefly examines the links with climate change adaptation.

Policy and institutions. It is critical that decision makers at all levels are committed to disaster risk reduction, so that resources and planning guidance are provided. Just as important is the participation and understanding of individuals at the local level where disasters are felt. This category includes the country's overall policies, the legislative process, and the institutional framework for implementing measures. The tools that have been developed for policy and institutions are aimed at mainstreaming disaster risk reduction into development planning from the national to community level. This aims to bring about a "culture of safety and resilience".

Because of their comprehensive nature, these tools focus on the *process* of decision-making. For example, the methods recommend piggybacking on existing institutional structures and becoming integrated within national decision-making calendars[9], rather than creating extra workloads through parallel activities. They aim to create an overall picture of risk and the options for reducing them. Through integration with existing development plans, the disaster risk reduction strategies explicitly support national goals. Furthermore, the process outlined in these tools is multidisciplinary, so that planners clearly see how activities in one sector may influence risks in another. The methods highlighted in the annex give an overview of priorities, potential actions, and roles and responsibilities. These tools can be utilized at various levels so that commitment is built throughout the system. For example,

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[8] See www.proventionconsortium.org and www.unisdr.org for resources.

[9] The United Nations Development Assistance Framework (UNDAF) is a good example of an existing development policy tool into which DRR could be incorporated.

SOPAC's Comprehensive Hazard and Risk Management (CHARM) is implemented through a series of workshops aimed at broad stakeholder consultations at the national and regional levels.[10]

These methodologies follow the same general consultative process as existing tools for climate change, such as guidelines on NAPAs and national communications. However, there are great opportunities for synergy between the two political frameworks, as traditionally disaster management has involved ministries of interior, civil defense and health, while the focal point for climate change is usually the ministry of environment. DRR tools encourage the engagement of officials from all relevant sectors, including finance and planning, in addition to interaction with National Hydrometeorological Services (NMHSs), which are the main providers of weather and climate data and information.

Risk identification and early warning. This is a familiar area when thinking of disaster management activities—assessing the risks facing a community and determining which ones are likely to affect people. Science and technology are important in understanding the physical processes behind hazards and how they will interact with community infrastructure and activities. For example, an extensive network of monitoring technology may be required for meteorologists and hydrologists to gather data on climate hazards and to build a picture of climate change trends. At the local level, this information is supplemented by community members' historical knowledge on events such as floods or droughts. Again, vulnerability must be added into the equation because the mere presence of a hazard does not automatically translate into a risk. Risk is *the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.*[11] Communities need information both on hazards and their vulnerabilities to determine priorities for reducing their risk.

The tools for risk identification may include national assessments to gain a broad understanding of risk for entire sectors or geographical regions. Or, as shown in ADPC's *Community-Based Disaster Risk Management Field Practitioners' Handbook*, a tool can provide a framework for assessment teams working in a participatory manner with individual communities. Local knowledge is combined with scientific understanding and advanced technologies to generate a fuller picture of risks. This particular guideline is very specific, carefully describing exercises that help to build a common understanding of risk (e.g. through creating seasonal calendars or histories of floods/droughts over the last decades). Once they are understood and there is a system for monitoring them, it is also important to establish a communication system for early warning. The WMO *Guidelines for Climate Watches* are directed at national meteorological services to support the clear communication of climate information to users in a timely manner.

Including climate change in the disaster risk reduction framework enhances the analysis because climate change is likely to bring hazards for which there is no existing experience. For example, sea level rise or extreme events that go beyond today's boundaries will require planners to look outside of currently applied risk reduction measures. Climate change, along with urban growth, economic globalization, and emerging health issues are all combining to rapidly change the nature of communities' vulnerability.

Knowledge management and education. Supporting the local community's involvement is crucial for implementing strategies that will lead to a culture of safety. This area of disaster risk reduction includes managing the information and data that has been gathered, educating people about their risks, and building people's capacity to devise and implement risk reduction measures. The information and knowledge should not flow in only one direction; planners must also learn about the community's needs and wants so that they can better support development and risk reduction. These experiences can then be shared with other communities and successes replicated.

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[10] ADB, 2002

[11] ISDR online library: http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm

An important step is to translate risk information into dialogue with communities. The Emergency Management of Australia's guide on community awareness goes through the steps of identifying the target audience, the best methods of communication, and evaluating the results. As people are constantly bombarded by information, it is not sufficient to merely send messages out. Instead, these tools stress the importance of defining *what action* needs to be taken by the community, whether that is to change their behavior or to examine their disaster risks more closely. The process outlined by knowledge management and education tools, such as WMO's guidelines, requires cooperation between scientists and practitioners so that the necessary technical information is conveyed in a form that community members can use. It also requires regular assessments by practitioners and end users to improve efficiency and strengthen interactions. The WMO *Guide to Climatological Practices* offers the World Climatic Atlas Project, climate maps, interpretation of climatological information, and climate classifications (e.g. bioclimatic, genetic, and special classifications).

Conveying the concepts and risks associated with climate change to people at the local level is a challenge for the adaptation community. The uncertainty regarding impacts on any particular location presents a unique hurdle in making climate change relevant to people's daily lives when they may be focused on their daily needs. Short-term considerations will take precedence over adapting to impacts that may not be immediately apparent. Linking into existing disaster risk reduction efforts for climate variability and extreme events is a good entry point for building understanding and adaptive capacity.

Reducing Underlying Risks. Risks must not only be identified and institutional capacity in place; action to reduce the factors that increase risk is necessary. This includes measures in environmental management, poverty reduction, protection of critical facilities, networking and partnerships, and financial and economic tools to ensure a safety net in case of disasters. Applications will be most effective if they build on local knowledge, respect local cultures, and provide multiple benefits. For example, conserving wetlands reduces risks through flood mitigation and storm protection while also providing livelihood support, water purification, and erosion control. Measures may strive to reduce the extent to which a planned development project will increase a community's vulnerability. In this case, a risk assessment should be conducted as part of the project's evaluation (e.g. planners for a waterfront property development should consider how sea level rise and storms may affect future residents), much the same way an environmental impact assessment or cost-benefit analysis are now often included. There are also measures to reduce the risks already existing in infrastructure and systems throughout the world, for example through retrofitting or enforcing land use zones.[12]

This type of DRR tool is by necessity sector-focused because the tools aim to develop concrete, detailed measures. This normally involves specialized knowledge and skills. The Pan American Health Organization (PAHO)'s guidelines, which have been used throughout Latin America and the Caribbean, focus on drinking water and sewerage systems. This tool guides a team within a water company through a vulnerability analysis and in devising risk reduction measures. It takes them through the process of identifying strengths and weaknesses in the physical infrastructure and organizational systems.[13] This tool can help ensure that measures are in place to guarantee that drinking water supplies are protected from likely hazards and that the sewerage system would not break down in the event of a disaster leading to the spread of epidemics. Using this tool for adaptation could involve, for example, looking at how climate change will affect the water company's ability to maintain service with any changes in water resources. Another example from Switzerland discusses how more than 6% of the country is prone to slope instability. Regional authorities produced hazard maps and developed a system of three land use

[12] Reducing the development project-induced vulnerability is "prospective risk management", while reducing existing vulnerability is "compensatory risk management". See UNDP, 2004.

[13] PAHO, 1998

zones (indicated by three different colors on the maps) where construction could be undertaken without restriction, with certain safety measures, or not at all.[14]

As efforts within the adaptation field proceed from awareness and training to implementing measures on the ground, these tools will be useful for organizations aiming to tangibly reduce vulnerability. PAHO's guideline looks at likely impacts on water systems from various hazards, including earthquakes, floods, and droughts. By including climate change as a factor in designing risk reduction, the water system could be further strengthened and the margin of safety broadened.

Preparedness and response. DRR preparedness and response tools are often used ahead of a disaster to be ready when a hazard strikes. Preparedness can mean having sufficient relief supplies and medical care, in addition to establishing coordination mechanisms between key organizations and individuals. This is the traditional realm of disaster management, which recent disasters like Hurricane Katrina have shown is extremely vital to limiting damage in the hours and days afterwards. The reconstruction and recovery period is the most opportune time to incorporate risk reduction. Political will and public awareness are high and often additional resources are available. However, there is great pressure to get homes assembled and infrastructure systems running very quickly so there can be a return to normalcy, with the result that DRR does not often take place during recovery. If risk reduction is not incorporated at this time, it's likely that vulnerabilities will merely be rebuilt rather than reduced.

