IEA Training Manual
An integrated environmental assessment and reporting training manual

VIA Module
Vulnerability and Climate Change Impact Assessments for Adaptation

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Definition of Key Terms

Adaptation includes initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected stresses, including *climate change* effects. Various types of adaptation exist, for example, anticipatory and reactive, *private* and *public*, and *autonomous* and *planned*. Examples include: raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

Adaptive capacity refers to the whole of capabilities, resources and institutions of a country or *region* to implement effective *adaptation* measures.

An assessment is the entire social process for undertaking a critical objective evaluation and analysis of data and information designed to meet user needs, and to support decision-making. It applies the judgment of experts to existing knowledge to provide scientifically credible answers to policy-relevant questions, quantifying, where possible, the level of confidence.

Climate change refers to a change in the state of the *climate* that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or *external forcings*, or to persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*. Note that the *United Nations Framework Convention on Climate Change (UNFCCC)*, in Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the *climate* on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (*internal variability*), or to variations in natural or *anthropogenic external forcing* (*external variability*).

Development path or pathway is an evolution based on an array of technological, economic, social, institutional, cultural and biophysical characteristics that determine the interactions between natural and *human systems*, including production and consumption patterns in all countries, over time at a particular scale. *Alternative development paths* refer to different possible trajectories of development, the continuation of current trends being just one of the many paths.

Ecosystem is a dynamic complex of plant, animal and micro-organism communities and their non-living environment, interacting as a functional unit.

Ecosystems-based adaptation refers to the management, conservation and restoration of ecosystems creating a valuable yet under-utilized approach for climate change adaptation, complementing other actions such as the development of infrastructure

Ecosystem services include the benefits people obtain from ecosystems (sometimes called ecosystem goods and services). These include provisioning services, such as food and water, regulating services, such as flood and disease control, cultural services, such as spiritual, recreational and cultural benefits, and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

The **Intergovernmental Panel on Climate Change** (**IPCC**) is a scientific intergovernmental body focused on evaluating the risk of climate change caused by human activity. The panel was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), two United Nations organizations. The IPCC shared the 2007 Nobel Peace Prize with former Vice President of the United States Al Gore.

Kyoto Protocol to the *United Nations Framework Convention on Climate Change (UNFCCC)* was adopted in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in *Annex B* of the Protocol (most Organization for Economic Cooperation and Development countries and countries with *economies in transition*) agreed to reduce their *anthropogenic greenhouse gas* emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) by at least 5 per cent below 1990 levels in the 2008 to 2012 commitment period. The Kyoto Protocol entered into force on February 16, 2005.

Mainstreaming refers to the integration of adaptation objectives, strategies, policies, measures or operations such that they become part of the national and regional development policies, processes and budgets at all levels and stages.

Maladaptation refers to any changes in natural or *human systems* that inadvertently increase *vulnerability* to climatic *stimuli*; an *adaptation* that does not succeed in reducing vulnerability but increases it instead.

Mitigation refers to a technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to *climate change*, mitigation means implementing policies to reduce *greenhouse gas* emissions and enhance *sinks.*

Precautionary principle is a management concept stating that in cases where there are threats of serious or irreversible damage, lack of full scientific certainly shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Resilience refers to the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization and the capacity to adapt to stress and change. In the context of ecosystems, resilience refers to the level of disturbance that an ecosystem can undergo without crossing a threshold into a different structure or with different outputs. Resilience depends on ecological dynamics as well as human organizational and institutional capacity to understand, manage and respond to these dynamics.

Scenario is a description of how the future may unfold based on "if-then" propositions, typically consisting of a representation of an initial situation, a description of the key drivers and changes that lead to a particular future state. For example, "given that we are on holiday at the coast, if it is 30 degrees tomorrow, we will go to the beach".

Uncertainty implies anything from confidence just short of certainty to informed guesses or speculations; it is important to recognize that even good data and thoughtful analysis may be insufficient to dispel some aspects of uncertainty associated with the different standards of evidence and degrees of risk aversion/acceptance that individuals participating in this debate may hold. (WMO/TD No.1418, p.33)

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

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

Sources: IEA Training Manual Module no 1, IPCC, 2007; Halle et al., 2009, UN/ISDR 2004, UNDP 2006, UNEP 2007.

List of Acronyms

CCE – Climate Change Explorer
CIAT – International Center for Tropical Agriculture
DPSIR – Drivers Pressures State Impact Responses
ECCO – Environment and Climate Change Outlook
EEA – The European Environmental Agency
EIA – Environmental Impact Assessment
GEO – Global Environmental Outlook
GCM – Global Circulation Model
GPS – Global Positioning System
GHG – Greenhouse Gas
IEA – Integrated Environmental Assessment
IED – The Institute of Economic Development
IIED – International Institute for Environment and Development
IISD – International Institute for Sustainable Development
IPCC – The Intergovernmental Panel on Climate Change
LDC – Least Developed Country
NAPA – National Adaptation Programs of Action
PRSP – Poverty Reduction Strategy
RCM – Regional Climate Models
SRES – Special Report on Emission Scenarios
UN/ISDR – United Nations International Strategy for Disaster Reduction
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
UNITAR – United Nations Institute For Training and Research
UNFCCC – United Nations Framework Convention on Climate Change

Overview

Impacts of climate change pose very serious risks for countries, vital ecosystems, and sectors including agriculture, forestry, health, local economic activities and biodiversity. In conjunction with other pressures, they could also exacerbate other serious local and regional challenges, such as poverty, poor healthcare, inequitable distribution of resources, diminishing ecological resiliency and energy insecurity. This module will help you identify impacts of changing climate and developing adaptive responses. It aims to help carry out a vulnerability and impact assessment based on an ecosystem analysis and suggest sectoral adaptation options that are relevant to the decision-makers. The adaptation options could be developed into practical implementation plans at the sub-ministerial level. The module builds on the IEA conceptual framework and analytic methods by providing guidance for their application to the case of climate change while preserving the integrated approach.

Supported by examples and exercises, the module describes the process for addressing climate change in the context of other development priorities and ecosystems to help decision-makers' move towards more sustainable development pathways and ecosystem resilience. In this module, we emphasize that, when developing responses to climate change, the following key principles need to be taken into account (Bizikova, *et al.*, in press):

- **First**, since maintaining healthy and resilient ecosystems, achieving development priorities and improving the quality of life are as important as adaptation to climate change; it is the combination of promoting conservation and restoration of ecosystems, development choices, adaptation actions and capacities that will allow us to effectively address the climate change.
- **Second,** understanding the linkages between the impacts of a changing climate and their implications at the local level is more complex than is captured in spatial, regional and global climate models. Participation of local partners is necessary to facilitate integration of climate impact information with local development knowledge to create pathways that promote resilience and adaptation to climate change.
- **Third**, understanding adaptation as part of ecosystem management and development requires balancing the focus of the biophysical risks associated with climate change with specific risks and opportunities in order to address issues such as ecosystem and human well-being, capacity and long-term development.

This module outlines key approaches to help in assessing vulnerability to climate change in the context of other non-climatic issues and stresses such as environmental change and consumption levels, and their integration with other drivers and pressures. In this way, they make use of the general DPSIR framework. The DPSIR framework also helps in mainstreaming responses to climate change with other development measures.

This module is structured according to the following logic:
Overview of the course materials
Introduction and Learning Objectives
Relevance
Characteristics of vulnerability and scope of the assessment
Defining vulnerability
Specifying vulnerability to climate change
Vulnerability assessment and the DPSIR framework
Monitoring vulnerability
Impacts of climate change and their assessment
Creating responses - determining the adaptation options
Mainstreaming climate change into development decisions
Developing Adaptation responses
Prioritizing the adaptation options

Developing a basic implementation plan and a communication strategy
Implementing adaptation responses
Communicating climate change and adaptation

Course Materials

Introduction and Learning Objectives

Climate change impacts will affect social and ecological systems in complex and broad-ranging ways as technological, economic, social and ecological changes take place across regions, groups and sectors. Many of these impacts, such as impacts on ecological systems, have cascading effects on social, economic and health outcomes. In order to respond to climate change, more vigorous actions are required to mitigate emissions of greenhouse gases (GHGs) and to adapt to unavoidable consequences that are increasing vulnerability around the world.

This module has been specifically developed to include adaptation issues into the Integrated Environment Assessment (IEA) process. The IEA process is part of a mandate requiring that countries regularly monitor their State of the Environment. Traditionally, these have been developed in national, sub-regional and Global Environment Outlooks (please refer to Module 1 of the IEA training manual for more background). This module provides training on how to include vulnerability, climate change and adaptation in the IEA process.[1] When focusing on impacts of climate change and developing adaptation responses, we can either be broad or focus on target-specific themes such as agriculture, water resource management and coastal development. During the process of developing responses to climate change, there are several IEA modules that are not discussed in detail here, but have obvious relevance for this module, including the IEA process (Module 2), impact strategy (Module 3), data and indicators (Module 4), assessing environmental trends, policies and impacts (Module 5), scenarios (Module 6) and evaluation (Module 8).

The DPSIR framework underlines the IEA process. It is explained in detail in Module 5 and refers to Drivers (D), Pressures (P), State and trends (S), Impacts (I) and Responses (R). For this module, a "current" DPSIR will be developed in which the responses (R) will focus only on capacities to cope or to adapt (vulnerability assessment). A future DPSI will be developed (Impact assessment) in which the R will focus only on needed capacities. These will then be analyzed along side proposed Responses in the form of adaptation options. It is suggested that the assessments are ecosystem-based and the adaptation options are sectoral-based in an attempt to make science policy relevant.

This module places local sustainability, its development challenges and local vulnerabilities in the context of climate changes at regional and global levels in order to understand their linkages. It is well recognized that a response strategy to climate change is an additional and new area of sustainable community development, that in addition to many other local priorities like reducing poverty, improving sanitation and safe access to fresh water, health issues and diminishing ecological resiliency.

Accordingly, there is a need to explore linkages between climate change and development priorities and identifying those overarching sustainable development pathways that combine building resilient communities and promoting adaptation to climate change.

This module follows seven key steps:

1. Identifying characteristics of vulnerability and scope of the assessment
2. Assessing vulnerability and the DPSIR framework

[1] Specific methods of integration are listed in the Appendix.

3. Monitoring vulnerability
4. Identifying the impacts of climate change and their assessment
5. Creating responses and determining the adaptation options
6. Prioritizing the adaptation options
7. Developing a basic implementation plan and a communication strategy

In order to illustrate the concepts and methodologies introduced in the steps of this module, a number of case studies focusing on vulnerability, identification of adaptation options, prioritization and implementation are presented. To help the facilitators through the training event, we also included guidance on the key stakeholders and materials needed for the training.

Upon successful completion of this module, the user will be prepared to integrate climate change and vulnerability into IEA. Specifically, they will be able to:

- Conduct and interpret vulnerability assessments by understanding its key components of exposure, sensitivity and capacity;
- Identify impacts of future climate change and climate variability on human well-being and environment
- Identify key areas of integration, in which adaptation to climate change goes hand-in-hand with other development priorities and building resilience in natural and human systems;
- Identify and develop basic elements of an implementation plan to progress with adaptation options.

Building on the generic IEA framework, the following are key questions to be answered through integrated climate change and vulnerability assessments for adaptation at the local, regional and national context:

1. What are the key exposures and sensitivities leading to vulnerability and how effective are the applied coping strategies?
2. What are the key consequences of climate change impacts on the environment and human well-being?
3. What are the adaptation responses that could address the estimated impacts of climate change while helping build resilience in natural and human systems?
4. What are the types of policies, capacities and main steps needed to be undertaken to implementation adaptations?

Relevance

Climate change: Impacts and vulnerabilities that the Earth system faces

Climate change is a reality. It is considered the biggest environmental threat in human history and the defining human challenge for the twenty-first century (IPCC, 2007; UNDP, 2007). Consequences of climate change are already felt throughout the Earth system. The effects of climate change are observed on every continent and in all sectors. However, adaptation to these changes needs to not only respond to these impacts, but also needs to be integrated into sustainable development strategies and their implementation.

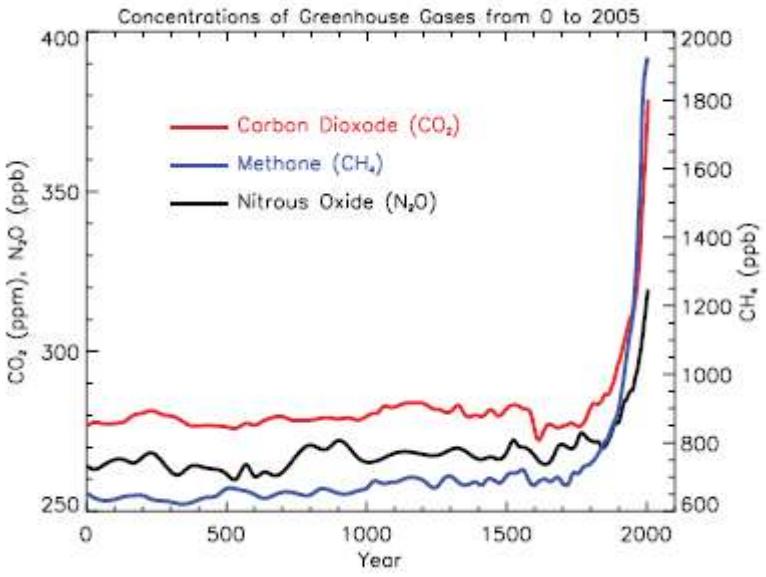
Box 1: Defining climate change

The Earth's climate is a complex system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water, and living things. The atmospheric component of the climate system most obviously characterizes climate; climate is usually defined as "average weather," described in terms of the mean and variability of temperature, precipitation and wind over a period of time, ranging from months to millions of years (the typical period is 30 years).

Projecting changes in climate systems is different from a weather forecasting and is indeed a much more manageable issue. Based on the foundation of current climate models, there is considerable confidence that climate models provide credible quantitative estimates of future climate change. However, to be able to predict changing climate, the results will not only depend on the interaction among characteristics of the climate, but also on the amount of greenhouse gasses (GHGs) released into the atmosphere. The amount of GHGs in the atmosphere is determined by released gases both from human and natural sources and by their removal through sinks, which mainly include photosynthesis in vegetation. Furthermore, the climate reacts over long periods to influences upon it; many GHGs remain in the atmosphere for thousands of years.

Source: IPCC, 2007; UNEP, 2009

Figure 1: Atmospheric concentrations of important long-lived GHGs over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the GHG per million or billion air molecules, respectively, in an atmospheric sample.

