

**Compendium on methods and
tools to evaluate impacts of, and
vulnerability and adaptation to,
climate change**

UNFCCC Secretariat

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1. Introduction

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are obligated by the Convention and various decisions of the Conference of the Parties (COP) to assess their national-level impacts of climate change and their efforts to adapt to these impacts as inputs for their national communications. Parties need to select from a daunting array of potentially applicable methods and tools for making these assessments, and from various sources of information concerning their use. New methods and tools are constantly being developed and the application of those that are already in use is steadily being refined. There is therefore a need for a centralized source of information that can be maintained and regularly updated.

In 1999, the UNFCCC Secretariat took a first step towards disseminating information on methods and tools when it produced a report entitled *Compendium of Decision Tools to Evaluate Strategies for Adaptation to Climate Change*. Since then, the adaptation assessment process has changed considerably and in some ways grown more sophisticated. The UNFCCC Secretariat has subsequently updated the original compendium and broadened its scope. An updated compendium entitled *Compendium of methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change* was launched in 2004.

The current revision of the compendium was undertaken as part of the Nairobi work programme on impacts, vulnerability and adaptation to climate change. Among its activities the work programme seeks to:

- Promote the 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
- Promote the development and dissemination of methods and tools for assessment and improvement of adaptation planning, measures and actions, and integration with sustainable development.

The revision draws on information provided by Parties and organizations 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. The submissions and a synthesis report can be found on the UNFCCC website (<http://unfccc.int/3922.php>).

The challenge of continuously updating is not only to expand the structure of the compendium to include new tools that have come into use and to modify it to include tools applicable to the entire process of vulnerability and adaptation assessment (not simply decision making), but also to reorganize it so as to capture the range of thinking reflected in the different recent approaches to the assessment process.

The earlier work (sometimes referred to as the first generation) in climate change impacts and adaptation studies focused more on impacts than on adaptation. The motivation for the research was often driven by the need to understand how great the impacts of climate change might be to know how much urgency to give to the mitigation agenda or the stabilization of greenhouse gas concentrations in the atmosphere. This work was facilitated by a number of “guidance documents,” among which the most prominent were:

- ▶ SCOPE Report on impact Assessments (Kates et al., 1985)
- ▶ Intergovernmental Panel on Climate Change (IPCC) Guidelines (Carter et al., 1994; see Chapter 2 of this document)
- ▶ U.S. Country Studies Program (Benioff et al., 1996; see Chapter 2 of this document)
- ▶ United Nations Environment Programme (UNEP) Handbook (Feenstra et. al., 1988).

The first generation studies were generally based on climate scenarios derived from general circulation models (GCMs). The chosen scenarios were commonly applied to models of ecosystems, to specific species within an ecosystem, or to a component of the biogeophysical environment such as sea level; coastal zones, including coral reefs; the hydrological cycle; mountains; deserts; or small islands. These “first order” impacts were sometimes carried forward to the modeling of “second order” impacts on economic sectors such as agriculture, forestry, water resource management, human health, and so forth. Only at the end of a long research process was adaptation considered, and only infrequently were socioeconomic scenarios developed alongside the climate scenarios.

More recently there has been an upsurge in interest and concern about adaptation linked to current climate variability and current vulnerability in addition to the concern with future climate and vulnerability. The context has also been broadened to include other environmental and social stressors, and changes in socioeconomic conditions and sustainable development.

This change in emphasis has led to the development of a second generation of studies that begin with current climate variability and current adaptation (or the lack of adaptation or maladaptation). This empirical approach provides a grounding in reality on which to base projections of future impacts, vulnerability, and adaptation. New methods, frameworks, and guidelines are being developed to facilitate second order studies, including:

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- ▶ The United Nations Development Programme (UNDP) Adaptation Policy Framework (Burton et al., 2004; see Chapter 2 of this document)
 - ▶ The National Adaptation Programmes of Action (NAPA) Guidelines (UNFCCC, 2002; see Chapter 2 of this document)
 - ▶ The Assessments of Impacts and Adaptations to Climate Change (AIACC) projects (see Chapter 2 of this document).