Aside from large catastrophes, the damage from small- and medium-scale recurrent disasters is often devastating and flies under the radar of the international community. These impacts are likely to accumulate, with the result that a vicious cycle ensues in which successive disasters erode the community's resilience and more losses are suffered with each event. Preparedness and response are essential for communities facing such hazards.

Preparedness and response tools may include guidelines for needs assessments and recovery planning, standards for humanitarian relief, and checklists for preparedness. The International Federation of the Red Cross and Red Crescent Societies (IFRC) developed a self-assessment to support national organizations in analyzing their policies and plans, organizational structure, and capacities to respond to a disaster. One area for improvement for these tools would be to ensure that communities are prepared not only for disasters they have faced in the past but also new hazards that may accompany climate change. Climate change and DRR organizations could look beyond the usual severity of hazards and their usual areas of impact to jointly consider new risks and the preparedness mechanisms necessary to address them.

IFRC's *Guidelines for Emergency Assessment* is designed for generalists and based on decades of experience following emergencies. Another tool developed by ECLAC, on the other hand, targets specialists for socio-economic impact assessment. It aims to provide insight into how disasters impact society directly and indirectly on a longer time horizon. The capacities necessary for adapting to climate change could be included in such an assessment, including factors like livelihoods and community organization, among others. The output from these assessments should feed into reconstruction plans.

III. Conclusion

Climate change is recognized as an emerging risk that must be included in current DRR and development planning. Policy makers and practitioners working on climate change adaptation should benefit from the experiences and knowledge amassed by the DRR community in dealing with extreme weather events and recurrent hydro-meteorological hazards. Utilizing DRR tools developed for existing risks is one such

[14] Raetzo, *et al*, 2002

opportunity. The tools presented in this paper are only a small selection of those used by the DRR community. New risks and the aggravation of existing risks posed by climate change need to be more comprehensively addressed in DRR tools. Committed individuals and organizations working in disaster risk reduction and climate change are steadily coming together toward integrated climate risk management. This collaboration will help to give communities a broader understanding of their vulnerabilities, while at the same time expanding effectiveness by working with partners in the fields of development, environment, poverty reduction, financial planning, and health. By focusing on decreasing vulnerabilities to current weather and climate related risks communities will benefit now and be prepared for the risks posed by climate change.

Selected DRR Tools

Political commitment and institutional aspects

Title	**South Pacific Applied Geoscience Commission (SOPAC)'s** ***Comprehensive Hazard and Risk Management (CHARM)***
Description	CHARM is defined as a comprehensive hazard and risk management tool for use within an integrated national development planning process. It aims to facilitate greater collaboration between risk reduction projects at all levels (though mostly at the national level with participation from stakeholders for decision-making) and across sectors to enhance sustainable development. CHARM takes all hazards into account across the whole country.
Appropriate use	This tool can be used for mainstreaming disaster risk reduction into ongoing national development planning processes. It aims to address all hazards including natural and human-induced, and also to help identify measures that can be implemented in all phases of disaster management (prevention, preparedness, response, and recovery). The emphasis is on bringing a wide range of stakeholders together for risk reduction to enhance effectivess of the combined efforts.
Scope	National level
Key output	The immediate output of the CHARM process is to develop a matrix summarizing national risks and risk reduction measures (or "treatment options") that considers the activities of all agencies. Planners then target the gaps identified in the matrix. Step 1 – Context established Step 2 – Risks identified Step 3 – Risks analyzed Step 4 – Risks evaluated Step 5 – Risks treated and results evaluated
Key input	Step 1 – Identification of national development priorities, organizational issues, and initial risk evaluation criteria Step 2 – Identification of hazard, vulnerable sectors, and impacts Step 3 – Assessment of risks with stakeholders based on agreed indicators, such as frequency of hazards, potential impacts, etc. Step 4 – Determination of acceptable levels of risks and priorities for action Step 5 – Selection of risk reduction measures; Assignment of roles and responsibilities for all partners; Evaluation against agreed criteria
Ease of use	Readily usable by those with experience in policy analysis, developing work plans, and inter-agency planning
Training required	Knowledge of tools for each step is needed (e.g. to rank development challenges, develop budgets)
Training available	Training is available through broad stakeholder consultation workshops involving both national and regional stakeholders. SOPAC has also developed a manual.
Computer requirements	Word processing and spreadsheets
Documentation	SOPAC, 2001. *Comprehensive Hazard Risk Management Regional Guidelines for Pacific Island Countries*. Suva: South Pacific Applied Geosciences Commission. Guideline and manual available in print or on CD (see Contacts below)

Applications	CHARM has been used for planning in Palau, Kiribati, Vanuatu, Fiji, and Tonga, and it has also been aligned to the Joint Australia-New Zealand Risk Management Standard
Contacts for framework, documentation, technical assistance	SOPAC Secretariat Private Mail Bag, GPO Suva, Fiji Islands Tel: +679 338 1377 Fax: +679 337 0040 Atu Kaloumaira, Community Risk Programme Advisor Email: atu@sopac.org Noud Leenders, Community Risk Management Advisor Email: noud@sopac.org
Cost	Free
References	see Documentation

Risk Identification and Early Warning

Title	**Asian Disaster Preparedness Center (ADPC)'s Community-Based Disaster Risk Management Field Practitioners' Handbook**
Description	The handbook briefly explains the concept of community-based disaster risk management (CBDRM) and provides practical tools that can be applied in community-level programming. The Handbook is divided into four parts: 1) an introduction to CBDRM; 2) specific step-by-step exercises; 3) cross-cutting issues of gender and communication; and 4) disaster risks in Southeast Asia The tools in Section 2 cover seven types of activities in CBDRM: 1. Selecting the community 2. Rapport building and understanding the community 3. Participatory disaster risk assessment 4. Participatory disaster risk management planning 5. Building/training a community disaster risk management organization (CDRMO) 6. Community-managed implementation 7. Participatory monitoring and evaluation The resource pack for risk identification (Step 3) includes instructions and guiding questions for the most commonly used participatory assessment tools, e.g. constructing timelines, hazard maps, rankings, and calendars.
Appropriate use	This handbook is a comprehensive how-to guide that can be used to assist project teams working at the local level to ensure the participation of community members in reducing disaster risks. Each of the seven steps, particularly Step 3, is clearly outlined, along with simple instructions for group exercises, information to gather, and stakeholders to involve.
Scope	Community level
Key output	Overall: *"The CBDRM process should lead to progressive improvements in public safety and community disaster resilience. It should contribute to equitable and sustainable community development in the long term."* Step 1 – Priority vulnerable communities identified Step 2 – Trust between community and project members; understanding of community needs among project members Step 3 – Disaster risks identified and community members understand these risks Step 4 – Community disaster risk management plan Step 5 – CDRMO established and equipped with skills to implement their disaster risk management plan Step 6 – Planned activities implemented effectively and on time, with participation of stakeholders Step 7 – Appropriate indicators of program success developed and progress measured, with participation of stakeholders
Key input	Step 1 – Information on various criteria developed by decision makers Step 2 – Information about the community and efforts to develop relationships/understanding with community members Step 3 – Range of qualitative and quantitative data about the hazards, vulnerabilities, and capacities in the community Step 4 – Dialogue among stakeholders to identify needed measures Step 5 – Identification of CDRMO members and training