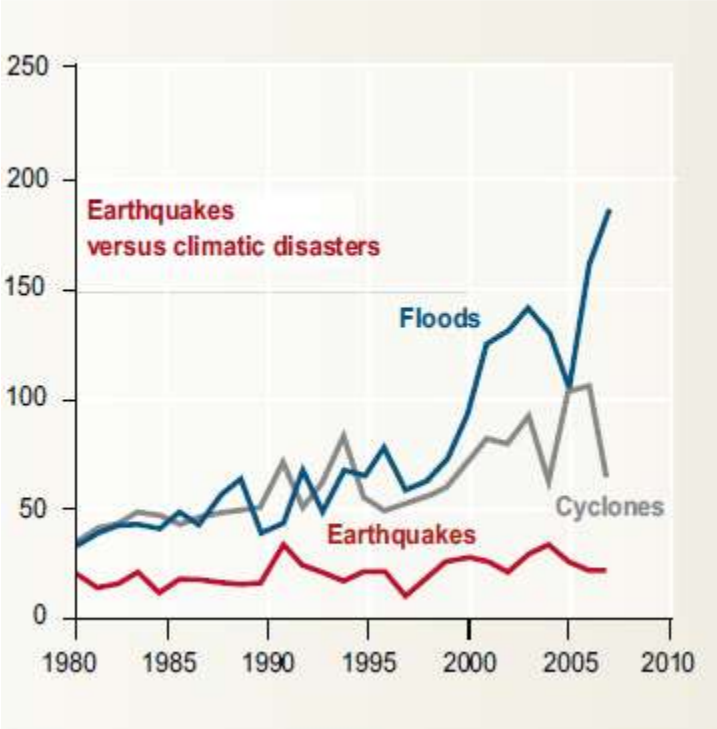


We are already committed to changes based on past emissions of GHGs into the atmosphere, and it is the future that is being decided. Some of the observed changes include (UNEP, 2009):

- Of the last 12 years (1995–2006), 11 are among the 12 warmest since records began in 1850. The temperature increase is widespread across the world but is most marked in the northern polar regions.
- Sea levels across the globe have risen in a way consistent with the warming. The total global rise in the twentieth century amounted to 17 centimetres.

- Satellite data recorded since 1978 show the annual average Arctic sea ice extent has shrunk by 2.7 per cent each decade, with larger decreases in summer. Mountain glaciers and average snow cover have declined in both hemispheres.
- From 1900 to 2005, precipitation (rain, sleet and snow) increased significantly in parts of the Americas, northern Europe and northern and central Asia resulting in floods, but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia, causing serious droughts. Furthermore, floods and cyclones have occurred more frequently in the last 30 years, while other disasters not influenced by climate (such as earthquakes) are constant over decades. However, a lack of systematic high quality observation before satellite observations makes it difficult to detect a long-term trend (Figure 2).

Figure 2. Trends in number of reported disasters



Source: UNEP, 2008

When identifying impacts of global changes, including climate change, we are concerned about changes happening at a fast pace that would make it impossible for humans and ecosystems to adapt. Although Earth's complex systems sometimes respond smoothly to changing pressures, it seems that this will prove to be the exception rather than the rule. Many subsystems of Earth react in a nonlinear, often abrupt, way, and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, then important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humans (Rockström, *et al.*, 2009).

Critical elements of climate change impacts include the possibility of sudden changes linked to thresholds or tipping points, especially for vulnerable complex systems; a tiny perturbation can qualitatively alter the state or development of a system, leading to large and widespread consequences. Examples of such changes include climate impacts, such as those arising from ice sheet disintegration and leading to large sea-level rises or changes to the carbon cycle, or those affecting natural and managed ecosystems, infrastructure and tourism in the Arctic (Schneider, *et al.*, 2007).

When we are looking into the future, a wide range of impacts attributed to climate change are projected. Even if GHG and aerosol concentrations were kept constant at 2000's levels, some anthropogenic warming and rise in sea level would continue for many centuries. Backed up by new studies and observations, the IPCC projects the following regional-scale changes (UNEP, 2009):

- most warming will happen over land and at the highest northern latitudes, and least over the Southern Ocean and parts of the North Atlantic;
- contraction of the area covered by snow will also lead to an increase in the depth at which most permafrost will thaw and to a decrease in the extent of sea ice;
- increase in the frequency of extremes of heat, heat waves and heavy precipitation; and
- a likely increase in tropical cyclone intensity.

We can reduce these impacts and minimize their consequences by mitigating emissions of GHGs and also by adapting to unavoidable consequences. There is no single solution. Adaptation should not only be seen as a reaction to the changing climate but rather as an opportunity to improve human and ecosystem well-being and build resilience. Implementing environmentally sound adaptation options should lead to measurably reduced vulnerability, improved resilience to future changes and higher potential for well-being.

1. Characteristics of Vulnerability and Scope of the Assessment

Defining vulnerability

People and communities are experiencing a number of threats, such as climate change and environmental degradation, social and economic changes. These changes do not occur in isolation and often reflect changes in the global markets that may amplify or dampen the importance of the environmental challenges. Vulnerability refers to the potential of a system to be harmed by an external stress (for instance a threat). It is defined as a function of exposure, sensitivity to impacts and the ability or lack of ability to cope or adapt. The **exposure** can be to hazards such as drought, conflict or extreme price fluctuations, and also underlying socio-economic, institutional and environmental conditions. The severity of the **impacts** not only depend on the exposure, but also on the **sensitivity** of the specific unit exposed (such as an ecosystem, a watershed, an island, a household, a village, a city or a country) and on **the capacity to cope or adapt**. The concept of vulnerability is an important extension of traditional risk analysis, which focused primarily on natural hazards (Turner et al., 2003; Schneider, *et al.*, 2007; Jäger and Kok, 2008; Leichenko and O'Brien, 2002). This concept has also undergone a shift from research-based activities to a stakeholder-driven approach that can be anchored in the past and present (vulnerability assessments) and provide responses bearing in mind potential future scenarios (impact assessments; see Box 4).

Box 2: Overview of the development of vulnerability assessments

Vulnerability assessments focused on climate change impacts and adaptation are the product of three streams of research. The first two traditions, impact assessments and risk/hazards research, generally focus on the multiple effects of a single stress. Impacts assessments would, for example, examine if building a hydropower station could impact local communities, habitat and biodiversity. Risk and hazard assessment could include potential emergency events, such as floods and earthquakes. A third type of assessments is focused on the multiple causes of a single effect; for example, food security studies generally focused on hunger or famine. Such studies see hunger as the consequence of a number of stresses and issues such as drought, political marginalization, inequality, global market changes, land degradation and other environmental stresses.

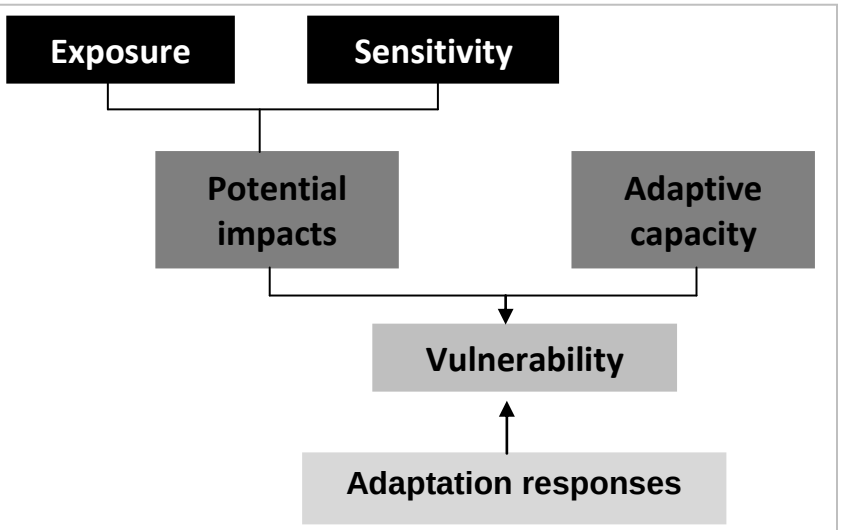
The emerging field of currently-conducted vulnerability assessments draws heavily from these three streams. Thus, the novelty is not so much the development of new conceptual domains, but the integration across these three traditions.

Source: Schroter, *et al.*, 2005 (modified)

Vulnerability to climate change

When focusing on climate change, vulnerability could be described as the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes (Figure 3). The term *vulnerability* may therefore refer to the people and communities living in a specific system, including **the vulnerable system itself** (e.g., low-lying islands or coastal cities); the **impacts to this system** (e.g., flooding of coastal cities and agricultural lands or forced migration); or the **mechanism causing these impacts** (e.g., disintegration of the West Antarctic ice sheet) (UNEP, 2009).

Figure 3: Components of vulnerability to climate change



Source: Allen Consulting, 2005 (modified)

In the context of climate change, vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed; people's *sensitivity*; and their *adaptive capacity*. Exposure could include geographical location, especially related to high exposure to risks (i.e., people living in the areas of natural disasters such as drought or coastal areas and river basins affected by floods).

Sensitivity and adaptive capacity are context-specific and vary from country to country, from community to community, among social groups and individuals, and over time in terms of its value, but also according to its nature. A population could be considered sensitive based on their overall level of social development (i.e., a population containing people sick with malaria, HIV/AIDS, areas with rain-fed agriculture, limited access to resources for migrants, widows, disabled people with higher level of poverty and food insecurity). Finally, adaptive capacity depends on access to resources that could help in responding to threats and exposures (i.e., functioning community networks, access to low-rate loans, accessible services such as health care and sanitation, irrigation systems and water storage, etc.).This includes the ability of individuals to cooperate within households, but also with neighbors and with the community leaders and their involvement in decision-making. Adaptive capacity of the communities is often depleted when they are in conflict zones, when they forced to migrate and in areas with low law enforcement.

Box 3: Examples of human health vulnerabilities in the context of climate change

Exposure	Impacts on human well-being and environment	Sensitivities, limited capacities and pressures contributing to the impacts
- More frequent geographically widespread and sustained epidemics of infectious and waterborne disease with high human mortality	- Geographically widespread changes in climate that increase the geographic area and number of disease vectors - More frequent heavy rainfall and drought events that disrupt water supply and sanitation and expose	- Severely degraded or collapsed health care system - Poor and declining immunity, nutritional and health status of large portion of population - High poverty rates that limit access to health care - Lack of disease surveillance, vector control and prevention programs - Large portion of population lose reliable access to potable water and sanitation - Land use changes, including new reservoirs that

	people to waterborne pathogens	increase habitat for disease vectors
- Emergence of new or more virulent strains of infectious disease - More frequent but geographically- and temporally-limited epidemics with high or moderate mortality - Increase in number of infectious disease cases and mortality in endemic areas and seasons	- Changes in disease and vector ecology and transmission pathways altered by changing climate - Changes in climate that moderately increase exposures by expanding endemic areas and seasons	- Land use changes that increase habitat for disease vectors - Crowding - Drug resistance - International migration, travel and trade - Water storage and sanitation practices - Poor programs for disease surveillance, vector control and disease prevention - Declining quality and increasing cost of health care
- More frequent but geographically and temporally limited epidemics that are not life threatening with no mortality	- Altered disease and vector ecology and transmission pathways - Moderate increase exposures by expanding endemic areas and seasons	- Limited access to health care - Lacking effective disease surveillance, vector control and disease prevention - Malnutrition - Limited access to potable water and sanitation

Source: Leary and Kulkarni, 2007 (selected)

Finally, there is a very strong relationship between exposure to climate impacts and adaptive capacities and overall ecosystem degradation. Specifically, climate change exacerbates ecosystem degradation (i.e., land-cover change, over-exploitation, pollution) causing substantial changes in ecosystems structure and function so they are no longer able to provide ecosystems services such as fresh water, coastal flood protection and erosion control. On the other hand, ecosystem degradation often triggers more disasters and reduces nature's and people's capacities to withstand impacts of climate change and disasters because degradation is limiting ecosystems abilities to provide buffers against floods, heavy rain and sea-level rise (UNEP, 2009).

Box 4. Exposures and sensitivities leading to vulnerability in West Africa

Throughout West Africa, agriculture is the mainstay of the economy. Over 74 per cent of the region's poor are involved in agricultural production, and exports of agricultural products are the dominant source of foreign exchange. While agriculture is the main livelihood source for most poor people, it is typically supplemented by other activities, such as seasonal and urban migration, handicrafts and small scale trading.

Of all the **exposures**, drought commonly receives the most attention. First, because the agricultural production is mostly rain-fed, it is very **sensitive** to repeated exposure to drought. This also includes **vulnerability** of population, as alternative sources of income could not cover the reduction in production so drought led to widespread famines and periods of hunger and nutritional stress. Because the poor generally rely on agriculture for a major part of their income, drought has a significant direct impacts, but by reducing access to water, it also has indirect, but significant, impacts on health of people and local ecosystems. In addition to drought, hail, lightning and tornados are pervasive threats to agricultural productivity and livelihoods throughout the region. People are better able **to cope** when they use terraces to control soil erosion and small-scale water collection systems; or in ways of diversifying their income sources, perhaps by purchasing tools for a specific job, like construction. Such investments also help reduce vulnerability and improve overall livelihood security. Finally, in terms of actual sensitivity and extent of vulnerability, substantial differences exist among the poor as a population and more differences appear when comparing farming systems, urban and rural livelihoods, gender, households or household members.

Source: Dow, 2005

We may regard vulnerable people and communities as victims of environmental degradation, volatile markets, climate change and other risks; however, it is becoming apparent that many vulnerable communities have the capacities to anticipate and cope with these risks. For example, in flood-prone areas, many communities use housing construction materials that could be easily dissembled or moved. However, if the flooding is too frequent, too severe or occurs during the major cropping seasons, and communities are less able to obtain key crops, meaning that their capacities could be exceeded and they could suffer serious consequences. These consequences are also influenced by overall ecosystems health and, very likely, in areas with degraded ecosystems they are also less able to provide a buffer for the communities against flooding. The concept of **resilience** has been used to characterize a system's ability to bounce back to a reference state after a disturbance, and the capacity of a system to maintain certain structures and functions despite disturbance. If the resilience is exceeded, collapse can occur (Gunderson and Holling, 2002; Jäger and Kok, 2008; UNEP 2009). Therefore, the focus of the vulnerability reduction efforts should be on helping to increase resilience both for people and ecosystems, instead of only reacting to actual impacts.