Much of the work under way includes a blend of first and second-generation approaches and tools, and the research approaches are evolving rapidly, as is to be expected in a relatively new area of research and study. The more recent emphasis on current climate variability, and current vulnerability and adaptation, has been associated with more sophisticated approaches to socioeconomic scenarios, to stakeholder participation, to adaptation policies and measures, and to the assessment and strengthening of adaptation capacity. These changes are reflected in the content and structure of this updated version of the compendium, making it more relevant to today's needs. This is not the end of the road, however. As understanding of climate change impacts expands and as social and economic circumstances change, there will be a continued need for new approaches and new research tools and methods. Users of this compendium are thus challenged to go past the role of passive users and to make their own contributions to the improvement of methods and tools.

1.1 Focus and Scope of the Compendium

This updated compendium is organized in a way that allows existing adaptation analysis and decision frameworks and tools to be catalogued in manner that is clear and easy to use and does not prescribe or recommend methods or tools. Whereas the original compendium for the most part organized discrete adaptation decision tools according to sectors of application, echoing the sectoral model based approach to vulnerability and adaptation assessment of the time, the organization of this revised compendium reflects the expanded scope and comprehensiveness of methods currently in use.

Thus, the revised compendium attempts to reflect the current state of knowledge by collecting and summarizing three broad categories of frameworks, methods, and tools. First, it reviews some of the complete frameworks (both what are previously referred to as first generation approaches and second generation approaches), those methods that prescribe an entire process for the assessment of vulnerability and adaptation and in some instances assemble toolkits to support this process. These frameworks offer a broad strategic approach.

Second, the compendium establishes a structure for cataloging tools that assist in addressing key cross-cutting themes or whose application spans multiple steps of the assessment process, as well

as discrete tools that are applicable to multiple sectors. These are not comprehensive frameworks, nor are they tools applicable only to a specific sector and step of an assessment framework. Some constitute partial frameworks or particular research orientations that prescribe an approach to undertaking an assessment (e.g., stakeholder analysis) and can be applied at various stages of the assessment. Others are tools that are applicable to more than one sector or tend to address a particular stage of an assessment (e.g., GCM downscaling, socioeconomic scenario building, decision making).

Third, as the first version of the compendium did, this revised version organizes discrete tools specific to particular sectors. Much of the content of the original compendium has been conserved here. We have significantly updated the agriculture sector to reflect the development and use of new methods and tools.

The compendium is intended for use by either assessment managers or technical researchers; it does not require extensive technical knowledge of modeling or specific decision-making techniques. Some of the frameworks and tools described in the compendium may require particular expertise, and these requirements are explicitly described.

The compendium provides users with key information about available frameworks and tools, special features of each framework or tool, and information about how to obtain documentation, training, or publications supporting each tool. It has been designed to be used as a reference document to identify available frameworks and tools for assessing vulnerability and adaptation. This is not a manual describing how to implement each tool, but rather a survey of possible tools that can be applied to a broad spectrum of situations and a map to point users to additional sources of information.

Each framework or tool is described in a summary table that summarizes its key features. With these tables as a reference, users can decide which frameworks and tools they want to use and then can obtain further documentation for the listed contact to fully evaluate each option. Each tool has been summarized to identify its potential applications. Looking at the resources available and the individual needs of the project, the user can identify which tools may be most appropriate to analyze the adaptation options they are considering.

The compendium is not a “cookbook.” It does not provide full documentation for frameworks, models, or other tools. Users will need to obtain this information from the providers. Furthermore, users should carefully consider the alternative frameworks and tools discussed in the compendium. The appropriateness and usefulness of each may vary depending on users’ circumstances and information needs. Options for analysis should be carefully investigated and considered.

Tables include relevant topics from the following list:

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- ▶ **Description.** Explains the type of framework or tool being presented (e.g., spreadsheet, process-based model) and what type of information this tool helps the user to evaluate (e.g., monetary costs, human health risks). This area also provides a basic summary of how the tool works, including the type of data required and the processes used to evaluate these data.
 - ▶ **Appropriate use.** Describes where the framework or tool is (and is not) applicable. This gives the user an idea of the stage at which it is appropriate to use.
 - ▶ **Scope.** Covers the fields in which the framework or tool is applicable, including geographic (i.e., whether it is specific to a particular region) and assessment characteristics (e.g., national or site-specific).
 - ▶ **Key output.** Describes the final product of the framework or tool (e.g., a model, a cost-effectiveness evaluation, an organizing framework).
 - ▶ **Key input.** Explains the information or data required to use the framework or tool.
 - ▶ **Key tools.** For frameworks, describes discrete tools that would play an important role in implementing a complete framework.
 - ▶ **Ease of use.** Describes the level of difficulty associated with implementing the framework or tool.
 - ▶ **Training required.** Describes the level of expertise and any specific skills required to use the framework or tool effectively.
 - ▶ **Training available.** Describes the training available to learn how to use the framework or tool effectively.
 - ▶ **Computer requirements.** Describes the computer hardware and software necessary to use the framework or tool.
 - ▶ **Documentation.** Provides the citations for sources describing in detail how to use the framework or tool. Generally this is a user's manual or similar document.
 - ▶ **Applications.** Briefly describes actual cases and projects where the framework or tool has been applied.
 - ▶ **Contacts for framework/tools, documentation, technical assistance.** Provides information on who to contact for further information, documentation, and technical assistance. Generally the agency or firm that developed the framework or tool, or, for

several of the tools applicable to multiple sectors, someone who can provide a reference to an expert for a particular application.

- ▶ **Cost.** Provides the monetary cost of obtaining documentation or software for the framework or tool. Where applicable, gives information on the approximate cost of implementing the framework or tool. Where the exact cost is unavailable, relative cost is used (e.g., high, medium, or low relative to other described).
- ▶ **References.** Lists the citations for documents, articles, etc., that have critically discussed use of the framework or tool.

Finally, this compendium is part of an ongoing process and should be considered a living document. As the frameworks and tools it describes are used and field tested, they will be steadily improved and their application refined. Furthermore, the compendium is in no way intended to provide a comprehensive listing of approaches, cross-cutting issues, or sectors or of the potential frameworks and tools that might be characterized as such. Rather, the hope is to set up a structure that will accommodate the addition of other tools and frameworks currently in use as well as new approaches that will be developed in the future.

Notes on using the compendium

Summary tables in the compendium provide an overview of the framework or tool in question. They are designed to assist the user in identifying methods and techniques to investigate further. The main function is to direct users how to obtain more information, not to instruct the user on how to apply any particular framework or tool.

Many of the frameworks and tools overlap with one another. They should not be thought of as representing discrete points on a continuum, embodying either-or choices. Users may find that more than one framework or tool might be suited to their goals. It may be that users might benefit from combining elements of different methods or techniques that are profiled here.

The compendium is intended to be a living document. It reflects the state of knowledge at the time it was compiled. Additionally, it provides a structure that should allow it to grow to incorporate new frameworks and tools.

1.2 Organization of the Compendium

Chapters 2, 3, and 4 of the compendium contain the summary tables that describe each framework or tool. Table 1.1 summarizes their organization and lists the frameworks and tools described in the compendium.

Table 1.1. Organization of frameworks and tools in the compendium

Chapter 2: Complete Frameworks and Supporting Toolkits

IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations
U.S. Country Studies Program (USCSP)
UNDP Adaptation Policy Framework (APF)
Assessments of Impacts and Adaptations to Climate Change in Multiple Regions and Sectors (AIACC)
Guidelines for the Preparation of National Adaptation Programmes of Action (NAPA)
United Kingdom Climate Impacts Programme (UKCIP) Climate Adaptation: Risk, Uncertainty and Decision Making

Chapter 3: Cross-Cutting Issues and Multisector Approaches

3.1 Development and Application of Scenarios

3.1.1 General tools

IPCC-TGCIA Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment
The Climate Impacts LINK Project
NCEP Global Ocean Data Assimilation System (GODAS)
RClimDex
SimCLIM
UKCIP02 Climate Change Scenarios
Climate Information and Prediction Services (CLIPS) Project and Regional Climate Outlook Forums (RCOFs)

3.1.2 Climate downscaling techniques

Statistical Downscaling
Statistical DownScaling Model (SDSM)
Dynamical Downscaling
MAGICC/SCENGEN
Weather Generators
COSMIC2 (COuntry Specific Model for Intertemporal Climate Vers. 2)
PRECIS (Providing REgional Climates for Impacts Studies)

Table 1.1. Organization of frameworks and tools in the compendium (cont.)