	Step 6 – Responsibilities carried out by members; periodic reviews Step 7 – Range of qualitative and quantitative data about activities' impacts; dialogue between stakeholders
Ease of use	Readily usable
Training required	Some training or experience in working at the local level would be useful
Training available	Contact Zubair Murshed at mzubair@adpc.net or adpc@adpc.net
Computer requirements	• none for community risk identification exercises • word processing and spreadsheet skills for program planning and implementation, depending on complexity of local activities • GIS optional for community disaster risk assessment (Step 3)
Documentation	Imelda Abarquez and Zubair Murshed, 2004. *Community-Based Disaster Risk Management: Field practictioners' handbook*, Bangkok: Asian Disaster Preparedness Center. Can be downloaded from http://www.adpc.net/pdr-sea/publications/12Handbk.pdf
Applications	This methodology has been used in several communities throughout South and Southeast Asia.
Contacts for framework, documentation, technical assistance	Information Manager, PDR SEA Asian Disaster Preparedness Center (ADPC) P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand. Tel.: (66-2) 516-5900 to 5910, Fax: (66-2) 524-5360, Email: adpc@adpc.net, Website: www.adpc.net
Cost	Free
References	Arcilla, M. J. D., Delica, Z. G. et al (Eds), 4B: *Project Development, Monitoring and Evaluation in Disaster Situations, 1998*: Quezon City, Philippines, Citizen's Disaster Response Center. Gutteling and Wiegman, 1996, *Exploring Risk Communication: Advances in natural and technological hazards research*, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Title	**World Meteorological Organization's *Guidelines on Climate Watches***
Description	The guidelines describe how to establish a climate watch system and the information required in a climate watch. Governments typically react to extreme climate events through "crisis management" rather than through continuous risk reduction. Decision makers have cited the lack of information about approaching climate hazards with sufficient notice to take action. Climate watches aim to deliver this necessary, accurate information to end-users through the national meteorological services (NMSs) in a timely and useful manner.
Appropriate use	This tool targets "the special situation and needs of smaller NMSs, which have limited resources" in establishing the system and issuing climate watches. The process is based on continuous collaboration with climate information users, and it should serve as a mechanism to initiate preparedness activities to limit impacts from climate anomalies (e.g. excessive rainfall over several months). The guideline discusses the rationale for a climate watch system, current activities and capacity in NMSs, characteristics and operation of a climate watch system, format and criteria for issuing a climate watch, and various annexes, including examples of climate watches. Climate watch format: • a standard heading, issuing authority, and time and date of issue • areas for which the advice is current (the appropriate regions) • period during which the climate watch is valid • where appropriate, an indication of the reason for the climate watch, which may include graphical information • relevant skill of long range forecasts • possible follow-on effects of the climate anomaly • date at which the next update will be issued
Scope	National level; meteorological services
Key output	Information about significant climate anomalies for the forthcoming season(s) that may have substantial impacts on a sub-national scale. A. Establishment of national climate watch system B. Capacity built for the climate watch system C. Operation of national climate watch D. Climate watch system evaluated
Key input	A. A network of observation stations; an understanding of the current and recent past climate of the region in question; linkage with regional/global monitoring systems; dissemination channels to reach users; partnerships with key stakeholders B. Understanding of users' needs; criteria for issuing a Climate Watch defined (e.g. average rainfalls below a certain level for the season); technical training; strengthening of communication links C. Monitoring and analysis of climate data; communication with other organizations that maintain their observation systems; communication with intermediaries to translate information for user groups D. Periodic reviews of the system and process; dialogue with users on their needs to identify gaps in dissemination or content E.

Ease of use	Usable by national meteorological services
Training required	Requires expertise in meteorology/climatology and understanding of climate information users' needs
Training available	(see Contacts)
Computer requirements	Software for forecasting; word processing
Documentation	WMO, 2005. *Guidelines on Climate Watches*, Geneva: World Meteorological Organization. http://www.wmo.ch/web/wcp/wcdmp/html/Guidelines%20on%20Climate%20Watches.pdf
Applications	
Contacts for framework, documentation, technical assistance	Omar Baddour, Chief, World Climate Data and Monitoring Programme WMO, 7bis Ave. de la Paix C.P. 2300, CH-1211, Geneva 2, Switzerland Tel: (41-22) 730-8268 or 730-8214 Fax: (41-22) 730-8042 E-mail: obaddour@wmo.ch
Cost	Free
References	(See references and links in document) Technical documents published under the WMO World Climate Data and Monitoring Programme (WCDMP) http://www.wmo.ch/web/wcp/wcdmp/html/wcdmpreplist.html

Knowledge Management and Education

Title	**EMA's *The Good Practice Guide: Community awareness and education in emergency management***
Description	During the emergency period, a well-prepared community can reduce the impacts from the disaster. Community members often play a large role in providing relief for each other. This tool presents best practices, ideas, plans, and suggestions for educating the community on disaster preparedness, rather than a how-to guide on communications. The broad framework can be easily adapted for specific communities. The guide provides the following information: 1. Introduction to the issue and how to get people's attention 2. Planning a campaign, with information on a range of communication tactics 3. Evaluating a campaign 4. Working with the media, partners and sponsors, and the community 5. Information resources
Appropriate use	The guide aims to assist in planning and implementing community awareness and education campaigns. It is aimed at local government authorities, health services, police, fire services, schools, and other community organizations. It lays out the basic steps of an awareness campaign, describes communication tactics (e.g. print/electronic communications, give-aways, special events, etc.), and outlines a method for evaluating the campaign's performance.
Scope	Local level
Key output	Step 1 – Target audience identified Step 2 – Target audience's needs and wants identified Step 3 – Key message developed Step 4 – Measurable objectives identified Step 5 – Tactics chosen Step 6 – Required resources secured Step 7 – Awareness and education campaign implemented Step 8 – Awareness and education campaign evaluated and documented results available
Key input	Step 1 – Information on vulnerable groups and potential partners in reaching them Step 2 – Discussions with community representatives and members; Review of existing sources of information (newspapers, radio, etc.) Step 3 – Identification of hazards and priority messages Step 4 – Development of campaign objectives and concrete indicators to measure changes Step 5 – Identification of effective information sources and delivery methods for the target audience, as well as the required resources Step 6 – Partnerships developed; Information on available staff and financial resources Step 7 – Commitment of staff and volunteers; Definition of roles, responsibilities, and a timetable for activities Step 8 – Review of the campaign against indicators, e.g. through surveys, observation, or discussions
Ease of use	Readily usable

Training required	none
Training available	see Contacts below
Computer requirements	none
Documentation	EMA, 2000. *The Good Practice Guide: Community awareness and education in emergency management*, Canberra: Emergency Management Australia. http://www.crid.or.cr/digitalizacion/pdf/eng/doc12728/doc12728.htm
Applications	Based on EMA's experience in Australia, but easily adaptable to other contexts
Contacts for framework, documentation, technical assistance	Emergency Management Australia PO Box 1020 Dickson, Australian Capital Territory 2602, Australia Tel: (61-2) 6256 4600 Fax: (61-2) 6256 4653 Email: ema@ema.gov.au
Cost	Free
References	References included in document on case studies, additional methodologies, communication tips, etc. Documents on local risk management, community education, community preparedness, and related sites (mostly in Spanish): http://www.crid.or.cr/crid/MiniKitCommunityParticipation/documentos_interes_participacion_comunitaria_ing.html#capacitacion EMA publications on community evacuation coordination, flood warnings, and other response activities at: www.ema.gov.au

Risk Management Applications

Title	**Pan American Health Organization (PAHO)'s *Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis***
Description	These guidelines provide the basic tools to evaluate the vulnerability of a drinking and sewerage system to various natural hazards. These systems are vital to development, as well as to ensuring a return to normalcy following a disaster. Conducting this vulnerability analysis helps identify preparedness and mitigation measures to limit risks. It also identifies the response mechanisms that should be put into action in the event of a disaster. The risk of damage to water systems increases with factors such as uncontrolled growth in urban areas, deficiencies in infrastructure, and climate change. The guide is divided into four sections: • Planning • Principles of vulnerability analysis • Description of hazards and impacts • Conducting a vulnerability analysis for specific hazards
Appropriate use	The tool is ideally used during the disaster preparedness phase to identify and implement mitigation measures. It is aimed at engineers and technical personnel of water service companies to project how the water systems will perform in the event of the disaster and to minimize damage. Vulnerability and probabilities of damage are expressed as various formulae. The guide provides an overview for each section with issues to consider at each step. It also includes checklists (e.g. Characteristics of an emergency operations center and the emergency committee; Components of an emergency response plan), matrices to describe system vulnerabilities (formats provided in annexes), and extensive information on impacts on water systems from earthquakes, volcanoes, hurricanes, floods, etc. in Chapter 3 and annexes.
Scope	Water systems (with coverage being sub-national, municipal, etc.)
Key output	• Planning – Emergency committee established within the water company, with roles and responsibilities defined; Emergency operations center established; Partnerships with national organizations established. • Vulnerability analysis – Identification and quantification of deficiencies in the physical system and the organization's capacity to provide services in a disaster; Strengths of the physical system and the organization identified; Recommendations for mitigating disaster impacts. • Mitigation and emergency response plans for *administration/operational* aspects – Identification of roles and responsibilities, resources required, and measures to reduce vulnerability. Measures may include: improvements in communication systems, provision of auxiliary generators, frequent line inspections, detection of slow landslides, repair of leaks, and planning for emergency response. • Mitigation and emergency response plans for *physical* aspects – Identification of roles and responsibilities, resources required, and measures to reduce vulnerability. Measures may include: retrofitting,