Defining the scope of the assessment[2]

In principle, you can carry out an IEA assessment that includes vulnerability and climate change impacts assessments for any given issue, geographic area or level of decision-making. In practice however, there usually are two choices: analysis based on jurisdictional (political) boundaries, or on non-political boundaries (e.g., ecoregion, watershed). Using either approach has advantages and disadvantages; only rarely do the two spatial boundaries coincide, as they do, for example, in small island states. In practice, assessments are often focused on a country, but even in this case, there is a need to analyze specific issues on the level of ecological units (e.g., ecosystems, watershed, airsheds), usually both in sub-national and transboundary contexts.

In a more traditional approach, the analysis is organized around environmental themes (e.g., water, air). From the perspective of policy, however, environmental problems under different themes often intersect with the same set of socio-economic processes or policies. Development of the transportation infrastructure, for instance, has implications for land cover, water quality and biodiversity. Such impacts would appear fragmented if the analysis were structured around environmental themes. So, from one point of view, analyzing environmental implications of the sector would be more practical/strategic.

However, using a sectoral approach, for example, transport, energy, agriculture, may result in fragmenting the environmental picture. Pressures on water quality, for example, may need to be addressed under agriculture, energy and municipal water supply.

Although we have presented sectoral and thematic approaches as two distinctly different alternatives in this module, there are ways to combine the two, depending on the environmental problems and information needs of your country or region. Before starting an actual assessment, your core group should have analyzed its assessment needs, and agreed on a clear set of the objectives and goals for the process.

Exercise 1:

1. What were the contexts of previous State of the Environment reporting processes in your country?
2. Having considered the contexts of previous reporting processes and the existing and environmental and climate change information needs for decision-making, what is the best context for assessment process in your country?
3. How might the new assessment process and report be designed to sufficiently address transboundary environmental issues and problems?

For further details on stakeholder involvement see IEA Module 3 and 5

[2] Source and for details see Module 5

2. Vulnerability assessments and the DPSIR framework

Please refer back to module 5 of the IEA training manual for this section

The point of departure for vulnerability assessments and interventions lies in the question ‘‘Vulnerable to what?’’ When answering this question, attention should be spent on not only trying to investigate the singular or most important cause of vulnerability, but also on identifying where and how different drivers and pressures interact and lead to vulnerability, as well as the available capacities to cope with threats. This exercise shows that processes such as epidemics or environmental changes, including climate change, are not occurring in isolation of one another, or in isolation of other drivers and pressures, including those linked to economic globalization (Leichenko and O’Brien, 2002). A community that switches to planting cash crops and whose market prices are dropping will have fewer resources to cope with severe climatic events, which could include droughts, floods or cyclones. Similarly, communities that are heavily in debt may not allocate enough resources to maintain early warning systems, regular inspections of dykes or upgrade dykes. They are more susceptible to potential impacts of climatic events than a well-prepared community. When assessing vulnerability, we should take into account that vulnerability can vary considerably between countries or regions, but even among members of the same community. Furthermore, vulnerability is a dynamic concept, and stressors on the human-environment system are constantly changing, as well as the available capacities over time.

Vulnerability assessment is very suitable for identifying areas of unsustainability and specific capacities and potential responses of the vulnerable people in the context of exposure in particular locations, but it is challenging to take into account whole system perspectives, with driving forces and pressures often operating in national or even global scale. DPSIR is a framework applied in GEO reports, including the fifth *Global Environment Outlook: Environment for Development (GEO-5),* and it seeks to connect causes (drivers and pressures) to environmental outcomes (state and impacts), including impacts of changing climate, and to activities that shape the environment (policies, responses and decisions), including both adaptation and mitigation responses to climate change. Integrating principles of vulnerability assessment with available information on current and future climate change into the DPSIR framework helps in developing adaptation responses that are relevant to other socio-economic and environmental challenges. An opportunity to better understand the impacts of environmental change on human systems even further is provided by the vulnerability approach (Kok and Jaeger, 2007; see Figure 4).

As an IEA analytical framework, DPSIR entails analysis of the following components, which could be done in three stages:

- Stage 1: Drivers, Pressure, State and Trends
- Stage 2: Impacts
- Stage 3: Responses (for vulnerability assessment, only focusing on coping and adaptive capacities)

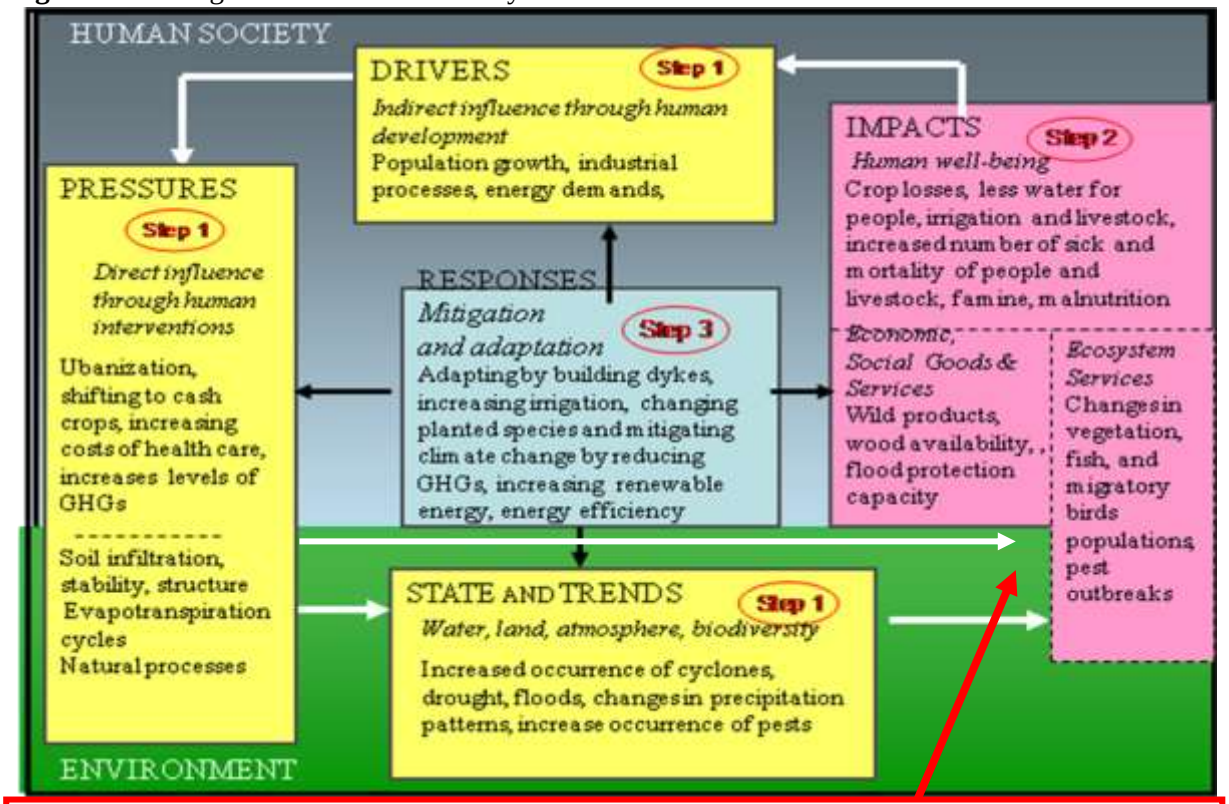
We believe that there could be different ways of analyzing environment and areas using the DPSIR framework and the climate change lens. Depending on the scale of the analyses, drivers and pressures would change. Below

are different examples of how the different elements of the DPSIR could be identified. How the DPSIR is developed depends on the scale chosen for the analysis; depending on the scale, the drivers and pressures would change.

Step 1: Drivers, Pressure, State and Trends
What is happening to the environment and why?
Step one of the DPSIR addresses the question of what is happening to the environment, why these changes are happening and the trends associated therewith (see UNEP, 2007). The following are simple climate change-related examples for the components in the first step:

- Drivers (e.g. industrial activities, farming, landfill sites, consumption patterns)
- Pressures (e.g. urbanization, changes in agricultural production, increased $C0_2$ emissions)
- State (and effects/trends) (e.g. more drought and/or flooding)

Figure 4: Linking DPSIR and vulnerability assessment



Understanding the vulnerability includes identifying to which extent the system is sensitive to identified impacts in the context of available adaptive capacities. The following questions could be used to investigate the available capacities and strategies:

- How often do the identified impacts, including disasters, hit the community? Is the incidence growing?
- Based on the trends, drivers and pressures, what are the main causes of vulnerability?
- What coping strategies exist for each identified impact? How effective are these coping strategies? What are the capacities that are lacking to address the identified impacts?
- Which organizations/institutions, if any, support existing coping strategies or promote new strategies?

Step 2: Impacts

What are the consequences for the environment and humanity?

Induced by the drivers and caused by pressures, the state of the environment (the physical, chemical or biological components of the Earth systems, biosphere, basins, etc.) impacts the normal functioning of ecosystems and the welfare of human beings. Environmental and other impacts are indeed ecosystem-specific. Box 5 shows state/changes on the hydrological regime and their impacts on human health, food security, human safety and socio-economic well-being on a global scale.

Box 5: Linkages between state changes in the water environment and environmental and human impacts

State Changes	Environmental /Ecosystem Impacts	HUMAN WELL-BEING IMPACTS			
		Human Health	Food Security	Physical Security and Safety	Socio-economic Effect
CC – disturbances to the hydrological regime on the global scale					
↑ Sea surface temperature	↔Trophic structure and food web	↓ Food safety	↔ Fishery species distribution ↓ Aquaculture production		↓ Profits (loss of product sales)
	↑ Coral bleaching		↔ Artisanal fisheries	↓ Coast protection	↓ Tourism attraction
	↑ Sea-level rise		↔ Aquaculture facilities	↑ Coastal/island flooding	↑ Damage to property, infrastructure and agriculture
	↑ Tropical storm and hurricane frequency and intensity	↑ Disruption of utility services	↑ Crop damage ↑ Aquaculture damage	↑ Drowning and flood damage ↓ Coast protection	↓ Energy production ↓ Law and order ↑ Damage to property and infrastructure
↑↓ Precipitation	↑ Flood damage	↑ Water-related diseases	↑ Crop destruction	↑ Drowning and flood damage	↑ Damage to property
	↑ Draught	↑ Malnutrition	↑ Crop reduction		
Human water use-related issues: Disturbances to the hydrological regime at basin and coastal scale					
↑ Stream flow modification		↓ Downstream drinking water ↑ Water-borne diseases	↓ Irrigated agriculture ↓ Island fish stocks ↓ Salination ↓ Floodplain cultivation	↑Flood control ↑Community displacement	Freshwater fisheries
	↑ Ecosystem fragmentation, welfare infilling and drainage		↔ Artisanal fisheries		
	↓ Sediment transport to coasts		↔ Aquaculture facilities	↑ Coastal erosion	↓ Reservoir lifecycle

Source: Jäger and Kok, 2008

Step 3: Responses—for vulnerability assessment only (defining the existing capacities)

What is being done and how effective is it?

These responses are normally measures that need to be taken to address to address the impacts. These responses need to be crafted to minimize the impact of the drivers and pressures on ecosystems and maximize the welfare of human beings. It is important to distinguish between coping and adaptation strategies. While, **coping strategies** undermine capacities of the people to respond to future threats, **adaptation actions** aim to create proactive responses that help build future **capacities**. We will focus on how to develop adaptation responses to climate change impacts in the context of other development challenges, and the need to preserve ecosystems and build capacities in the next chapters.

Exercise 2: Create groups of 3–4 persons. Based on the discussion from the previous exercise, indentify an ecosystem or an area and complete the following tasks within approximately fifteen minute, using flipchart paper to record key points. Please be prepared to discuss your key points in plenary.

1. For the selected area/ecosystems identify major current exposures and sensitivities.
2. What are the main coping strategies and capacities that people use the respond to the exposures?
3. On sticky notes, write down key drivers and pressures that also contribute to the identified exposures, sensitivities and coping responses and stick next to the impacts written on the flipchart.
4. Try to identify examples of policies and measures that help coping and maintaining capacities to respond to exposure and policies on the other hand limit capacities when responding to exposures

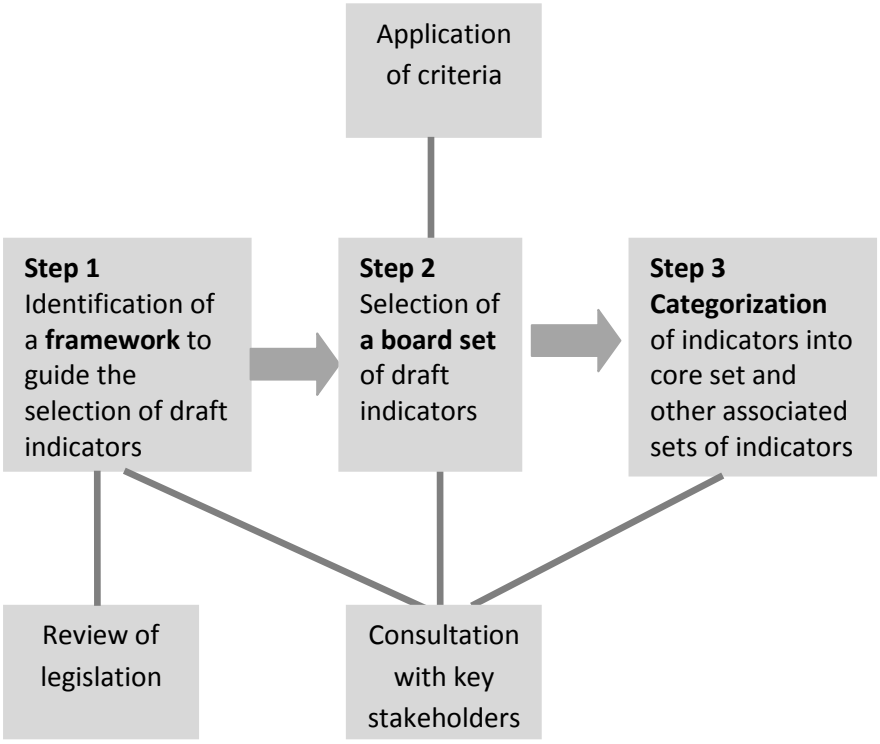
Focus: Area /Ecosystem/	
1. Current exposures	**Current sensitivities**
2. Examples of coping responses	
3. Current policies and measures that help in coping with exposures	**4. Current policies and measures that are limiting capacities to cope with exposures**

3. Monitoring vulnerability

An indicator is a single measure of a characteristic and an index is a composite measure of several indicators or indices. Indicators and indexes can be useful when guiding decision-making and prioritizing intervention, as they allow for a comparison of characteristics (Downing and Ziervogel, 2004). However, the vulnerability indicators must also account for the diverse socio-economic and environmental situation within countries, regions and processes that shape vulnerability and available capacities.