3.1.3 Socioeconomic scenarios

Developing Socioeconomic Scenarios: For Use in Vulnerability and Adaptation Assessments
Adoption of Existing Socioeconomic Scenarios
Qualitative and Quantitative Scenarios Emphasizing Stakeholder Input
UKCIP Socio-Economic Scenarios

3.2 Decision Tools

Policy Exercise
Benefit-Cost Analysis
Cost-Effectiveness
Multicriteria Analysis (MCA)
Tool for Environmental Assessment and Management (TEAM)
Adaptation Decision Matrix (ADM)
Screening of Adaptation Options
Climate-Related Risks Estimate as Indicators of Necessity for Adaptation Responses
Costing the Impacts of Climate Change in the UK
Identifying Adaptation Options
UKCIP Adaptation Wizard
Adaptation Actions
Business Area Climate Impacts Assessment Tool (BACLIAT)
Nottingham Declaration Action Pack (NDAP)
Community-based Risk Screening Tool – Adaptation & Livelihoods (CRiSTAL)

3.3 Stakeholder Approaches

Stakeholder Networks and Institutions
Scoping
Vulnerability Indices
Agent Based Social Simulation
Livelihood Sensitivity Exercise
Multistakeholder Processes
Global Sustainability Scenarios
MPPACC (Model of Private Proactive Adaptation to Climate Change)

3.4 Other Multisector Tools

Climatic Change and Variability (CCAV)
Expert Judgment

Table 1.1. Organization of frameworks and tools in the compendium (cont.)

Historical or Geographic Analogs: Forecasting by Analogy
Uncertainty and Risk Analysis
Estimating Adaptation Costs: M-CACES
Impacts Database
PAGE2002 (Policy Analysis for the Greenhouse Effect)
Resource Approach to Assessment of Climate Change Impact on Human Activity
Comprehensive Hazard and Risk Management (CHARM)
Community-Based Disaster Risk Management Field Practitioners' Handbook
Guidelines for Emergency Assessment
Guidelines on Climate Watches
Natural Disaster Mitigation in Drinking Water and Sewerage Systems: Guidelines for Vulnerability Analysis
Handbook for Estimating the Socio-Economic and Environmental Effects of Disasters
The Good Practice Guide: Community Awareness and Education in Emergency Management

Chapter 4: Sector-Specific Tools

4.1 Agriculture Sector Tools

APSIM (Agricultural Production Systems sIMulator)
WOFOST
ACRU (Agricultural Catchments Research Unit)
Process Soil and Crop Models: CENTURY
ORYZA 2000
Information and Decision Support System for Climate Change Studies in South East South America (IDSS-SESA Climate Change)
Decision Support Systems Linking Agro-Climatic Indices with GCM-Originated Climate Change Scenarios
Model of Agricultural Adaptation to Climatic Variation (MAACV)
Relative Risk Index (RRI)
Government Support in Agriculture for Losses due to Climatic Variability
AgroMetShell
Agroclimatic Water Stress Mapping
Local Climate Estimator (New_LocClim)
FAOclim 2.0
CLIMWAT 2.0
CM Box

Table 1.1. Organization of frameworks and tools in the compendium (cont.)

	CLOUD (Climate Outlooks and Agent-based Simulation of Adaptation in Africa)
	CRAM (Canadian Regional Agriculture Model)
	Process Crop Models: Decision Support System for Agrotechnology Transfer (DSSAT) developed under the International Consortium for Agricultural Systems Applications (ICASA)
	Process Crop Models: General-Purpose Atmospheric Plant Soil Simulator (GAPS 3.1)
	Process Crop Models: Erosion Productivity Impact Calculator (EPIC)
	Irrigation Model: CROPWAT
	Irrigation Model: AquaCrop
	Process Crop Models: Alfalfa 1.4
	Process Crop Models: AFRC-Wheat
	Process Crop Models: RICEMOD
	Process Crop Models: GOSSYM/COMAX
	Process Crop Models: GLYCIM
	Economic Models: Econometric (Ricardian-based) Models
	Economic Models: Input-Output Modeling (with IMPLAN)
4.2	Water Sector Tools
	WaterWare
	Water Evaluation and Planning System (WEAP)
	RiverWare
	Interactive River and Aquifer Simulation (IRAS)
	Aquarius
	RIBASIM
	MIKE BASIN
	Spatial Tools for River Basins and Environment and Analysis of Management Options (STREAM)
	CALVIN (CALifornia Value Integrated Network)
	OSWRM (Okanagan Sustainable Water Resources Model)
	European Flood Alert System (EFAS)
4.3	Coastal Resources Tools
	Inter-governmental Panel on Climate Change (IPCC) Common Methodology (CM)
	UNEP Handbook Methodology
	Bruun Rule
	SURVAS
	DIVA and DINAS-COAST