	substitution, repair, placement of redundant equipment, improved access, etc.
Key input	• Planning – Information on: national standards, institutional coordination, and resources available for preparedness and response; and dialogue with partners • Vulnerability analysis – Information on: organizational and legal aspects, availability of resources, hazards and likely impacts on the water system, current state of system and operating requirements, sensitivity of components to hazards, and the response capacity of the services. • Mitigation and emergency response plans – Information from the vulnerability analysis, priorities for implementating measures, and resources available.
Ease of use	Can be used as an overview for the emergency committee, although the vulnerability analysis should be conducted by a team of specialists.
Training required	Vulnerability analysis requires extensive experience in the design, operation, maintenance, and repair of a drinking water and sewerage system's components.
Training available	The Virtual Campus of Public Health is a consortium of institutions led by PAHO/WHO for continuing education. http://www.campusvirtualsp.org/eng/index.html
Computer requirements	Various specialized software, word processing, and spreadsheets
Documentation	PAHO, 1998. *Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis.* Washington, DC: Pan American Health Organization, Regional Office of the World Health Organization. http://www.paho.org/English/DD/PED/natureng.htm
Applications	Used throughout Latin America and the Caribbean. Case study in documentation from Limon, Costa Rica, to assess earthquake vulnerability.
Contacts for framework, documentation, technical assistance	Emergency Preparedness and Disaster Relief Coordination Program, Pan American Health Organization 525 Twenty-third Street, N.W., Washington, D.C. 20037, USA Fax: +1 202-775-4578 E-mail: disaster@paho.org Contact lists for the Americas during a disaster: http://www.paho.org/english/DD/PED/contactos.htm
Cost	Free
References	Bibliography available in document

Preparedness and Response

Title	**Economic Commission for Latin America and the Caribbean (ECLAC)'s *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters***
Description	One of the problems following disasters is that damaged areas are often reconstructed quickly and without adequate resources. The result is that vulnerability is reconstructed rather than reduced. This tool helps to assess the direct and indirect socio-economic impacts of disasters, and to identify the most affected areas and priority areas for recovery. It outlines the conceptual and general methodological aspects of estimating the asset damage, losses in the flows of goods and services, as well as any effects on the macroeconomy. The handbook is divided into five sections: 1. Methodological and conceptual framework 2. Assessing impacts in social sectors 3. Assessing impacts on infrastructure 4. Assessing impacts in economic sectors 5. Assessing impacts in cross-sectoral areas, such as the environment, gender, and employment
Appropriate use	This type of assessment should follow the emergency phase of a man-made or natural disaster, so it will not interfere with urgent humanitarian activities. Sufficient quantitative information on damages is also more likely to be available after that period. The tool is good for organizations that want to understand a wider range of disaster risks. By assessing the direct and longer-term indirect socio-economic impacts, organizations then have a better idea of how to reduce the risks in future programs that may have development or environmental goals. The tool can be adapted to comprehensively assess socio-economic impacts of climate change. Sections 2-5 include a definition of the sector, an overview of likely direct and indirect damages, the quantitative and qualitative information needed, possible information sources, general instructions on analyzing the data, and issues to consider in assessing macroeonomic impacts arising from damages in that sector. It is not a step-by-step guide, but rather gives an overview of general steps to be taken in each assessment.
Scope	National or sub-national level; sectoral
Key output	A measurement, summarized in table form and in monetary terms where possible, of the impacts of disasters on the society, economy and environment of the affected country or region. Results are divided into direct, indirect, and macroeconomic effects (employment, the balance of payments, public finances, and prices and inflation). The disaster may also have benefits, so the assessment refers to the *net effect*. The assessment identifies the key geographical areas and sectors affected, together with corresponding reconstruction priorities. It can provide a way to estimate the country's capacity to undertake reconstruction on its own and the extent to which financial and technical cooperation are needed. For the longer term, it may identify the public policy changes and development programs to address these needs.
Key input	Quantitative and qualitative information on conditions both before and following the disaster. The assessment team must decide on the balance between precision and speed in conducting the assessment. "Shadow prices" may be used to try to take into account the indirect effects and externalities of disasters.
Ease of use	Experience with economic valuation and assessing damage in specific sectors

	required. The use of market vs. social prices will depend on the availability of information and time to conduct the assessment.
Training required	Specialist knowledge in each sector
Training available	Instituto Latinoamericano y del Caribe de Planificación Económica y Social (ILPES), ECLAC's training division, offers courses on various economic and social issues of the region. ILPES, Av. Dag Hammarskjöld 3477, Vitacura, Casilla 179-D, Santiago, Chile Fax: (56-2) 206-6104, Tel: (56-2) 210-2506/7 Email: cursosilpes-cepal@eclac.cl
Computer requirements	Various software programs are recommended for some assessments, e.g. Redatam by CELADE (see References) or other GIS programs (ArcView, MapInfo, IDRISI, or GISMAP)
Documentation	ECLAC, 2003. *Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters*, Santiago, Chile: Economic Commission for Latin America and the Caribbean. www.proventionconsortium.org/toolkit.htm Hardcopies available at: ECLAC Publications, Casilla 179D, Santiago, Chile Email: publications@eclac.cl Fax: + 56 2-210-2069
Applications	The handbook has been used throughout Latin America and the Caribbean. Assessments following the Indian Ocean disaster also used the methodology, particularly in the cases of Indonesia and India.
Contacts for framework, documentation, technical assistance	Ricardo Zapata-Martí, Focal Point for Disaster Evaluations Economic Commission for Latin America and the Caribbean Av. Presidente Masaryk 29, 11570 México, D.F. Apartado Postal 6-718, México D.F. Telephone: +52 55-5263-9600, Fax: +52 55-5531-1151 E-mail: cepal@un.org.mx, izapata@un.org.mx
Cost	Free
References	Redatam software: http://www.eclac.cl/redatam/default.asp?idioma=IN The Handbook, sample reports, and case studies: http://siteresources.worldbank.org/INTDISMGMT/Resources/guidelines.htm

Title	**IFRC's *Guidelines for Emergency Assessment***
Description	These guidelines provide advice on the organization of emergency assessments, starting with an introduction of key concepts and then outlining each step. The steps are roughly laid out in the order required during an assessment. The chapter on fieldwork notes some basic principles that should underlie activities, such as participation, inclusion or marginal groups, looking out for biases, etc. Results of the general assessment can indicate where more technical assessment is needed. The framework can be easily adapted to incorporate climate change issues as it provides fairly general guidelines on the assessment process.
Appropriate use	Aimed at generalists in the Red Cross Red Crescent community conducting an assessment to provide an overview of the situation. The guidelines cover the following steps, some of which would overlap: • Planning • Office tasks • Fieldwork (organization and management) • Analysis • Reporting The chapter on fieldwork includes detailed descriptions of various types of information gathering exercises and issues to consider for each one, including tips on establishing trust, cultural sensitivities, suggested questions, and extensive checklists that were compiled by sector specialists. It gives very clear, easily understandable directions for carrying out activities. The chapter on analysis provides worksheets team members may use in synthesizing information. These are largely based on IFRC's vulnerability and capacity framework (see References).
Scope	Local affected areas
Key output	• Planning – Determination of whether an assessment is needed, objectives and terms of reference, and type of assessment (rapid/detailed/continual). • Office tasks – Arrangements for coordination, required resources identified, team assembled and briefed, key locations identified. • Fieldwork – Sufficient information gathered in selected locations on issues identified during planning phase. • Analysis – Identification of the main problems, affected populations, and local capacity; Recommendations for further actions. • Reporting – Clear, concise reports following a recommended format: summary; background information; details and assumptions; needs, coping strategies, and assistance; and program proposals.
Key input	The guidelines recommend that each of these steps are generally undertaken sequentially, so that the output of the planning phase is used as an input to the office-based tasks, and so on. • Planning – Information from secondary sources on the nature of the emergency and urgency of an assessment • Office tasks – Objectives and terms of reference; Information on potential team members' skills