Indicator development often begins with a conceptual framework, followed by the selection of indicators based on a criteria of suitability. Indicator development is often an iterative process, where a large number of environmental, socio-economic or sustainable development issues are narrowed down in successive rounds of dialogue with stakeholders and experts to a few high-level measures. Figure 5 provides an example of the process used for indicator development in South Africa (IEA, Module 4).

Figure 5: Example of an indicator development process from South Africa (source: IEA module 4)



Vulnerability can be monitored by identifying indicators and by creating indices that could both be presented spatially and non-spatially.

Examples of indicators that could be used to assess vulnerability:

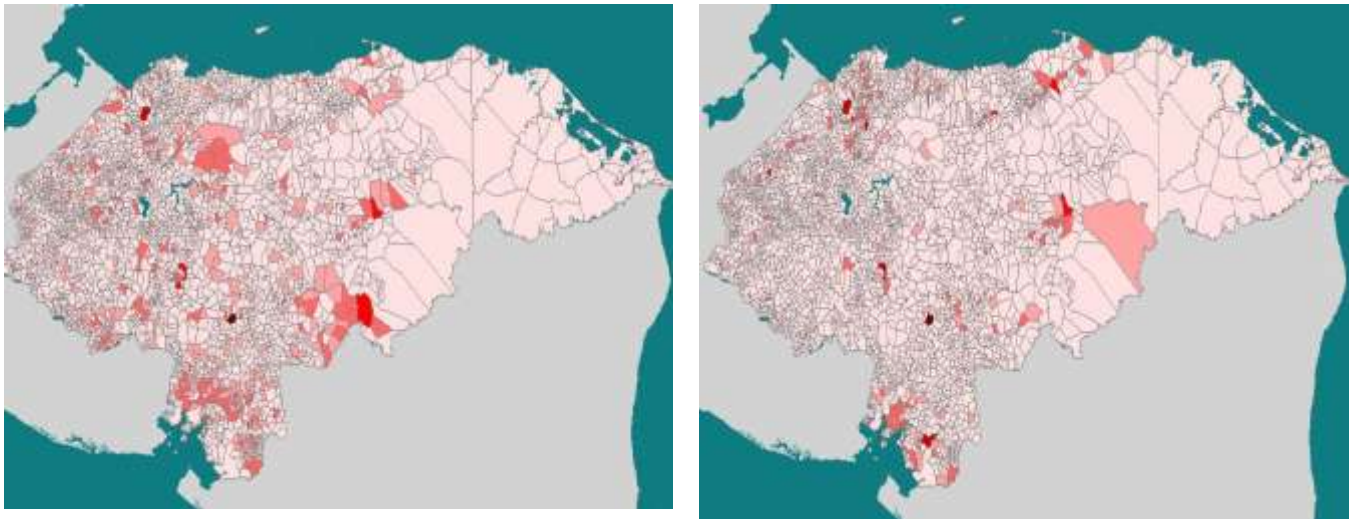
- Frequency of natural events (floods, droughts and cyclones)
- Location and intensity of wild fires
- Infrastructure (road network, coastal defense etc.)
- Land use
- Assets, land value, house value
- Household size, female-headed households
- Food sufficiency (amount of available food storage)
- Population affected by natural disasters
- Crop types, cropping systems (monocropping, multiple cropping), fertilizer consumption or input use

- Irrigation rate, irrigation source
- Percentage of households below poverty
- Level of education or literacy
- Health care delivery

Examples of indexes:

- Human development index
- Social vulnerability index
- Environmental vulnerability index
- Coastal risk index

Figure 6: Spatially represented indictors for Honduras, a population at the risk of flooding and landslides (source: Winograd, n. d.)



Optional Exercise 3: The objective of this exercise is to select and assemble a group of indicators to assist in climate change vulnerability assessments. Continue in the same groups from the previous exercise and with the identified exposure, sensitivities and coping strategies. Try to create a brief list of potential indicators (up to five indicators) that can be used to monitor changes in exposure, sensitivity and applied coping strategies in the selected area/ecosystem.

For further details on stakeholder involvement see IEA Module 4

4. Impacts of Climate change and their assessment

The climate change impact assessments are traditionally based on projected scenarios of future climate change and presented as changes in temperature, precipitation, rise in sea level and others. Using available information and data, it is possible to analyze the changes and trends in climate parameters. When analyzing the impacts of climate change, it is important to go beyond the direct impacts and economic consequences of climate change, and consider the role of ecosystem services and the social dimension of climate change impacts. For example, changes in precipitation and temperature could impact the environment by changing species distribution and phenology, changes in water availability including both floods and droughts, contributing to soil degradation and forest fires. These impacts could further lead to mentioned economic impacts (i.e., deterioration of infrastructure, changes that include lost revenues in agricultural and timber production, industrial processes and employment), impacts on ecosystem services (i.e., availability of freshwater, fuel and food; flood and disease protection and cultural values) and social impacts (diseases, mortality, reduced labour productivity, conflicts over resources, migration and changes in social networks; Environment DG, 2008).

Table 1: Examples of major projected impacts on selected sectors

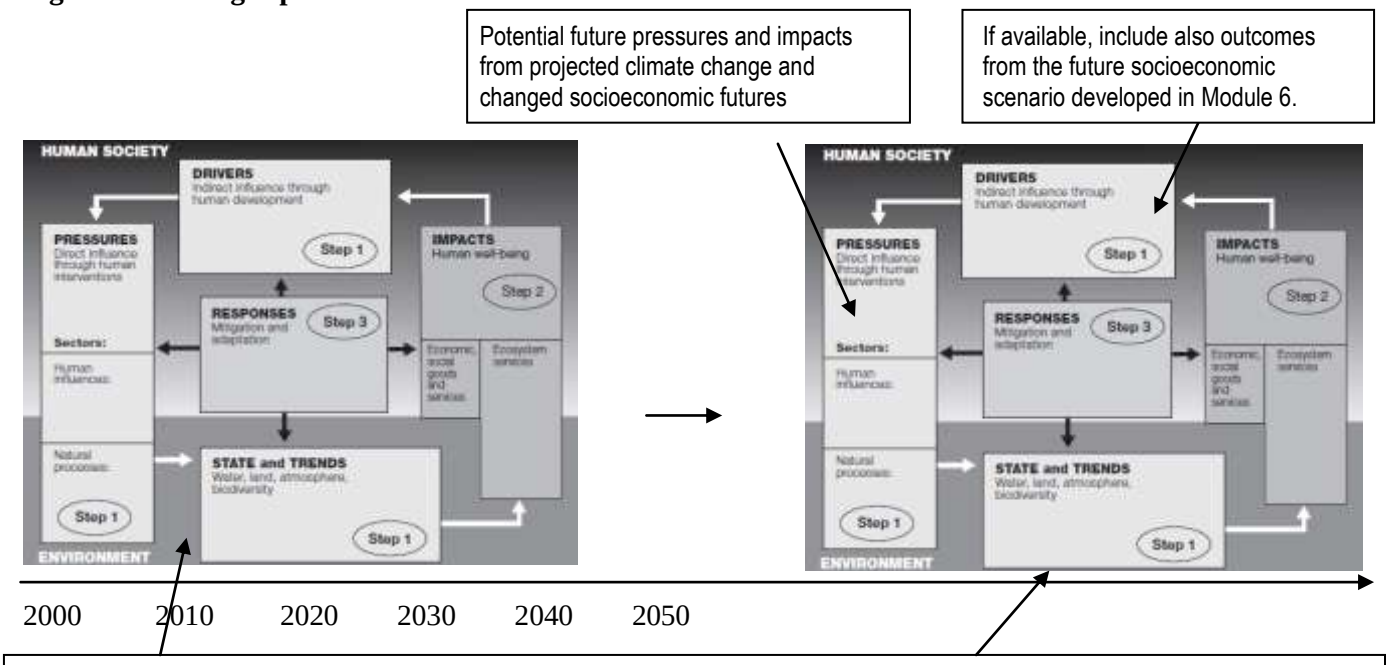
Climate driven phenomena	Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlements and society
Temperature change Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	Increased yields in colder environments Decreased yields in warmer environments Increased insect outbreaks	Effects on water resources relying on snow melt Effects on some water supply	Reduced human mortality from increased cold exposure	Reduced energy demand for heating and increased demand for cooling Declining air quality in cities Reduced disruption to transport due to snow, ice Effects on winter tourism
Heat waves/Warm spells Frequency increases over most land areas	Reduced yields in warmer regions due to heat stress Wildfire danger increases	Increased water demand Water quality problems (e.g., algal blooms)	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing Impacts on elderly, very young and poor
Heavy precipitation events Frequency increases over most land areas	Damage to drops Soil erosion Inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater Contamination of water supply Water stress may be relieved	Increased risk of deaths, injuries, infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding Pressures on urban and rural infrastructure Loss of property
Drought-affected areas increase	Land degradation Crop damage and failure Increased livestock deaths Increased risk of wildfire	More widespread water stress	Increased risk of malnutrition Increased risk of water and food-borne diseases	Water shortages for settlements, industry and societies Reduced hydropower generation potential

Cyclones and storm surges – Frequency increases	Damage to crops Windthrow (uprooting) of trees Damage of coral reefs	Power outages cause disruption of public water supply	Increased risk of deaths, injuries, water and food-borne diseases Posttraumatic stress disorders	Withdrawal of risk coverage in vulnerable areas by private insurers Potential for population migrations Loss of property
Sea level rise – Increased incidence of extreme high sea-level (excluding tsunamis)	Salinization of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to salt water intrusion	Increased risk of death and injuries by drowning in floods Migration-related health effects	Costs of coastal protection versus cost of land-use relocations Potential for movements of population and infrastructure

Sources: UNEP (2009)

In the previous chapter, we focused on identifying drivers, pressures, impacts and response to cope with current climate, climate variability and weather-related challenges. Similarly, we can estimate how future climate change will alter the human and natural environment. Figure 7 shows that we can integrate estimated climate changes such as sea-level rise, increased occurrence of cyclones, changes in precipitation patterns as trends and then develop the rest of the elements of the DPSIR. If available we can also add future pressures and drivers outlined in scenarios of future socio-economic changes developed based on IEA module 6.

Figure 7: Linking experienced and future weather-related and climate events



Developing projections of future climate change consists of two steps:

1) Identifying scenarios of potential levels of GHGs based on projections of future socio-economic development so-called global emission scenarios based on the Special Report on Emission Scenarios published in 2000 (Nakicenovic, *et al.*, 2000), and

2) Using the estimated levels of GHGs corresponding to these future scenarios as the basis for simulations using general circulation models (GCMs), which calculate the interrelationship of the elements of the earth system and thereby project future climate trends. Regional climate models (RCMs) are based on the results of the GCM, and project the climate in more precise geographical detail (Kropp and Scholze, 2009).

Each step of projecting climatic variables includes uncertainties, but by choosing more than one emission scenario, working with an ensemble of GCMs and using different techniques to obtain regional projections, we could minimize these uncertainties to levels that enable us to use the projections to indentify consequences of climate impacts and needed adaptations (for details see Table 2 and figure 8). The results of these models provide estimates of how basic climatic variables will develop in the future at the global or regional levels as a range of potential future impacts, all of which are equally plausible. This means that decision-makers and practitioners will need to consider how to apply this range of impacts to their area of interests in order to identify vulnerabilities and adaptation. However, the important part of a climate change impact assessment should be not only be obtaining information about changes in basic climatic variables such as temperature and precipitation, but also to gather information on their consequences on ecosystems and human well-being.

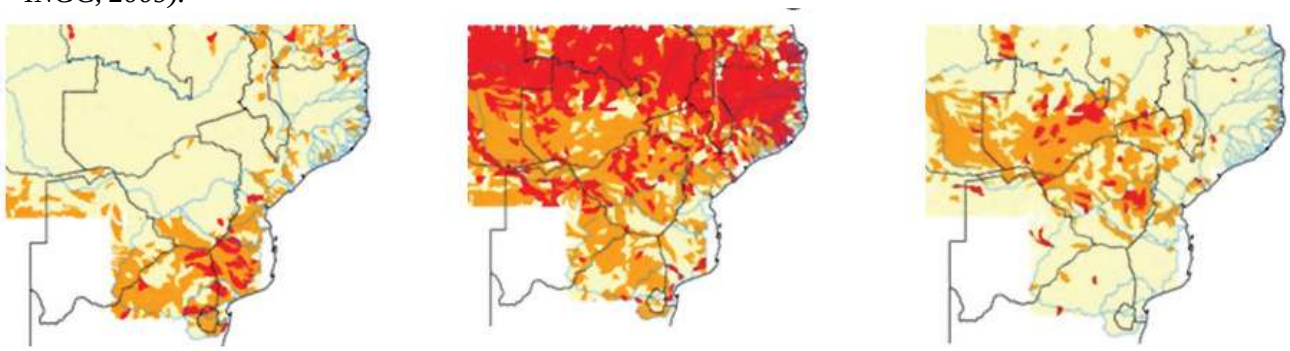
Table 2. Key steps and uncertainties when projecting climate change

Key steps	Major outcomes	Major uncertainties and how to address them
Projection of future emissions	Scenarios of population, energy, economic changes	Assumptions about and relationships between future population, socio-economic development and technical changes are uncertain; this can be address by making climate projections for a range of these SRES emissions scenarios.
Concentration of GHGs CO_2, methane, sulphates	Carbon cycle and chemistry models	The imperfect understanding of the processes and physics in the carbon cycle, chemical reactions in the atmosphere and feedback between climate, the carbon cycle and atmospheric chemistry generates uncertainties in the conversion of emissions to concentration of GHGs in the atmosphere. To reflect this uncertainty in the climate scenarios, the use of atmosphere-ocean general circulation models (AOGCMs) is needed.
Global climate change Temperature, rainfall, sea level, etc.	Coupled global climate models	There is much we do not understand about the workings of the climate system, and hence uncertainties arise because of our incorrect or incomplete description of key processes and feedbacks in the model. This is illustrated by the fact that current global climate models, which contain different representations of the climate system, project different patterns and magnitudes of climate change
Regional detail Mountain effects, islands, extreme weather	Regional climate models	The climate varies on timescales of years and decades; for any given period in the future (e.g. 2041–2070) natural variability could act to either add to or subtract from changes (for example in local rainfall) due to human activity. This uncertainty cannot yet be removed, but it can be quantified. This is done by running ensembles of future climate projections
Impacts Flooding, food supply	Impact models	Different regionalization techniques (described in the next section) can give different local projections, even when based on the same GCM projection; this can be addressed by using more RCMs or statistical downscaling for different GCMs