Table 1.1. Organization of frameworks and tools in the compendium (cont.)

	CoastClim of Simulator of Climate Change Risks and Adaptation Initiatives (SimClim)
	Community Vulnerability Assessment Tool (CVAT)
	Decision Support Models: COSMO (Coastal Zone Simulation Model)
	The South Pacific Island Methodology (SPIM)
	Shoreline Management Planning (SMP)
	RamCo and ISLAND MODEL
	ReefResilience Toolkit
	Smartline
4.4	Human Health Sector Tools
	MIASMA (Modeling Framework for the Health Impact Assessment of Man-Induced Atmospheric Changes)
	Environmental Burden of Disease Assessment
	CIMSiM and DENSiM (Dengue Simulation Model)
	UNFCCC Guidelines: Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change
	LymSiM
	Mapping Malaria Risk in Africa (MARA) Low-end Information Tool (LITe)
4.5	Terrestrial Vegetation Sector Tools
	LPJ (Lund-Postdam-Jena Model)
	IBIS (Integrated BIOSphere Simulator)
	Medrush Vegetation Model
	CENTURY
	MC1
	IMAGE (Integrated Model to Assess the Greenhouse Effect)
	AEZ (Agro-ecological Zones) Methodology
	CASA (Carnegie-Ames-Stanford Approach) Model
	TEM (Terrestrial Ecosystem Model)

1.3 Definitions

Methodology /ay /approach: A complete framework that prescribes an entire process for the assessment of vulnerability and adaptation and offers a broad strategic approach. An approach in some instances assembles certain methods and toolkits to support this process. Examples include: IPCC Technical guidelines (1994), NAPAs guidelines (2002), Adaptation Policy Framework (2004).

Method. A set or sequence of steps that should be followed in order to accomplish a specific task within a larger framework. Method can be implemented through using a number of tools. Examples include: Methods for development and use of scenario data in the vulnerability and adaptation assessment, e.g. those presented in the UNEP Handbook (1998) and IPCC-TGCIAGuidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment (1999).

Tool. A means or instrument by which a specific task is accomplished. Examples include: RCMs, impact models, decision tools (cost-benefit analysis, MCA, TEAM, ADM, etc), stakeholder tools (vulnerability indexes, Livelihood Sensitivity Exercise, etc.).

References

Benioff, R., S. Guill, and J. Lee (eds.). 1996. *Vulnerability and Adaptation Assessments: An International Guidebook*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Lim, B. and E. Spanger-Siegfried (eds.). 2004. *Adaptation Policy Framework (APF) for Climate Change: Developing Strategies, Policies and Measures*. United Nations Development Programme, New York. Available at http://ncsp.undp.org/report_detail.cfm?Projectid=151

Carter, T.R., M. L. Parry, H. Harasawa, and S. Nishioka (eds.). 1994. *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations*. Department of Geography, University College, London.

Feenstra, J., I. Burton, J. B. Smith, and R. Tol (eds.) 1998. *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. Institute for Environmental Studies, Free University, Amsterdam.

Kates, R. W., J. Ausubel, and M. Berberian (eds.). 1985. *Climate Impact Assessment. Studies of the Interaction of Climate and Society. Scientific Committee on Problems of the Environment. SCOPE Report No. 27*. John Wiley and Sons, Chichester, United Kingdom.

UNITAR. 2003. *Developing Human and Institutional Capacity to Address Climate Change Issues in LDCs: Preparing for NAPAs*. United Nations Institute for Training and Research. Available at <http://www.unitar.org/ccp/LDCreport.pdf>.