	• Fieldwork – Secondary information, interviews with community members and authorities, group exercises, household visits, etc. • Analysis – Summaries of information that have been checked for consistency, discussion among team members. • Reporting – Results of the analysis.
Ease of use	Readily usable by anyone conducting an assessment.
Training required	None
Training available	Contact regional and country offices: http://www.ifrc.org/who/delegations.asp
Computer requirements	None, although word processing and spreadsheets may be useful for analysis and reporting.
Documentation	IFRC, 2005. *Guidelines for Emergency Assessment*. Geneva: International Federation of the Red Cross and Red Crescent Societies. http://www.proventionconsortium.org/files/tools_CRA/IFRC-guidelines-assessments-LR.pdf
Applications	Based on IFRC's experience in conducting assessments following disasters around the world.
Contacts for framework, documentation, technical assistance	International Federation of Red Cross and Red Crescent Societies PO Box 372, CH-1211 Geneva 19, Switzerland Tel: +41 22 730 4222 Fax: +41 22 733 0395 E-mail: secretariat@ifrc.org Web site: www.ifrc.org
Cost	Free
References	IFRC, 1999. *Vulnerability and capacity assessment: an International Federation guide*. Geneva: International Federation of the Red Cross and Red Crescent Societies http://www.ifrc.org/what/disasters/dp/planning/vcaguidelines.asp Sphere Project, 2003. *Humanitarian Charter and Minimum Standards in Disaster Response*. Geneva: Sphere Project. http://www.sphereproject.org/handbook/index.htm IFRC, 1999. *Code of conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organizations in Disaster Relief*. Geneva: International Federation of the Red Cross and Red Crescent Societies. http://www.ifrc.org/publicat/conduct/code.asp IFRC, 2000. *Better Programming Initiative: options for better aid programming in postconflict settings*. Geneva: International Federation of the Red Cross and Red Crescent Societies.

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PAPER NO. 4: WORLD METEOROLOGICAL ORGANIZATION

Introduction

Different climatic regimes lend themselves to different trends in hydrometeorological extremes, some of which may pose considerable risks to life, infrastructure, socio-economic development and the environment. On the other hand, windows of opportunity afforded by favorable climatic conditions need to be seized in advance to enhance socio-economic development. Positioning climate information and services as effective tools to leverage opportunities as well as risk management has therefore a major thrust in WMO programmes, aimed at contributing to the well being of its Members. WMO in collaboration with its Members are the original climate networkers constantly striving to keep pace with the scientific and technological advancements and are a natural partner in dealing with climate related issues. It has a clear future goal, of reaching the benefits of rapidly advancing knowledge on climate to each and every section of the society.

A burgeoning variety of tools and processes are being developed to improve decision-making to reduce risks and avail opportunities associated with climate variability and change. Acknowledging that a much wider array of tools and approaches to adaptation exists, WMO adaptation related tools primarily focus on the specific context of capacity building, proactive role and awareness raising to support adaptation to climate variability and change.

As many communities are not prepared to cope with climate disasters facing them today, an ongoing challenge is to build their resilience. In answer to this challenge, disaster risk reduction activities should address a comprehensive mix of factors contributing to communities' vulnerabilities. There are numerous tools and methodologies that have been developed to put this approach into practice. The value of disaster risk reduction and the experiences gained by its practitioners have been increasingly tapped by organizations active in climate change adaptation. In this context, WMO believes that the Nairobi Work Programme will facilitate identification of options for extending, improving and linking different screening tools developed by other organizations involved in adaptation, such as UNDP, OECD, the World Bank, and others and explored linkages among their tools. It is also expected that reports of these organization to the UNFCCC Secretariat will highlight some of the common problems and issues in developing and implementing adaptation tools.

In the following paragraphs, some notable activities of WMO relevant to Methods and Tools for the implementation of the Nairobi Work Programme are highlighted, with indications of the potential contributions of the WMO and the National Meteorological and Hydrological Services (NMHSs).

Methods and Tools

Climate Watches

Weather extreme events such as hurricanes, thunderstorms, tornadoes, etc. require weather watches for which most NMHSs issue early warnings and undertake special monitoring. In a similar manner, 'climate watches' deal with climatic extremes like heavy monsoons, flooding, cold waves, heat waves, droughts, etc., which require long-term monitoring with historical observations and its integration into the context of global climate patterns. By incorporating recent climate analysis as well as outlooks, climate watches serve as advisories and forewarnings of climate anomalies, therefore enable continuous and timely climate related risk assessment and management to avoid damages to life and property. The necessary mechanisms have already been put in place in some parts of the world to issue climate watches (e.g., the North American Drought Monitor, the IGAD Climate Prediction and Applications Centre (ICPAC) and the SADC

Drought Monitoring Centers in Gaborone, Botswana). WMO works with NMHSs and many institutions in the world to issue regional climate watch bulletins. Through its programs World Climate Data Management Programme (WCDMP) and Disaster Risk Reduction Programme (DRR) in collaboration with the Commission for Climatology (CCl) and NMHSs, WMO has planned for the coming four years period 2008-2011 to establish and implement climate watch systems at national levels. The main focus for these efforts is to improve preparedness and reduce socio-economic vulnerability to climate hazards in developing and least developed countries. Through Risk Reduction (DRR) Programme, other agencies are expected to be part of the implementation process of climate watches including resource mobilization, partnership for an integrated early warning system as well as the outreach of the decision makers at regional and national levels. Additional information climate watches can be found in the attached Annex.

RClimDex

There is a general consensus within the climate community that any change in the frequency or severity of extreme climate events would have profound impacts on nature and society. It is thus very important to analyze past data to find extreme events and understand future trends. The monitoring, detection and attribution of changes in climate extremes usually require daily resolution data which are observed by NMHSs. Under the supervision of WMO, 27 core indices have been defined based on daily temperature values or daily precipitation amounts to find extreme events and changing trends. Some are based on fixed thresholds that are of relevance to particular applications. WMO in cooperation with Environment Canada has developed two software packages for data homogenization (RHTest) and indices calculation (RClimDex) based on a very powerful and freely available statistical package R which runs under both Microsoft Windows and Unix/Linux. The RClimDex provides a friendly graphical user interface to compute all 27 core indices. This software will allow all interested parties to benefit from improved monitoring of change with broader spatial coverage that is currently unavailable.

Climate Information and Prediction Services Project (CLIPS)

The 12th World Meteorological Congress (1995) considered that the provision of climate information and predictions would improve economic and social decision making, and that this would support sustainable development, and established a Climate Information and Prediction Services (CLIPS) project within the World Climate Applications and Services Programme (WCASP). WCASP and CLIPS build on the rapidly developing atmospheric and oceanographic research as well as the wealth of data, experience and expertise within the NMHSs and related entities and provide a framework to deliver operational user-targeted climate services. This programme has successfully demonstrated the immense potential of the concept in several regions across the globe, and a global network of CLIPS Focal Points has been established to ensure national and regional coordination of climate products and services. Capacity building and training are integral components of WCASP/CLIPS. The CLIPS project can thus be an effective framework within which regional climate change information and the associated adaptation issues can be integrated. Development of training curricula, training workshops and regional showcase projects, which are key components of CLIPS, need substantial resource mobilization to cater to the growing needs of climate information providers as well as user sectors, particularly in the Developing Countries and the Least Developed Countries.

Regional Climate Outlook Forums (RCOFs)

Specific institutional frameworks can be established, with appropriate stakeholders taking the lead, to address relevant climate change issues at the local and sector levels. In this context, the Regional Climate Outlook Forums (RCOFs), a concept conceived and supported by WMO as part of Climate and Prediction Services (CLIPS) activities, need special mention. RCOFs constitute an important vehicle in developing countries for providing advanced information on the future climate information for the next season and beyond, and for developing a consensus product from amongst the multiple available individual predictions. RCOFs stimulate the development of climate capacity in the NMHSs and facilitate end-user liaison to generate decisions and activities that mitigate the adverse impacts of climate variability and change and help communities to build appropriate adaptation strategies. There is a great potential for the regional climate activities that currently take place under RCOFs and through CLIPS training to expand, through the actions of the WMO regional associations and the NMHSs (facilitated by the Secretariat) to expand the use of currently available tools (e.g., PRECIS, MAGIC, etc.) to more countries and to include information on climate change scenarios assembled by World Climate Research Programme (WCRP) such as climate projections created for the IPCC Fourth Assessment Report (AR4). This would enable NMHSs to contribute to their national communications to the UNFCCC and to develop or enhance their dialogue with users of climate information on climate risks and vulnerability, and would also support improved regional coordination on climate matters, standardization of tools and increased evaluation (feedback) on model outputs. This evolution from the current state (ability in some sub-regions to undertake RCOFs and develop seasonal predictions) would require technology transfer (to enhance computational capability) including hardware, software, models and data storage devices; stable Internet; ability to download data through the Internet; trained climate experts; research. WMO will continue to support the RCOFs initiatives as they contribute significantly to building capacity in the NMHSs.