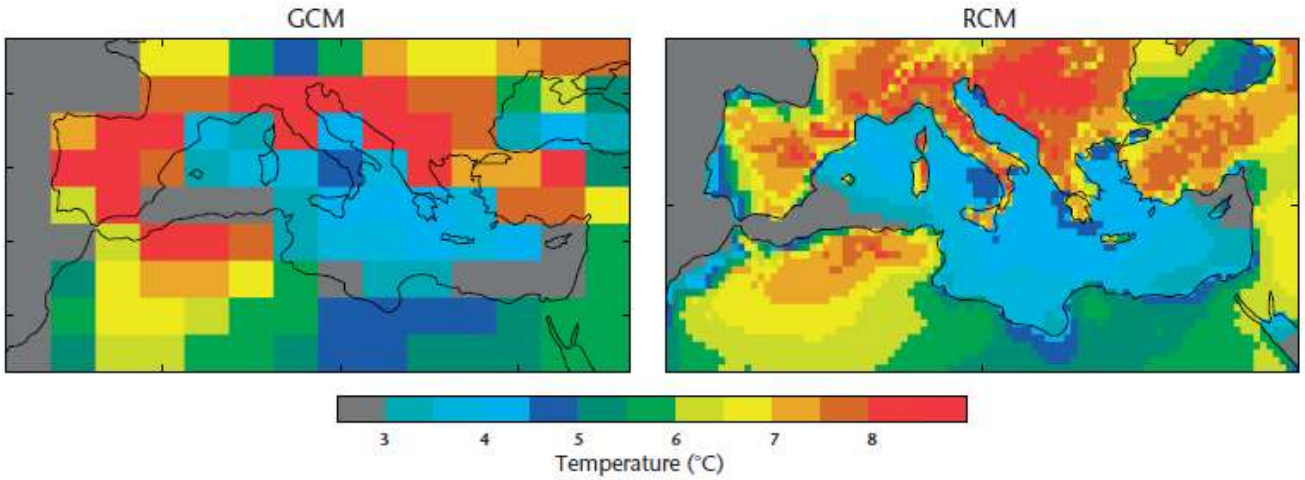
Source: Jones, *et al.*, 2004

Figure 8. Examples of presenting projecting of climatic variables while addressing uncertainties.

A. The maps below indicate that an outcome is unlikely to happen if two or fewer models projected that outcome (beige shade); likely to happen if 3-4 models projected it (orange shade); and very likely to happen if 5–7 models projected it (red shade). For example, the likelihood that water flows will increase is regarded as unlikely by the models except for the South, where 5–7 models are projecting increases (left map) *(Source: INGC, 2009).*



B. Example of temperature projections for Southern Europe (source: Jones, *et al.*, 2004)



In general, it is challenging to gather information for a comprehensive assessment of future climate change impacts relevant to specific area and specific impacts, such as on water, soil, yields and migration from readily available data portals and published documents. Some specific impacts, such as changes in the characteristics of water supplies or impacts on certain crops can be modeled using outputs from climate change scenarios (key impacts by continents are presented in Table 3). Relevant projections on other impacts, such as impacts on biodiversity, fish population, changes in some disease occurrence and extreme weather events, may not be possible to generate from climate models and resources available for most climate and environmental assessments, and therefore other methods must be used to estimate the relevant impacts. These methods include literature reviews, examining historical trends and impacts of current climate variability on current resource-base such as biodiversity, population of fish, water and soil, extreme weather events. An example of a comparison of consequences of current impacts of climate variability and future projections is presented in Table 4.

Table 3. Illustrative regional impacts of climate change

Africa

- Agricultural production, including access to food, will be severely compromised and the area suitable for agriculture, the length of growing seasons and yield potential, particularly along margins of semi-arid and arid areas, are expected to decrease.
- By 2020, crop yields from rain-fed agriculture may be reduced substantially.
- By 2020, between 75 and 250 million people are projected to be exposed to increased water stress due to climate change. By 2050, between 350 and 600 million people are projected to be at risk of water stress. There will be a significant increase in the number of people experiencing water stress in northern and southern Africa.
- By 2050, production of many crops in Egypt will be reduced by up to 11 per cent for rice and by 28 per cent for soybeans.
- Sea-level rise will have significant impacts on coastal areas. By 2050, in Guinea, between 130 and 235 km^2 of rice fields (17 per cent and 30 per cent of existing rice field area) could be lost as a result of permanent flooding due to sea-level rise.
- By 2050, a large part of the western Sahel and much of southern-central Africa are likely to become unsuitable for malaria transmission. Meanwhile, previously malaria-free highland areas in Ethiopia, Kenya, Rwanda and Burundi could experience modest incursions of malaria.

Asia and Central Asia

- By 2020, an additional 49 million people are projected to be at risk of hunger. Some projections suggest a 7 per cent to 14 per cent increase in risk of hunger.
- Significant regional differences in wheat, maize and rice yields are expected. Yields might increase by up to 20 per cent in East and South-East Asia and decrease by up to 30 per cent in Central and South Asia.
- Climate change is likely to lead to an increase in agricultural areas needing irrigation, as usable water resources decline. A 1ºC increase in temperature is projected to result in a 10 per cent increase in agricultural irrigation demand in arid and semi-arid regions of East Asia.
- By 2050, an additional 132 million people are projected to be at risk of hunger.
- By 2050, in Bangladesh, rice and wheat production might drop by 8 per cent and 32 per cent respectively.
- By 2050, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins such as changing, is likely to decrease as a result of climate change, while demand is likely to increase with population growth and rising standards of living. This could adversely affect more than a billion people in Asia by the 2050s.
- Climate change-related melting of glaciers could affect a half billion people in the Himalaya-Hindu-Kush region and a quarter billion people in China who depend on glacial melt for their water supplies.
- Coastal areas, especially heavily populated mega delta regions in South, East and South-East Asia, will be at greatest risk of increased flooding from the sea and, in some mega deltas, flooding from rivers.
- By 2050, more than one million people may be directly affected by sea-level rise in each of the Ganges-Brahmaputra-Meghna deltas in Bangladesh and the Mekong delta in Viet Nam.
- Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia according to projected changes in the hydrological cycle.
- Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanization, industrialization and economic development. Up to 50 per cent of Asia's total biodiversity is at risk.
- 24 per cent to 30 per cent of coral reefs may be lost in the next 10 to 30 years.

Latin America and the Caribbean

- By 2020, generalized reductions in rice yields and increases in soybean yields (with CO_2 effects considered) are projected.
- By 2020, an additional 5 million people could be at risk of hunger (CO_2 effects not considered).
- Greater heat stress and dryer soils may reduce yields to a third in tropical and subtropical areas where harvests are near maximum heat tolerance.
- By 2020, in temperate areas such as the Argentinean and Uruguayan pampas, pasture productivity could increase by between 1 per cent and 9 per cent.
- By 2020, net increases in the number of people experiencing water stress are likely to be between 7 and 77 million.
- Over the next decades, Andean inter-tropical glaciers are projected to disappear, affecting water availability and hydropower generation.
- In Peru, the retreat of glaciers will affect the availability of water supply for 60 per cent of the population.
- In terms of health impacts, main concerns are heat stress, malaria, dengue fever, cholera and other water-borne diseases.
- By 2050, desertification and salinization are projected to affect 50 per cent of agricultural lands.
- By 2050, an additional 26 million people could be at risk of hunger (CO_2 effects not considered).
- For smallholders, a mean reduction of 10 per cent in maize yields could be expected by 2055.
- By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual

replacement of tropical forest by savannah in eastern Amazonia.
- Risk of significant biodiversity loss through species extinction is projected in many areas of tropical Latin America.
- Extinction of 24 per cent of the 138 tree species of the central Brazil savannas (*cerrados*) could result from the projected increase of 2°C in surface temperature. Tropical cloud forests in mountainous regions will be threatened if temperatures increase by 1°C to 2°C.

Sources: OECD (2009)

Table 4. An example of linking observed trends, projections and potential consequences of impacts for climatic variables

Climatic variable	Observations	Projections	Identified consequences of these projections for the studied areas based on experiences and knowledge of involved stakeholders
Precipitation	Increased heavy precipitation by approx. 5 per cent leading to local floods	Potential further increase in precipitation 3–10 per cent	Destruction of infrastructure and assets and increase in erosion Losses of agricultural production Losses of productive agricultural areas Losses of agriculture and livestock production Slow down of economic activities during heavy rainy seasons Destruction of infrastructure including damages in road infrastructure causing difficulty in market access Loss and injuries of people due to flooding, landslides and collapsing buildings

Gathering projections of climatic variables

Basic climatic variables (minimum and maximum daily temperature, maximum and minimum rainfall, evapotranspiration, sunshine duration, etc.), more elaborate indicators (length of the growing season, heat wave duration index, etc.) and complex indices (level of satisfaction of different crops water needs) allow one to identify short- and medium-term thresholds. More complex indices and indicators require significant modelling efforts, resources and expertise. Many impact assessments of future climate change often use simple data and, based on consultation with stakeholders, the consequences of these simple data sets on agriculture, forestry and other sectors are identified (Tables 1 and 3). Simple climate data include for example:

Precipitation

Mean annual precipitation
Monthly, seasonal (for example, DJF stands for average during from December until February) and daily precipitation rates
Runoff
Maximum 5-day precipitation
Consecutive dry days (for example, 7 days)

Temperature

Mean annual temperature
Maximum temperature (monthly)
Minimum temperature (monthly)
Sea surface temperature
Frost days

When climate data is insufficient for the desired area, one may consult the regional and global databases to obtain at least monthly averages for most climate parameters. *See, for example: IPCC Data Distribution Centre, http://www.ipcc-data.org and Climate Forecasting and Monitoring database, http://iri.columbia.edu (forecasts).*

Particular attention should be given to sectoral, national and regional studies, as these can provide the data needed to assess critical thresholds and specific tipping points. For instance, data on the recommended daily calorie

intake, duration of the growing season, and so forth are often available in poverty or food security reports. Furthermore, many regional and national reports on most climate hazards and events exist. *See, for example: USAID Famine Early Warning System Network, http://www.fews.net ; FAO Global Information and Early Warning System on Food and Agriculture, http://www.fao.org/giews/english/index.htm.*

For long-term climate changes and trends, data on climate parameters and future thresholds can be derived from climate change scenarios. However, considering that most scenarios are global or regional in scope, they are of limited use for national level analyses. In the same vein, the timescales used in these scenarios (50 to 100 years) are not appropriate for the decision-making process (which needs to address urgent and immediate needs on a 10 to 20 year timescale). *See, for example: IPCC Data Distribution Centre, http://www.ipcc-data.org; IPCC Reports http://www.ipcc.ch/ipccreports/index.htm.*

Given the often limited data, groups are recommended to focus on using historical and observed climate data and trends to construct good climate data series. If groups decide to use scenarios in the course of this exercise, it is recommended that they select simple rather than complex ones. With respect to GCMs, one must always examine the accuracy of the results obtained for the study region and the parameters used. Techniques exist to transform information from a global scale, to a regional and then national one. *See, for example: Vulnerability Network & Observatory, http://vulnerabilitynet.org or Assessments of Impacts and Adaptation to Climate Change in Multiple Regions and Sectors Project, http://www.aiaccproject.org/aiacc.html.*

The Climate Change Explorer provides users with an analytical foundation from which to explore the climate variables relevant to their particular adaptation decisions. The approach makes crucial links between understanding vulnerability, monitoring and projecting climate hazards and planning adaptation processes, and is grounded in several key assumptions regarding the interpretation of climate science. The Climate Change Explorer (CCE) Tool is a desktop client that provides an interface to download, manage and visualize downscaled model output. The tool is available at http://www.weadapt.org.

The World Bank Climate Change Portal is intended to provide quick and readily accessible global climate and climate-related data to the development community. The site is supported by the Google Maps platform and allows users to access data such as the outputs from climate models, historical climate observations, natural disaster data, crop yield projections and socioeconomic data at any point on the globe: http://sdwebx.worldbank.org/climateportal/.

The PREVIEW Global Risk Data Platform is a multiple-agency effort to share spatial data information on global risk from natural hazards. Users can visualize, download or extract data on past hazardous events, human and economical hazard exposure and risk from natural hazards. It covers tropical cyclones and related storm surges, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions. http://preview.grid.unep.ch/

Finally, further data can be accessed at the GEO data portal, http://geodata.grid.unep.ch; Global Climate Observing system (GCOS) for data sets, http://www.wmo.int/pages/prog/gcos/index.php; and at World Climate Research Programme (WCRP) disaster data portal, http://www.disdat.be.

Exercise 4: In your groups, continue to work with the same selected ecosystems, or select a different one and then identify major climate impacts. To obtain information about the future climate, use the websites listed above (suggested: http://sdwebx.worldbank.org/climateportal, http://preview.grid.unep.ch/ or available country projections), then complete the following two tasks on flipchart paper:

1. Fill the table on the flipchart paper by listing: a) the projected changes in the future climatic variables, b) impacts on ecosystems, and c) human well-being.

2. On sticky notes write down key drivers and pressures that also contribute to the identified impacts of climate change on environment and human well-being. Stick these pressures and drivers next to the impacts written on the flipchart.
3. Are the pressures and drivers different than those identified in Exercise 2? Are some pressures and drivers exacerbated by climate change?

a) Projected changes in climatic variables - future states and trends	
b) Impacts on ecosystems	**c) Impacts on human well-being**

Further reading exercise: In the same groups as Exercise 4, read the following case study: *A vulnerability study of coastal areas and climate change in Senegal* (C3D, Module 3) from http://c3d-unitar.org/c3d/userfiles/Module_3/EM3_Case_study2.pdf. Please review the applied approaches that were used to identify impacts of climate change in the case study.

5. Creating Responses: Determining the adaptation options

Mainstreaming climate change into development decisions

Impacts of climate change and needed adaptation measures cut across sectors; the challenges that nations face involve a complex matrix of economic, social, cultural, political, environmental and other multisectoral issues. Impacts of climate change and adaptation therefore need to be integrated within the broader milieu of national development planning, tools and processes, inclusive of PRSPs, in a participatory process. However, integrating adaptation into climate change into development policy planning and budgeting requires a carefully thought-out process. This process may be referred to as adaptation mainstreaming (IIED, 2008).

Box 6: The case of Cyclone Sidr

Bangladesh is one of the world's most climate-vulnerable countries, regularly hit by flooding and cyclones. Yet its highly effective early warning system has already saved tens of thousands of lives. This capacity is key in a region where extreme weather is set to become more frequent and intense as climate change progresses. Cyclone Sidr—one of the strongest storms ever in the Bay of Bengal—hit Bangladesh in November 2007. The government, however, was prepared: improved early warning technology had supplied news of Sidr's direction and intensity 72 hours before its arrival. A network headed by the World Meteorological Organization's global cyclone observatory started feeding data to its regional outpost at the Indian Meteorological Office in New Delhi. The message was relayed to authorities in Dhaka, who passed it on to the local Red Crescent office. Some 40,000 trained Red Crescent volunteers then disseminated the information to the 15 worst affected districts, cycling around the country, using megaphones to order residents into 1,800 cyclone shelters and 440 flood shelters. When Sidr hit, 2 million people were in shelters. Red Crescent estimated the death toll was between 5,000 and 10,000. A cyclone of a similar magnitude in 1991 killed over 190,000 people.

This integration of hi-tech information into low-tech, low-cost, locally appropriate information dissemination methods maximized the outreach of the system. **It also demonstrated the value of cross-sector and cross-scale coordination.** The system operates in conjunction with a broader action program supported by donors, including the United States and the European Union, which, since 1991 has supported disaster preparedness and improved post-disaster relief and reconstruction. Under this program, early warning and evacuation systems are integrated with infrastructure such as cyclone walls to protect from storm surges.

Source: IIED, 2008

Until recently, development planning has not included vulnerabilities and risks posed by climate change to lives and livelihoods. Few countries have made serious efforts to mainstream climate change into their development planning, programs and budgeting; the process is at an embryonic stage, and even more so in developing countries. Yet, there is a growing consensus about the importance of mainstreaming adaptation to climate change and variability in the agendas of all sectors. Caribbean countries were the pioneers on adaptation-related works, owing primarily to their vulnerability to climate change as a result of environmental factors, including exposure to extreme weather and geo-economic realities (IIED, 2008).

Many countries are now going through this process of integrating their development and climate strategy. (See Box 7.) According to Kok, *et al.* (2006), such integration will include the benefits of improved ecosystems services; reduced poverty; more employment; improvements in health, energy and food security; infrastructure and climate benefits.

Box 7: Examples of demonstrated integrated development and climate strategies

Bangladesh – Agricultural policies in Bangladesh aim at food-grain self-sufficiency. In drought-prone areas, promotion of high-yielding varieties and increasing cropping intensity has created a more vulnerable production system. New policies currently implemented are anticipating increased drought frequencies and move towards the diversification of agriculture, including the promotion of horticulture, which will help alleviate poverty.

Senegal – Climate change poses an additional stress for the vulnerable forest and agricultural system in Senegal. Adapting to short-term climate variability through early warning systems and agricultural practices has proven to be a learning process for dealing with long-term climate change. Restoring soil fertility is a key factor in increasing and stabilizing agricultural production levels, and carbon sequestration offers an opportunity to work jointly on the development and climate agenda. Currently, biomass accounts for 43 per cent of total energy consumption; in rural areas, this can be as high as 80 per cent. Agro-forestry for the local energy supply contributes to the rehabilitation of degraded lands and provides a reliable energy source for the rural poor.

Source: Kok, *et al*., 2006

Mainstreaming climate change adaptation is not, however, an easy exercise. It would necessitate compromises and tradeoffs among competing local, national and/or regional interests and priorities. Yet any climate change adaptation mainstreaming process ought to be rooted in, and must contribute to, the sustainable development goals of the country at hand, taking into account all elements, including local/indigenous coping strategies.

Developing adaptation responses

Key characteristics of adaptation

Societies have a long record of adapting to the impacts of weather and climate, but climate change poses novel risks, often outside the range of experience, such as impacts related to drought, heat waves and floods. Adaptation to climate change is defined as, "[an] adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007; Adger et al., 2007). There is increasing recognition that the world's current progress in reducing emissions of GHGs is not occurring rapidly enough to avoid impacts from climate change in the coming century. Because of this, the world is "committed" to a certain level of global warming, and therefore a degree of impacts that will require adaptive responses by nations, communities and individuals. When addressing climate change, we must aim for actions that will get us onto a resilient, low emission development pathway, which operates at two levels (Robinson, *et al.,* 2009):

(i) the large collective decisions about structural issues such as coastal development, urban form, land use, transportation infrastructure, energy and water systems, etc., which will determine the framework within which we adapt and mitigate; and
(ii) the cultural, social and psychological dimensions of values, lifestyle and consumption behaviour.

To effectively develop adaptation responses to climate change relevant for the community, community representatives need to understand the consequences of the climate change impacts at the level of local development and ecosystems. Depending on the character of the coast, for example, increases in sea-level rise and heavy precipitation could lead to many different local impacts, including coastal wetland loss; changes in estuarine communities and littoral biological productivity; potentially negative impacts on ocean biodiversity and productivity; decreased food supply for sea birds and fishing communities. Additionally, an increase in extreme weather events could breach dykes, cause flooding and place additional stress on the ecological integrity of coastal areas. Furthermore, depending on the population density, the impacts could also cause serious damage to human settlements, infrastructure and agricultural production. Examples of identified specific impacts of climate change and tailored adaptation is presented in Box 8.

Box 8: The example of linking climatic impacts and identified adaptations in regions of Ghana for different regions and drivers and pressures

Zone	Climate impacts	Adaptation responses
Northern Savannah	Increased morbidity and disease prevalence Increased vulnerability of the poor Increased out-migration loss of human capital	Strengthening traditional social security support systems Strengthening public healthcare delivery Targeted social transfers and safety nets Increased investment in urban social services
Transition	Increased demand - water, energy and basic services Decreased income for people in fish industry Increased out-migration Increased food insecurity Threats to forest-based livelihood Potential conflicts and social tensions	Public-private partnership in service provisions Development of early warning systems and awareness-raising Promotion of conflict management mechanisms Provision of social safety nets for communities and migrants Development of alternative and additional livelihood
Forest	Decreased food security Dry-ups of water bodies and underground water Pressure on land	Improvement of social services to poor people Provision of small-scale irrigation Security of tenure Community-based land administration system

Coastal Savannah	Decreased water availability and quality Higher burden on women Increased migration Increased cholera	Recycling and total rain water harvesting Improvement in formal and informal safety nets Social protection for immigrants Economic diversification in secondary towns Increased accessibility of health care Education and awareness-raising – health issues

Source: Bizikova and Bailey, 2009 (modified)

Types of adaptation actions

When identifying adaptation options, we often think about **infrastructure development,** for example, building dykes, flood-resistant road and dams. Adaptation measures, however, should also consider options that help improve ecosystem resilience and building capacities, change governance systems, training and skill development. **Ecosystem-based adaptation**s are those that help to preserve and restore natural ecosystems that can provide cost-effective protection against some of the threats that result from climate change. For example, coastal ecosystems like wetlands, mangroves, coral reefs, oyster reefs and barrier beaches all provide natural shoreline protection from storms and flooding in addition to their many other services (Munang et al., 2009). By making ecosystems more resilient, ecosystem services (e.g., fish stocks, fuel, clean water) on which vulnerable communities depend for their subsistence and livelihoods are maintained (Hale, *et al.*, 2009). Finally, it is also important to identify measures that are focused on **capacity-development;** for example, helping communities learn new farming practices, use of technologies and develop new processing, marketing and vocational skills, to assist extension agencies in using early warning systems and forecasts, and assist government officials in integrating climate change into day-to-day planning.

Table 5. Examples of different types adaptation measures, including ecosystems-based, infrastructure and capacity-development measures, to address impacts in agriculture, water resource management and local economy

Infrastructure and changes in practices	Ecosystem-based measures	Governance, training and capacity development
Building grain silos Improved post harvest technologies such as setting up small-scale agro processing industries to utilize farm products Building small and medium dams Building flood-resistant roads to ensure market access	Prompting sustainable agriculture, organic farming and appropriate technology to reduce degradation Erosion control by encouraging contour farming and water storing Restoring vegetation around river beds to limiting flooding	Sustainable water management Farmers education – water harvesting and contour farming Training centres and microfinance to develop skills for off-farming season activities Vocational training – especially for youth, in places with high in-migration; and creation of markets and training in other sector skills including hairdressing, sewing, carpentry Developing agricultural extension services

Source: Bizikova and Bailey, 2009 (modified)

When developing adaptation responses to climate change, immediate short-term responses may not be the ones that could protect us from progressive changes in climate. On the contrary, they could make us even more vulnerable. There are trade-offs between short- and long-term adaptation measures, between choices to put resources into adaptation, mitigation or other development priorities. For example, flexible, timber-framed construction is effective in managing subsidence risk but may not cope as well with overheating and flood risks. Engineering interactions to defend coastlines from flooding and sea-level rise can also change the connectivity of coastal ecosystems and facilitate the spread of non-native invasive species. Consequently, the ultimate goal of the

adaptation actions is not only respond to changes in climatic variables, but also to move towards a resilient community and ecosystems. Using principles of sustainable development could help in identifying those adaptation responses, creating ancillary benefits or co-benefits between climate and development goals. For example, extensively using air-conditions to respond to heat waves, shifting to monocultures of heat resistant crops or building large dykes without resources for maintenance could be considered unsustainable and maladaptive responses.

Table 5: Developing adaptation responses by using the DPSIR example of potential future climate change leading to increased occurrence of drought (listed in states and trends)

Elements of the DPSI		**Responses – Adaptation**
States and trends	**Increased occurrence of droughts**	
Drivers and pressures	Population growth Migration from the affected areas Planting cash crops because of higher prices Reduced house-level food production	Promote local and community food storage, seed banks and silos Training to obtain skills for work in other sectors Promote inter-cropping, natural fertilizer/pesticides and avoid monocultures Promote small-scale water storage, rainwater harvesting, mulching and composting
Impacts on environment and human well-being	Reduced yields Lack of water for livestock Increasing rate of poverty Malnutrition	Changes in cropping patterns, natural soil erosion control, creating local ecosystems through planting indigenous trees and diversifying vegetation Encourage social support networks, rotational credits, promote breastfeeding and indigenous medicinal plant knowledge

This approach maintains sustainable development as its focus, and considers the ways that climate change goals can naturally be accomplished by pursuing a more broadly sustainable development path. Applying the DPSIR will help you to identify potential trade-offs between adaptation and other priorities (Table 5). Climate change is one of many anthropogenic stresses, such as land-use changes, that cause loss of biodiversity; disruption of carbon, nitrogen and other biogeochemical cycles; human-caused non-native species invasions; and releases of toxic substances. Reducing the impacts of these stresses on ecosystems would then buffer ecosystems from potential harmful impacts due to climate change (Rogers and McCarty, 2000).

Box 10: Examples of adaptation practices

Region, Country	**Climate-related stress**	**Adaptation practices**
Egypt	Sea level rise	Adoption of National Climate Change Action Plan integrating climate change concerns into national policies; adoption of Law 4/94 requiring Environmental Impact Assessment (EIA) for project approval and regulating setback distances for coastal infrastructure; installation of hard structures in areas vulnerable to coastal erosion.
Sudan	Drought	Expanded use of traditional rainwater harvesting and water conserving techniques; building of shelter-belts and wind-breaks to improve resilience of rangelands; monitoring of the number of grazing animals and cut trees; set-up of revolving credit funds.
Bangladesh	Sea-level rise; salt-water intrusion	Consideration of climate change in the National Water Management Plan; building of flow regulators in coastal embankments; use of alternative crops and low-technology water filters.

Philippines	Sea-level rise; storm surges	Capacity building for shoreline defence system design; introduction of participatory risk assessment; provision of grants to strengthen coastal resilience and rehabilitation of infrastructures; construction of cyclone-resistant housing units; retrofit of buildings to improved hazard standards; review of building codes; reforestation of mangroves.
China	Landslide	Dense and deep-rooted vegetation helps to bind soil together, resisting slippage of surface layers. China's Grain for Green program bans logging and agriculture on steep slopes and prohibits forest clearing for shifting agriculture in the mountains of Southwest China. In exchange, the local communities get grain provisions and cash subsidies, as well as resilience against flooding events.
Canada	Permafrost melt; change in ice cover	Changes in livelihood practices by the Inuit, including: change of hunt locations; diversification of hunted species; use of Global Positioning Systems (GPS) technology; encouragement of food sharing.
	Extreme temperatures	Implementation of heat health alert plans in Toronto, which include measures such as: opening of designated cooling centres at public locations; information to the public through local media; distribution of bottled water through the Red Cross to vulnerable people; operation of a heat information line to answer heat-related questions; availability of an emergency medical service vehicle with specially trained staff and medical equipment.

Source: Schneider et al. (2007) and World Bank (2009).

6. Prioritizing adaptation responses

There are number of options available when to responding to expected climate impacts, depending on, for example, available capacities; cultural, social and economic preferences; urgency of actions; adaptation options that need to be evaluated and prioritized. Prioritizing among adaptation options based on criteria that recognizes the importance of sustainable development also helps to realize synergies and avoid conflicts with other dimensions of sustainability. Box 9 outlines additional criteria that could be adjusted to particular local situations. In the context of water resource management in South Africa, an example of how criteria could be used to prioritize adaptation options is provided (Box 10). This case study shows that it is necessary to account for the local context and criteria that needs to be discussed within the local stakeholders' group to undertake the necessary adjustments before the prioritization of the adaptation options.