The Observing system Research and Predictability Experiment (THORPEX): A Global Atmospheric Research Programme

THORPEX, a part of the WMO World Weather Research Programme (WWRP), is an international research and development programme responding to the weather related challenges of the 21st century to accelerate improvements in the accuracy of 1-day to 2- week high impact weather forecasts for the benefit of society, the economy and the environment. THORPEX research topics include: global-to-regional influences on the evolution and predictability of weather systems: global observing system design and demonstration; targeting and assimilation of observations; societal, economic and environmental benefits of improved forecasts. The programme establishes an organizational framework that addresses weather research and forecast problems whose solutions will be accelerated through international collaboration among academic institutions, operational forecast centres and users of forecast products. THORPEX contributes to the development of a future global interactive multi-model ensemble forecast system, which would generate numerical probabilistic products, available to all WMO Members including developing countries. The purpose is to provide accurate, timely, specific and definite weather warnings in a form that can be readily used in decision support tools, to improve and demonstrate such tools in order to reduce the impact of natural hazards and to realize societal and economic benefits of improved weather forecasts.

WMO Disaster Risk Reduction Programme

From 1980 to 2005, natural disasters worldwide have taken the lives of nearly two million people and produced economic losses above one trillion (or one thousand billion) US dollars. During this period, weather-, water- and climate-related hazards and conditions accounted for 89% of total number of disasters, 72% of loss of life and 75% of total economic loss. However, over the last few decades, significant developments with monitoring, detecting, analyzing, forecasting and warning of weather-, water- and climate-related hazards have led to significant opportunities for reducing impacts of related disasters. For example, over the last 25 years, there has been nearly a 4-fold increase in the number of disasters and a 5-fold increase in the associated economic losses, whereas the loss of lives has in fact decreased to nearly one-third of its previous value. This is due to several factors, a critical one being the continuous development of natural hazard monitoring and detection and of development of specific end-to-end early warning systems, such as those for tropical cyclones.

The international movement in disaster risk reduction is supported by the Hyogo Framework of Action 2005-2015, drafted and approved at the World Conference for Disaster Reduction, Kobe, Japan, January 2005, which represents a set of outcomes and results that must be achieved if disaster risk is to be reduced. The HFA describes a range of key thematic areas that need to be addressed, particularly in high-risk nations and communities. These include:

- Governance: organizational, legal and policy frameworks;
- Risk identification, assessment, monitoring and early warning;
- Knowledge management and education;
- Reducing underlying risk factors; and
- Preparedness for effective response and recovery.

Implementation of HFA is a critical contribution to development of capacities for climate adaptation and climate-related risk management. The overall framework of DRM seeks to reduce the likelihood of undesired, negative outcomes such as disasters in the course of pursuing positive goals. This involves three types of actions and activities including, risk identification, risk reduction and risk transfer.

- Risk identification involves the identification of risk levels and the risk factors that cause losses. Risk identification creates the evidence base needed to support risk reduction and risk transfer decision and activities;
- Risk reduction involves measures to prevent losses. Examples of such measures include hazard-resistant infrastructure development, land use planning and zoning, early warning systems based on sound science but targeted at mobilizing action at the local level. Other measures include educational and preparedness programmes for a wide variety of actors such as decision makers, operational emergency planning and response staff and the development of contingency plans;
- Risk transfer involves the use of financial mechanisms to share risks and transfer them among different actors (e.g., at-risk populations, government, private sector). Examples of such tools include weather derivatives, catastrophe bonds and different types of insurance.

WMO, through its Fourteenth Congress (Cg-XIV, May 2003) established a new cross-cutting Disaster Risk Management Programme, (now changed to Disaster Risk Reduction Programme after Congress Fifteenth, 07-25 May 2007) with the vision to strengthen further international and national collaboration in disaster risk management This Programme addresses capacity development of NMHSs and their partnerships in supporting disaster risk management (DRM) decisions at the national level in the complete cycle of disaster risk management including prevention and mitigation as well as emergency preparedness, response, recovery and reconstruction. With the threat of the climate change and its potential impacts on the trends and severity of natural hazards, WMO is deeply committed to ensure that the latest knowledge and capacities in climate are translated into operational products that would enable our Members to enhance their capacities in climate-related risk management.

WMO Disaster Risk Reduction Programme addresses seven priority areas, to provide systematic support to strengthen Members' NMHSs capacities for strengthened disaster risk reduction. These include:

(a) Mainstreaming technical capacities such as hydro-meteorological risk assessment and early warning systems in the national disaster risk management plans, legislations and development planning. (Adaptation Planning);

(b) Strengthening capacities for meteorological, hydrological and climate-related hazard monitoring, databases, and methodologies for hazard analysis in support of risk identification, risk reduction and risk transfer activities. (Data and Observations, Methods and Tools);

(c) Strengthening capacities for operational meteorological, hydrological and climate-related hazard early detection and warnings built upon strong governance, organizational and operational processes (Adaptation Planning and methods and Tools);

(d) Strengthening capacities for provision of meteorological services in support of pre- and post-disaster emergency response and relief operations (Methods and Tools);

(e) Facilitation of partnerships among NMHSs and other key national agencies for a more coordinated approach to disaster risk management (Adaptation Planning);

(f) Strengthening educational and training programmes of NMHSs and their key stakeholders in DRM such as authorities, emergency response operators and media (Adaptation Planning and Socio-economic Information);

(g) Development of public outreach programmes and materials (Environmental and Socio-economic Information).

Climate Modeling and Downscaling

Concerted efforts are being made by some of the NMHSs and leading international climate modeling groups, under the coordination of the WCRP, to develop Regional Climate Models so that they become capable of providing regional scale (typically 25 x 25 km, and higher resolution with appropriate computing facilities), climate information for impact studies, and to facilitate their use within the modest computational infrastructure of the developing countries. Global efforts can be spearheaded by WMO to bridge the existing gaps between developed and developing countries in their understanding of climate change impacts through capacity building and regular updates of occurrence of extreme events and associated damages. Developing countries NMHSs may be provided with appropriate tools to respond rapidly to trends and developments of regional scenarios, changing needs, emerging issues and specific challenges. In particular, the application of the regional climate models in developing countries need adequate local observational data for model evaluation, and regional expertise to diagnose and interpret the simulated regional features. In order for the regional models to become reliable tools to generate high-resolution climate scenarios, these models need comprehensive validation for specific applications, nesting within higher resolution verified global models and the developing countries need assistance from the modeling groups to incorporate user feedback in resolving the model deficiencies, which can be facilitated by the WMO and WCRP. Regional climate models provide more useful local information needed by policy makers and planners on adaptation policies and to enhance the capacity of communities to cope with the future. Since fine resolution climate change information for use in impact studies can also be obtained via sophisticated statistical downscaling methods, coordinated efforts must also be undertaken to use these methods to develop and implement useful and plausible regional scale climate scenarios. These methods are computationally inexpensive with respect to regional climate models and they can be used to provide site-specific information, which can be critical for many climate change impact studies. Consequently, a coherent strategy is needed to facilitate the transfer of expertise from developed countries and to provide access to downscaling tools in developing countries with limited or modest computational resources, since all downscaling methods are complementary.