Box 9: Suggested criteria for evaluating climate change responses

Category	Criteria	Description of the criteria
Sustainability	**Mitigation co-benefits**	Changes in the level of greenhouse gas emissions created by the adaptation measure
	Environmental impacts	Identify environmental impacts on biodiversity
	Equity	Number of people benefiting from the adaptation—if possible disaggregated by gender, age, class
	Implementation cost	Identify the approximate cost of implementation; you could compare these costs with cost of inaction over time
	Operating and maintenance cost	Identify the cost of operation and maintenance over time, compared to other budget expenditures
Effectiveness	**Robustness**	Elaborate how effective this measure could be for a diverse range of plausible future scenarios
	Reliability	Identify if this measure is untested or the effectiveness of this measure is proven
Risk and uncertainty	**Urgency**	Identify the time frame of impact occurrence from recent past, present until short- and long-term futures
	Degree of risk or impact	Identify potential extent of future risks from minor and reversible until irreversible
	Precautionary	Estimate how well the risks are understood
Opportunity	**Ancillary benefits**	Identify how this measure will contribute to other community goals
	No-regret option	Indentify if this measure has benefits regardless of actual climate change impacts
	Window of opportunity	Identify if there is currently window of opportunity to implement this measure
Implementation	**Public acceptability**	Elaborate on public support or opposition to this measure

	Funding sources	Identify availability and sources potential funding
	Capacity (information, technical, staff, resources)	Estimate if current capacity is sufficient and, if not, what are lacking capacity gaps
	Institutional	Identify if implementation is within local control or it requires coordination with, or action by, other jurisdictions

The criteria provides a framework for the types of questions that should be considered when evaluating adaptation options, and can be customized for local use. For example, other criteria could be added such as "political leadership" and "political context." It is also important to bear in mind that, rather than identifying one best option, the goal is to develop a "portfolio" of options that can be implemented in shorter- and longer-time scales. This type of evaluation system can be used to think through various options, filtering out more desirable measures that can then be considered in greater detail. It can also help to identify what additional information is needed before a decision is possible.

Box 10: Water resource management strategies in response to climate change in South Africa: Specific focus on municipal water in arid regions

South Africa is a water-stressed country with an average annual rainfall of 500 mm (60 per cent of the world average). Only a narrow region along the south-eastern coastline receives good rainfall, while the greater part of the interior and western part of the country is arid or semi-arid. Sixty-five per cent of the country receives less than 500mm per year, which is usually regarded as the minimum for dryland farming.

Projection of future scenarios using the historical information

Future climate projections for the Northern Cape were created by using four different model outputs, which were analyzed and compared to the South African Weather Service observed data. Based on the climate model projections, the most severe impacts of reduced rainfall are likely to occur along the western part of South Africa, where small towns and subsistence farmers are most vulnerable. The available literature suggests that it would be prudent to account for climate change in water resource planning to meet the development objectives of South Africa.

Analysis of adaptation options and strategies

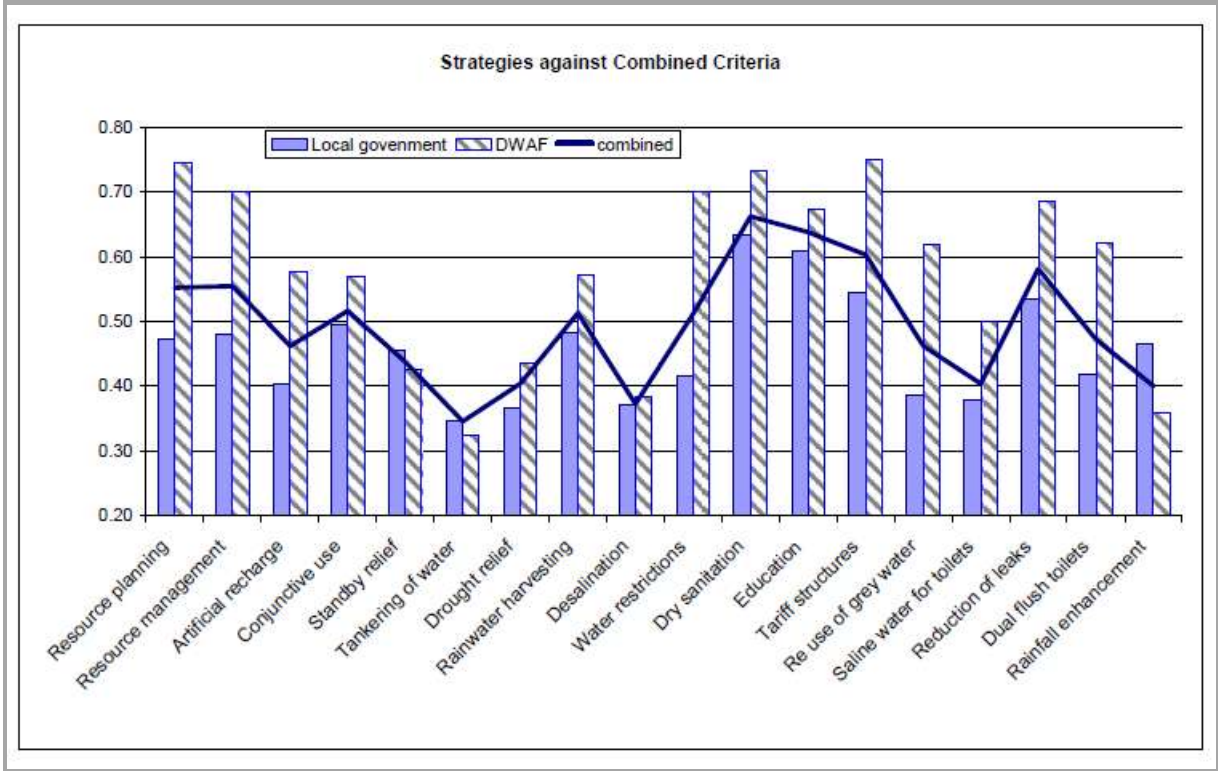
A number of interviews were held with relevant stakeholders and consultants who operate in this region in order to capture the current measures adopted to ensure an adequate supply of water in times of drought. A list of adaptation options strategies was compiled that best represented those currently being implemented at a local level.

The list of evaluated adaptation options: regional water resource planning, local water resource management and monitoring system (eg. telemetry), artificial groundwater recharge, conjunctive use of surface and groundwater, standby relief under critical conditions, tankering of water, drought relief and aid funding, rainwater harvesting, desalination, water restrictions, dry sanitation systems, education programs, tariff structures (e.g., block tariffs), reuse of grey water, saline water for toilets, reduction of leaks program, dual flush toilets and rainfall enhancement.

Definitions of criteria and scoring used for strategy analysis:

1. Additional yield / saving	How will the intervention impact on water supply through additional yield and/or savings? 1 = None, 2 = Low, 3 = Significant, 4 = Very high
2. Technology required	Is the technology for the intervention readily available? 1 = Not available, 2 = Must be imported, 3 = Available in the country, 4 = Locally available, 5 = Already installed
3. Additional capital expenditure	Will the intervention require additional capital expenditure? 1 = High cost, 2 = Medium, 3 = Low, 4 = No cost
4. Additional running costs	Will the intervention incur additional running costs?

	1 = High costs, 2 = Medium, 3 = Low, 4 = No operation and maintenance costs
5. Local employment	To what extent will the intervention impact on job creation? 1 = Loss of jobs , 2 = Neutral, 3 = Few jobs (<10), 4 = Many jobs (10–30)
6. Local capacity to implement	What level is the institutional capacity currently at with respect to the intervention? 1 = Very low, 2 = Low, 3 = Adequate, 4 = High
7. Acceptability to local community	What is the consumer acceptability of this intervention in terms of additional cost to them and convenience? 1 = None (high additional costs) , 2 = Low (some additional costs or inconvenient), 3 = Neutral, 4 = High (no additional costs)
8. Impact on local water resources	What impact will the intervention have on the water resources and the environment in the area? 1 = Negative, 2 = Neutral, 3 = Positive, 4 = Highly positive
9. Long term applicability	What is the period of impact of the intervention? (short to long term) 1 = <2 years, 2 = 2–5 years, 3 = 5–15 years, 4 = 15–25 years, 5 = >25 years



Identified adaptation actions and strategies

Based on the scoring, the following portfolio of strategies should be further investigated when developing a water resource management strategy that takes future climate change impacts into account:

1. *Supply side management*: reduction of leaks programs, regional water resource planning, local water resource management and monitoring, conjunctive use of surface and groundwater and rainwater harvesting.
2. *2. Demand side management*: dry sanitation systems, education programs, tariff structures and water restrictions.

Source: Mukheibir, 2005.

Exercise 5: In your previous groups, continue working with the created flipchart page that outlines key climate impacts on human well-being, and ecosystems, drivers and pressures that are contributing to the impacts. In this exercise, identify potential adaptation responses, using the following questions to guide you:

1. When identifying adaptation responses, consider both the listed impacts of human well-being and ecosystems and also the listed drivers and pressures that contribute to these impacts. Use the provided sticky notes or index cards to write down the responses and post them next to the relevant impacts, drivers and pressures.
2. Identify the most urgent adaptation options from the responses that the group came up with.

Optional tasks (complete if time permits):

3. Select up to three key criteria that the group would suggest to prioritize selected adaptation responses.
4. If time permits, evaluate the chosen adaptation actions according to the selected criteria (use a simple ranking system).

Be prepared to report back in plenary on this and the previous exercises.

7. Developing a basic implementation plan and a communication strategy

Implementing adaptation responses

Adaptation options are interwoven with other development decisions and choices involving a number of stakeholders and sectors. Further, in order to promote resilience, the focus of adaptation actions should also address capacity development and create policies that enable adaptation in the future. There is a growing list of adaptation actions for diversity of climate change and for various socio-economic conditions. Adaptation options include activities that are new and untested, but most of the activities are well-known to the communities. Local community members should be seen as having valuable knowledge about climate change impacts and adaptation, even if the options are not explicitly recognized as helping to reduce vulnerability to climate change. Building on this familiarity helps to empower local communities and helps decision-makers develop relevant responses to climate change.

Box 11. Linking different levels of governance when implementing adaptation responses

To understand adaptation decision-making, one must differentiate between decision-making *at* and *for* local levels, as both cases involve different scales and actors. Thus, adaptation at the local level is strongly related to the other levels of decision-making. The efforts to integrate adaptation into development processes at the regional, national, sectoral and project levels should ideally create a set of conditions, plans and incentives that allow sub-national actors to understand the changing risks they face and take actions to reduce their vulnerability to these risks (top-down). At the same time, however, many of these conditions, plans and incentives should be devised with participation and inputs from sub-national actors themselves, in order to ensure their uptake, sustainability, inclusiveness and overall success (bottom-up). Local actors should therefore both benefit from and shape adaptation decision-making at other levels in order to ensure successful adaptation responses. Lessons and experiences with adaptation at the local level must feed into higher levels of decision-making to make sure that local strategies remain relevant and appropriate, and provide a basis for transferring knowledge to other sectors and communities.

Source: OECD, 2009

To be effective in responding to climate change, it is important to consider and coordinate actions at different levels of government, from national level priorities down to local responses. When identifying adaptation responses, we tend to focus on local actions that address situations in areas where impacts are occurring, but we also need to think about strategic decisions at the national level that could increased capacities and set directions for local actions. Finally, sectoral adaptation focused on agriculture, forestry, health and infrastructure are areas where medium and large-scale investments tend to occur, and it is important that they are harmonized with national priorities, local needs and lessons learned (Table 6).

Table 6. Examples of priorities of effectively addressing adaptation responses at the national and sectoral level

National-level priorities	**Sectoral priorities**
- Improving the coverage and quality control of	- Carrying out an assessment of the available sector-specific

climate monitoring data. Commissioning national-level assessments of climate change impacts, vulnerabilities and adaptation options to gather more targeted information on how climate change affects specific national priorities and core government functions. - Moving the coordination for adaptation into powerful central bodies, such as the Office of the President or Prime Minister or planning agencies. - Including considerations of climate change risks within long-term visions, poverty reduction and sustainable development strategies. - Making a sound economic case for investing in adaptation. Ensuring adequate resource allocation (for example through a *horizontal fund for adaptation*) for the incorporation of adaptation considerations in policies, plans and programs.	information on climate change impacts and vulnerabilities; - Raising awareness among both sectoral planners and their counterparts within donor agencies of the implications of climate change on their specific areas of activity; - In cases where sectoral regulations and other decision-making processes are based entirely on historical climate information, there might be a need to introduce greater flexibility – such as more frequent updating of the climatic baseline (e.g., in the case of water resource management); - Boosting in-house capacity within sectoral ministries and donor agencies to better evaluate the implications of climate change for specific sectors; - Collecting better information on the costs and benefits of adaptation actions so that decision-makers at various levels can factor such information into their decision-making on how to implement adaptation-related actions. - Making "room" in the budget for adaptation responses identified in the context of cross-sectoral plans, or claiming resources from a horizontal fund for adaptation.

Source: OECD, 2009

In terms of implementation, adaptation options may be considered on different time scales. Short-term "no regrets actions" are actions whose implementation society would benefit from, even if anthropogenic climate change did not take place (IPCC, 2001). Short- to medium-term actions should focus on addressing current pressing vulnerabilities. These options often address already experienced problems with weather-related events. From the options that meet long-term development priorities, the project team could choose:

- A preferred option (often win-win solution) that it is supported by consensus within the project team;
- A "low-hanging fruits" option, which includes responses that require available recourses and is easy to implement;
- An area of the highest urgency (if it is applicable) to minimize major sources of vulnerability in the community;
- An area that provides a non-regret option that helps to address problems that need to be dealt with anyway.

Longer-term adaptation actions are those that would be really focused on building a resilient and sustainable community. It is also important to keep the list of long-term measures open or add options that will allow responses to climate change to be implemented in the future, when the need for adaptation and the performance of different measures is less uncertain. Completing the vulnerability and impacts assessment and the DPSIR helps to identify long-term priorities and levels of available capacities necessary for responding to future challenges. Together with priority adaptation options, they will guide you in deciding about long-term adaptation options.

Finally, it is important to keep in mind that the climate will continue to change in the future and future adaptation measures may be required. Maintaining and updating a list of potential adaptation options will allow responses to climate change to be implemented in the future when there is a need for further adaptation and/or mitigation and the performance of various options is less uncertain (Willows and Connell, 2003).

Box 12: The process of guiding implementation of adaptation responses in Kiribati

The Government convened a First National Consultation in the Gilberts and Line Islands, where representatives from each of the major inhabited islands identified recent large hazards and proposed strategies for adaptation.

1. Adaptation prioritization and responsibilities.

During the Second National Consultation, island representatives rated the adaptation options and classified them in four categories:
A = Urgent adaptation options that can be done by communities themselves
B = Urgent adaptation options for which communities needed assistance from the government
C = Adaptation options that were less important/urgent
D = Adaptation options for which there was no need or willingness to implement
Type B adaptation options were then allocated to the responsible ministries.