Annex

Title	**World Meteorological Organization's *Guidelines on Climate Watches***
Description	The guidelines describe how to establish a climate watch system and the information required in a climate watch. Governments typically react to extreme climate events through "crisis management" rather than through continuous risk reduction. Decision makers have cited the lack of information about approaching climate hazards with sufficient notice to take action. Climate watches aim to deliver this necessary, accurate information to end-users through the national meteorological services (NMSs) in a timely and useful manner.
Appropriate use	This tool targets "the special situation and needs of smaller NMSs, which have limited resources" in establishing the system and issuing climate watches. The process is based on continuous collaboration with climate information users, and it should serve as a mechanism to initiate preparedness activities to limit impacts from climate anomalies (e.g. excessive rainfall over several months). The guideline discusses the rationale for a climate watch system, current activities and capacity in NMSs, characteristics and operation of a climate watch system, format and criteria for issuing a climate watch, and various annexes, including examples of climate watches. Climate watch format: • A standard heading, issuing authority, and time and date of issue • Areas for which the advice is current (the appropriate regions) • Period during which the climate watch is valid • Where appropriate, an indication of the reason for the climate watch, which may include graphical information • Relevant skill of long range forecasts • Possible follow-on effects of the climate anomaly • Date at which the next update will be issued
Scope	National level; meteorological services
Key output	Information about significant climate anomalies for the forthcoming season(s) that may have substantial impacts on a sub-national scale. A. Establishment of national climate watch system B. Capacity built for the climate watch system C. Operation of national climate watch D. Climate watch system evaluated
Key input	A. A network of observation stations; an understanding of the current and recent past climate of the region in question; linkage with regional/global monitoring systems; dissemination channels to reach users; partnerships with key stakeholders B. Understanding of users' needs; criteria for issuing a Climate Watch defined (e.g. average rainfalls below a certain level for the season); technical training; strengthening of communication links C. Monitoring and analysis of climate data; communication with other organizations that maintain their observation systems;

	communication with intermediaries to translate information for user groups D. Periodic reviews of the system and process; dialogue with users on their needs to identify gaps in dissemination or content
Ease of use	Usable by National Meteorological Services
Training required	Requires expertise in meteorology/climatology and understanding of climate information users' needs
Training available	(see Contacts)
Computer requirements	Software for forecasting; word processing
Documentation	WMO, 2005. *Guidelines on Climate Watches*, Geneva: World Meteorological Organization. http://www.wmo.ch/web/wcp/wcdmp/html/Guidelines%20on%20Climate%20Watches.pdf
Applications	
Contacts for framework, documentation, technical assistance	Omar Baddour Chief, World Climate Data and Monitoring Programme WMO, 7bis Ave. de la Paix C.P. 2300, CH-1211, Geneva 2, Switzerland Tel: (41-22) 730-8268 or 730-8214 Fax: (41-22) 730-8042 E-mail: obaddour@wmo.ch
Cost	Free
References	(See references and links in document) Technical documents published under the WMO World Climate Data and Monitoring Programme (WCDMP) http://www.wmo.ch/web/wcp/wcdmp/html/wcdmpreplist.html

PAPER NO. 5: SECRETARIAT OF THE PACIFIC REGIONAL ENVIRONMENT PROGRAMME

SPREP submission on Nairobi Work Programme

The Secretariat of the Pacific Regional Environment Programme (SPREP) welcomes this opportunity to provide information in relation to adaptation activities in the Pacific Islands region. We also note that Pacific Island Member States of SPREP have already provided collective views in the context of a submission by the Alliance of Small Island States (AOSIS) with which SPREP is in agreement. SPREP is a regional organisation established by the governments and administrations of the Pacific region to look after its environment. It has grown from a small programme attached to the South Pacific Commission (SPC) in the 1980s into the Pacific region's major intergovernmental organisation charged with protecting and managing the environment and natural resources. It is based in Apia, Samoa, with over 70 staff. SPREP's mandate is to promote cooperation in the Pacific islands region and to provide assistance in order to protect and improve the environment and to ensure sustainable development for present and future generations.

(a) Existing and emerging assessment methodologies and tools.

Adaptation to climate change has been a major preoccupation for SIDS in the Pacific region for many years. All Pacific SIDS have carried out their first national communications to the UNFCCC and a number have carried out other in-depth studies related to adaptation. Most Pacific SIDS identified numerous adaptation activities that should be implemented in the near to medium term. Most of these proposed activities have strong community based components, as the majority of the activities fall within the following sectors: coastal zone management, water resources management, food security and human health – all of which are directly linked to the communities, their well-being, livelihoods and prospects for sustainable development.

The assessments carried out in the context of the first national communications followed models using simple simulations, allowing participants to make predictions on climate change impacts on vulnerable areas. Vulnerability assessments highlighted the key sectors mentioned above, but also looked at coral reefs, agriculture and biodiversity. Some examples of the findings of these assessments included a decline in fruit crops production and low export sales due to drought and low rainfall in previous years, and loss of agricultural land due to intrusion of seawater through flooding, inundation, and coastal erosion especially in the atoll islands.

There were however some limitations to the models, and other modalities were attempted in some Pacific SIDS, such as integrated risk reduction approaches, through the use of Climate Change Adaptation through Integrated Risk Reduction framework and methodology, to demonstrate a risk-based approach to adaptation and to mainstreaming adaptation. A number of case studies were carried out to demonstrate why reducing climate-related risks should be an integral part of sustainable development and practical means of how to do this. Climate-related risks are already high for island communities, as well as for basic infrastructure. Risks are likely to increase considerably under current climate change scenarios, as well as under observed climate variability and extreme events. Studies have shown that for some infrastructure projects, it is possible to avoid most of the costs attributable to climate change, and to do so in a cost-effective manner. Climate proofing undertaken at the design stage of the project is one approach to achieve this. However, it is also notable that the costs involved with this approach should still be considered as eligible activities for funding under the various adaptation funds.

(b) Opportunities, gaps, needs, constraints, and barriers.

The lessons learned from the various projects and programs in the Pacific can be summed up as follows: in the past most studies of adaptation options for Pacific SIDS have largely focused on adjustments to sea-level rise and storm surges associated with tropical cyclones. There was an early emphasis on protecting land through 'hard' shore-protection measures rather than on "soft measures" or on other options such as accommodating sea-level rise or retreating from it, although the latter has become increasingly important on continental coasts. However, later vulnerability studies conducted for selected small islands show that the costs of overall infrastructure and settlement protection is a significant proportion of GDP, and well beyond the financial means of most small island states. More recent studies since the IPCC TAR have identified major areas of adaptation, including water resources and watershed management, reef conservation, agricultural and forest management, conservation of biodiversity, energy security, increased share of renewable energy in the energy supply, and optimized energy consumption. The emphasis has thus become more broad-based and looks at climate change impacts from a more comprehensive perspective.

From a systemic perspective these lessons direct Pacific SIDS and their communities, within their means and with international technical and financial support, to:

· increase the ability of islands' physical infrastructure to withstand the impacts of climate change. For example, building and zoning codes that seek to climate-proof infrastructure;

· increase the flexibility of potentially vulnerable systems that are managed by Governments or communities, through adjustments in management practices, such as changes in use or location;

· enhance the adaptability of vulnerable natural systems, by reducing stresses due to non-climatic effects, such as pollution impacts on coral reefs, and improving overall resource management practices;

· reverse trends that increase vulnerability by reducing human activity in vulnerable areas, preserving natural systems that protect against hazards, such as preventing sand mining, and ensure that the incidence of "scoring own goals" is reduced;

· improve public awareness and preparedness by informing the public about risks and possible consequences of climate change, setting up early-warning and monitoring systems for extreme weather events, and by developing overall communications strategies that make climate change science accessible to the average citizen.

But that is perhaps where some of the biggest gaps exist. The lessons learned present major challenges for Pacific SIDS to address. Since proposed adaptation strategies have focused on reducing vulnerability and increasing resilience of systems and sectors to climate variability and extremes through mainstreaming adaptation, there is a need to ensure appropriate participatory modalities for these strategies. The early projects carried out in the context of the first national communications allowed for in-depth community participation, mainly due to the fact that only small site-specific examples could be studied under the limited funding available. For a broader nation-wide adaptation strategy to follow similar patterns would require some adjustments for many Pacific SIDS Governments and would certainly require technical and financial assistance. Consultative practices vary greatly throughout the regions, and have deep political-cultural roots. Particularly for the archipelagic and multi-island jurisdictions there are practical issues impeding conducting such in-depth consultations with all their communities. The costs of transportation and lodging and the possible need for outside expertise makes the development of a national adaptation strategy quite a daunting and expensive task if it is to be done comprehensively.

That being said, many Pacific SIDS are developing national sustainable development strategies (NSDS) or their equivalent. Those processes would provide opportunities to also include adaptation to climate change as part of the overall sustainable development strategy. Additional financing would need to be made available through international assistance, as this would entail additional costs to that allocated for the NSDS.

In addition to work on adaptation in the region, serious gaps exist in the scientific and meteorological work that the region requires in addressing climate variability and predicting extreme events, and which are of direct relevance to planning and implementing adaptation.

In response to interest from the regions, WMO embarked on work to assist SIDS in all regions to access the GCOS network. In the Pacific PI-GCOS has been in existence since 2002 with a steering committee forming its Action Plan and Implementation Plan.

Under the latter, a list of 31 projects were identified (with initial indicative budgets) to meet needs in areas ranging from research and policy development, to technical capacity building in observation networks and enhancement of operational early warning systems.

Its main achievements to date have been the enhancement of the capacity in nine Pacific SIDS in seasonal climate prediction, the rescue and management of historical climate data and improvement of access to data, as well as a marked improvement in the maintenance and increased output from GCOS identified GUAN and GSN stations in the Pacific. These achievements have been undertaken also in ways that have built local capacities in consideration also of the need for sustainability and appropriateness of these works.

It is a major contributor thus to cooperation and partnership for climate change work particularly in taking stock of, and supporting, the technical and scientific level needs for climate information and applications. At its formative meetings in 2000-3 the then PI-GCOS Steering Committee[1] decided to prepare project proposals with concrete and achievable targets, and with full budgets. These include pilot projects assessing the impacts of climate variability and change on ocean and island ecosystems, expansion and enhancement of climate prediction, along with operational training programmes to incorporate some of the new knowledge gained from this research within national climate centers of Pacific SIDS. Unfortunately, the large majority of the most key projects identified have not received funding and this remains a major barrier for work in the region.

The Implementation Plan reaffirms that PI-GCOS is intended to be a long term, user driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system. Its nesting within the climate change programme of SPREP ensures that the gaps in scientific knowledge and information in this area are addressed and that it provides and builds linkages across to other areas of efforts in climate change.

(c) Possible ways to develop and better disseminate methods and tools.

The development of adaptation methods and tools has been an ongoing effort in most Pacific SIDS, but has until recently not been recognized as such, especially not in the context of climate change adaptation. Island communities have adapted to changing circumstances and have developed traditional means of

[1] Then known as the Pacific Islands Regional GCOS Implementation Team (PIRGIT) now known simply as the PI-GCOS Steering Committee (SC).

coping in past generations. However, those adaptations have occurred within often-manageable timeframes, and the scope and pace of climate change reinforces the need for more rapid development of tools and options for communities, given the urgency of action on climate change adaptation.

SPREP recognizes the work done by the Expert Group on Technology Transfer on adaptation technology. However, it is also clear that a broader package of training and capacity building, as well as research on local level modification of technologies is needed. That would allow practitioners in different sectors in Pacific SIDS to use technologies to plan for and implement adaptation in their communities.

In this regard, SPREP is interested in the proposal from AOSIS, and which was echoed during the Dialogue on Long-term Cooperative action to address climate change in Bonn in May 2007, that an Adaptation Experts Group, similar in mandate and structure to the EGTT, be set up within the FCCC process.

A special report from the IPCC on the climate change implications for SIDS was also proposed in that Dialogue Meeting, and should also be considered as an option for pursuing other ways and means of steering the development of adaptation methods, tools and technologies.

Pacific SIDS have on numerous occasions called for the establishment of more targeted cooperation and technical advice from the UN system, not only for climate change but for sustainable development in general. The rapid growth of information and communications technologies is dramatically changing socio-economic and political structures of most nations. One of the main constraints of Pacific SIDS in particular is the lack to access to this Information and Communications Technology (ICT). There is a strong recognition that proper deployment of ICT must be one of the priorities for sustainable human development. Therefore Pacific SIDS through AOSIS welcomed the establishment in 1998 of SIDSnet which has provided an important basis for further action in its First phase. Phase Two of SIDSnet was launched by the UN in 2001, but the project ran out of funding in 2006. It has remained dormant since then.

There was a very good rationale in having this dedicated network for SIDS. Not all countries were or are enjoying these opportunities in ICT. Very few people in Pacific SIDS can take advantage of them. Many elements contribute to the constraint of both the use and the growth of ICT in these countries. These constraints include limitations of bandwidth, minimal access to computers and computer peripherals, not enough telephone lines, lack of technical and managerial expertise and too little private sector involvement. There is a need to strengthen local capacity to gain beneficial use of Internet, related information technologies and management practices. Otherwise, those countries could be marginalized in the new globalization fostered by ICT.

SPREP is raising this issue in the context of the planned workshop for SIDS on Article 6 of the Convention, where inter alia the re-structuring of Cci:net is going to be discussed. It is very likely that the participants at that meeting will call for a strengthening of the FCCC outreach to SIDS by making this network more like SIDSnet role as information gateway for SIDS, and improve information quality and quantity to facilitate activities of AOSIS and other beneficiaries such as governments, their related agencies and institutions, civil society non-governmental organizations and the private sector. Using such information gateways would greatly assist in better disseminating these tools for adaptation.

Nevertheless, there are other traditional methods that should still be utilized such as mentoring, training the trainers and specialized workshops on adaptation for climate change country team members from Pacific SIDS.

(d) Training opportunities.

Training and awareness raising are of great importance in planning adaptation, but a major gap exists through the inability of many Pacific SIDS Governments to retain personnel trained in climate change matters. Personnel trained as part of enabling activities or other projects learn valuable skills that are in short supply in the region. Certain specialist professions such as coastal zone managers or coastal engineers are mostly unavailable to Pacific SIDS Governments. This is of course a wider problem than climate change responses and relates to the overall national and regional strategies for education for sustainable development, which is the subject of on-going debate in the region.

In addition, the assessment and transfer of environmentally sound technologies for adaptation to climate change poses a complex challenge for Pacific SIDS. First, there is a lot of uncertainty regarding site-specific vulnerability and subsequently what adaptation will be required at the local level to the impacts of climate change. This uncertainty carries over to the identification of appropriate adaptation measures, options and technologies, as well as to the stakeholders that are affected. A national and local community discussion on hard technologies, which may not be appropriate, versus the importance of soft technologies needs to be encouraged. This is particularly true since there are potential synergies between mitigation and adaptation which may have either positive or negative effects. For example, the work on bio-fuels has highlighted the potential for soil conservation as an adaptation measure to be integrated into what is largely a mitigation activity.

A major opportunity for furthering the development of appropriate climate change skills in Pacific SIDS resides in the University Consortium of the Small Island States (UC-SIS). Established in the context of the Mauritius International Meeting on SIDS in 2005, the consortium brings together 5 regional and national SIDS universities and builds on their relative strengths to offer enhanced educational opportunities for SIDS. The FCCC should consider liasing with the UC-SIS for the purpose of identifying training opportunities.

Furthermore, in 2005 the Pacific Islands Forum Leaders endorsed the Pacific Regional Framework for Action on Climate Change, which established a series of priorities on climate change for the region. These priorities include:

1. Implementing adaptation measures

2. Contributing to mitigation of GHG emissions

3. Improving our understanding of climate change

4. Education and awareness

5. Improving decision making and good governance

6. Partnership and cooperation

Under each of these priorities it is envisaged that project activities will be undertaken by PICs nationally and regionally, supported by the relevant regional organizations. In addition it should be noted that the in order to ensure appropriate coordination of activities under the Framework, a Pacific Climate Change Roundtable (PCCR) should be established. Since responsibility for the Framework’s regional and international actions can and should be shared by the region’s organisations, SPREP has been called upon to convene regular meetings the PCCR inclusive of all regional and international organizations with active programmes on climate change in the Pacific region to:

- help update the Pacific SIDS on regional and international actions undertaken in support of the Framework;
- voluntarily lead or collaborate in implementing and monitoring actions relevant to their priorities and work programmes; and

- agree on mechanisms for measuring progress, identifying difficulties, and addressing actions needing special attention.

The PCCR should meet at least once a year, and should also afford the Pacific SIDS the opportunity to prepare for the annual meetings of the Conference of the Parties to the UNFCCC. This would afford the region significant opportunities for training and awareness raising, and for sharing information on best practices and new and emerging adaptation methods, tools and technologies.

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