2. Assessment of response required.
The adaptation options derived from the national consultation were then divided into five categories, according to the nature of the response: (i) changes to government policies and strategies; (ii) changes to laws and regulations; (iii) interaction of extension and information with communities; (iv) Formal adaptation investments and engineering works by government, island councils and contractors; and (v) informal adaptation investments by communities

3. Implementation of adaption options into ministries' operational plans.
The adaptation priorities were then circulated to all the relevant ministries. Those judged to be relevant and consistent with ministerial strategies were identified for funding under specific government programs and matched by external funding at 50 per cent. Urgent adaptation measures implementable by communities alone are expected to be supported through a small grants program.

Adaptation option	**Type of response**	**Priority category**	**Lead ministries**	**Applicable program in ministerial operational plans**
- Awareness - Awareness raising about climate change	Extension information	B	MELAD MCTTD MEYS	MCTTD – Provision of meteorological information to users MEYS – Curriculum development
- Water Resources - Protect water wells - Assess and locate available water - Water pumps and pipes to link good sources with settlement areas - Installation of freshwater tanks	Formal engineering and construction works	B B B B	MPWU MPWU MPWU	MPWU – Water Engineering Unit Design Rehabilitation and Implementation of Water Systems in the Outer Islands
- Inundation/Coastal Erosion - Plant mangroves - Limit removal of aggregates - EIA on coastal dev. activities - Prohibit types of development that destroy the environment (e.g., causeways)	Extens/Info Reg. Changes Reg. Changes Reg. Changes Reg. Changes	B B B B B	MELAD MISA MELAD MELAD MELAD	MELAD – Improving Env. through Conservation and Protection MISA – Rural planning and coastal erosion

Source: World Bank, 2006

Exercise 6: Developing an implementation plan

1. Build on the priority adaptation options from the previous exercise and outline them in a policy-relevant manner.

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2. Use a simple scale to estimate costs of adaptation options compared to cost of inactions to help justify the need for actions. (For example, investing in restoring coastal ecosystems and building a dyke will cost less than the last two flood damages).

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3. Create an overview of key priorities in a road map to implement the identified adaptation options.

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4. Identify capacity gaps that need to be developed for the successful implementation of the identified adaptation policies.

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Be prepared to participate in the plenary discussion.

Communicating climate change and adaptation

Module 7 of this training manual deals with the communication of the assessment, and Module 3 deals with design of an impact strategy. The entire training manual is designed to provide the capacity to address vulnerability and impacts of climate change and develop adaptation responses that promote sustainable

development and resilience. To progress toward policies and implementation, the options identified need to be communicated in a language that speaks to the target audience.

Expanded efforts are needed to collect knowledge from the experiences and practices, such as traditional knowledge, of at-risk groups. Mechanisms are also needed to integrate, interpret and communicate the created and collected knowledge and to assist stakeholders applying the knowledge in decision-making. It is also very important to use the communication to motivate, support and ensure that skills of policy-makers and leaders at the local level are improving on issues related to climate change and ensuring that diverse voices on the topic are given the opportunity to express their viewpoints. For some creative ways of communicating climate change see Box 15.

Box 15: Communicating climate change and adaptation

Makutano Junction – The Soap Opera

Makutano Junction is a gripping Kenyan produced television soap opera that currently attracts over seven million viewers in Kenya alone. It aims both to entertain and educate English-speaking African audiences. Set in a fictional Kenyan village, it follows the loves and lives of a colourful cast; romance, comedy, corruption, tragedy—it's all in there! The *Makutano Junction* was also conceived as a means of disseminating valuable information through an engaging and accessible medium. *Makutano Junction* viewers identify issues of interest to them, such as income-generation; mental and physical health; rights and responsibilities of good citizens; and development challenges including environment, which are then incorporated into the storylines. Eight series (comprising 13 half-hour episodes each) have now been produced and are being broadcast in Africa. (www.makutanojunction.org.uk)

Finally, communicating climate change is a continuing challenge. It requires providing information for different groups, including youth, community leaders, experts from diverse fields and members of governments, from the local to the national. All these groups require targeted messages. For details on communication please see IEA Module 7.

For further details on designing of an impact strategy see IEA Module 3

For further details on communication see IEA Module 7

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Module 1: The GEO approach to integrated environmental assessment
Module 2: National IEA process design and organization
Module 3: Developing an impact strategy for your IEA
Module 4: Monitoring, data and indicators
Module 5: Integrated analysis of environmental trends and policies
Module 6: Scenario development and analysis
Module 7: Creating communication outputs from the assessment
Module 8: Monitoring, Evaluation and Learning – for improvement and increased impact of the IEA process
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Appendix

Setting IEA in the context of existing UNFCCC processes

In the climate change negotiation process, the need to address adaptation to climate change in Least Developed Countries (LDCs, UNFCCC Art.4.9) is as fundamental as addressing mitigation efforts by industrialized countries. However, for both developing and developed countries, it is also crucial to focus on adaptation to climate change and other vulnerabilities so that countries are prepared for the impacts of climate change that we are already committed to. Preparing and implementing national adaptation programs of action (NAPAs) is recognized as the first step towards the creation of enabling environments for mainstreaming adaptation policies and strategies in LDC development planning.

NAPAs communicate urgent and immediate adaptation needs based on a comprehensive eight-step methodology ranging from the set up of a multidisciplinary team to ranking and prioritizing the country adaptation options that lead to the design of project profiles. These profiles will be developed into full projects and implemented.
The elaboration of NAPAs is therefore centred on:

- a participatory approach taking into account the relevant stakeholders (in particular concerned communities);
- a multidisciplinary approach linking economical, social and environmental factors; and
- the inclusion of already existing development plans and international environment agreements.

It is evident that the NAPA process is based on an integrated evaluation of adaptation needs.
In this context, despite similarities, the integrated environmental assessment (IEA) is neither a new NAPA process nor a competing methodology. The IEA could be envisaged and utilized as a toolbox to assess the vulnerability of countries, prioritize adaptation options for all the agreed-upon exercises under the UNFCCC, such as national communications, NAPAs or other similar requirements in other environmental accords. In other words, the NAPAs could be defined as policy-making endeavours, while the IEA is a tool to assist in conducting environmental assessments at local, regional and national levels.

Another distinction could be seen in the implementation of the adaptation options developed under each of these two methodologies. The NAPAs are documents to be officially endorsed by each LDC and submitted to the UNFCCC Secretariat for possible implementation under the LDC Fund, and managed by the Global Environment Fund. The IEA, being a pure technical methodology, does not aim to offer the same implementation and funding opportunities as policy documents like NAPAs agreed upon by all UNFCCC Parties. Indeed, as already mentioned above, the eighth step of the NAPA process expressly enables the elaboration of project profiles into full project documents to be executed on the field.

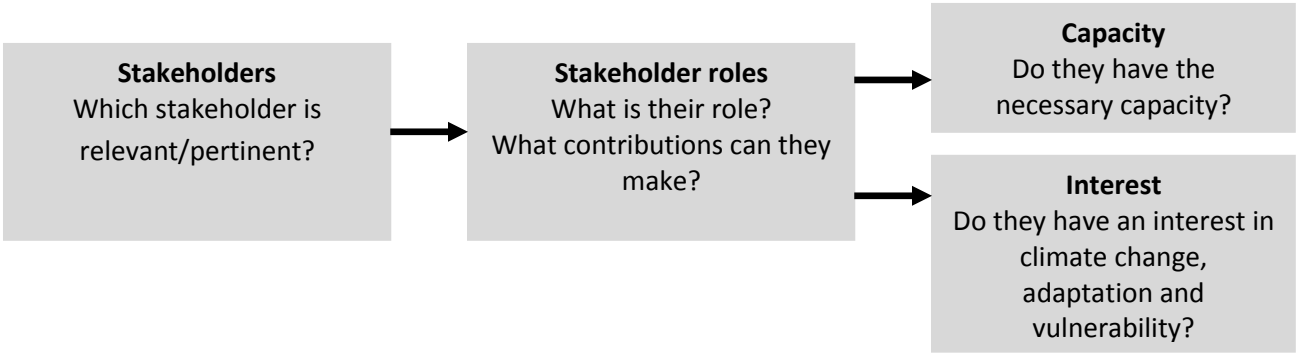
The differences between the two processes establish the unique purpose of each of these methodologies. For example, the multidisciplinary teams that must be created as the first step of the exercise may be less interdisciplinary for the NAPAs than in the IEA, as some political aspects (such as the country-driven aspect of NAPAs) may influence the whole process and its expected outcomes. For any team trying to conduct an IEA, the opportunities to create a trans-disciplinary team involving the public sector, the private sector, the civil society and the international organizations could be an opportunity to have a much wider scope.

Facilitator's preparation guide

In this section, we will provide a list of key steps and issues that the training facilitator should address before the training session. The key issues and steps include:

1. Inviting key stakeholders
2. Preparing materials for the participants of the training
3. Review of the exercise

Figure 3: Identifying stakeholders, their roles and interests



Sources: UN HABITAT (2002) in IEA Module 2

Identifying key stakeholders

Stakeholder involvement is an essential component of IEA in general and helps strengthen the assessments' relevance and legitimacy. As climate change affects a very wide segment of society, consider involving a wide range of stakeholders.

Assessing vulnerability to climate impacts at the local and regional level and developing adaptation options are strongly based on involvement and knowledge of stakeholder diversity, including community members, policy-makers, researchers, experts, civil society, non-governmental organizations and media. Local community members have valuable knowledge about consequences of climate change impacts and many of the adaptation options are already familiar to communities, even if they are not explicitly recognized as helping to reduce vulnerability to climate change. Building on the familiarity of these actions increases the empowerment of local communities and decision-makers, as they can see themselves as valuable sources of knowledge for developing responses to climate change.

In order to assure that the different stakeholders are represented, a *stakeholder analysis* is very helpful. The analysis identifies and examines key stakeholders, fulfilling criteria such as representation across sectors, gender and available capacities. The analysis alone does not guarantee, however, that the identified stakeholders are going to be active in the process—this may require incentives and strong leadership (Figure 3).

Stakeholder analysis includes three elements (IEA, Module 2):

1. *Key issues or problems that will be discussed throughout this module*. Identify stakeholders relevant to the vulnerability, climate change impacts and adaptation issues.

2. *Stakeholder long list*. Prepare a detailed list of stakeholders, structured by general categories (such as public sector and private sector) as well as sub-categories (see Table 1). The list should include stakeholders that meet any of the following criteria:

- They are affected by climate change and/or living in the areas of high vulnerability, which could be exaggerated by progressing climate change.
- They have information, resources or expertise required for climate change impact and vulnerability assessment, policy formulation and strategy implementation.
- They have control or influence on key mechanisms for adaptation and strategy formulation, implementation and communication.

Facilitators' can use Table 6 to identify key stakeholders. Often, participants that attend trainings focused on climate change are affiliated with meteorological offices, working with climate models and creating projections of climate variables, so they are familiar with projections for their regions and some impacts. However, it is often interesting to them to think about vulnerability, potential consequences of the impacts of climate change on human well-being and the environment, and also be engaged in developing adaptation responses. On the other hand, participants that are well aware of local vulnerabilities may not know how to work with climate data and how to link projection to people's livelihoods and environment. Therefore, it is important to think ahead and try to invite a variety of stakeholders.

Table 6: Example of a detailed list by influence and interest

	Influence to promote action at different levels of governance	**Interest in participating in work on climate change**	**Capacity to participate (expertise, data, availability etc.)**
Public Sector			
National climate change and sectoral authority			
Officials of national and regional public agencies Sectors and departments			
Regional and local government representatives Sectors and departments			
Scientific community and academia			
Private Sector -			
Business representatives			
Mass media			
Civil Society			
Community groups			
NGOs			
International organizations			
UN agencies			
European Union			
International Trade Organizations			
ASEAN			
NEPAD			

For further details on stakeholder involvement see IEA Module 2

Preparing materials for the participants of the training

Before the actual training, we would suggest that trainers prepare some key input for the event. Because Internet access could be a challenge in some locations, we would suggest downloading and printing projections of climatic variables before the training. If the participants represent one country, the datasets relevant for the country should be downloaded. If the participants are from different countries, during the exercises the groups can work on their particular region of interest. The facilitator should identify the countries and collect the data sets before the training.

The data can be downloaded from two sources:
1. Go to: http://sdwebx.worldbank.org/climateportal. Click on the country of interest and then scroll down on the site to see the listed data; this data set also shows how different models (and how many) projected similar trends.
2. Go to: http://preview.grid.unep.ch/. Select the country, timeline and listed events, such as cyclones, winds and surges or droughts and floods, and then create a map of past significant climate-related events.

If it is not possible to download and print the data, participants could complete the exercises by using information on climate change listed in Table 6. If the training is conducted with participants from one country or with focus on neighboring countries with similar climate change issues, local experts could be invited to provide a short (15 min) presentation on climate change impacts before Exercise 3.

Finally, we would also suggest that the facilitators assess the audience's knowledge of climate change at the early stages of the workshop. If the audience is knowledgeable about the basic definitions, and major past and present impacts, then the facilitator could proceed directly to the first chapter, 'Characteristics of Vulnerability and Scope of the Assessment.'

Review of the exercises

	Key description	Suggested time	Suggested reporting back
Exercise 1	Defining the scope of the assessment and report	5 min. for individual thought-gathering and 15 min. for a plenary discussion	Plenary discussion focused on the three question listed in the exercise Facilitator could write down the potential key elements of the ECCO assessment and report
Exercise 2	Understanding current exposure, sensitivities of people and environment, and identifying coping measures and role of policies that impact the areas, both by building resilience and by undermining capacities and responses	15 min. for the small groups and 15 min. for reporting back	Each group will list major exposure and sensitivities (up to three examples of each) Briefly question selected groups in the room until you collect three to five examples for each question: Could you list some examples of coping strategies? What policies contribute to these strategies? What policies are actually halting the coping actions?
Optional exercise 3*	Selecting and indentifying indicators to assist in monitoring vulnerability to climate change, climate variability and weather related events	15 min. for the small group work and 15 min. for the reporting back	Briefly question selected groups in the room until you collect three to five examples for each question: What are the examples of the indicators? Have you used these indicators before? Is there any change because you are focusing on climate-related exposures?
Exercise 4	Impacts of climate change on environment and human well-being in the context of other pressures and drivers	30 min. for the group work	No reporting back
Exercise 5	Identifying and prioritizing adaptation responses	30 min. for the group work 30 min. for reporting back	Each group will report back on what are the most significant impacts and the prioritized adaptation actions
Exercise 6	Developing an implementation plan	15 min. for the group work and 30 min. reporting back The exercise could be also done in plenary going through each question collectively If limited time is available select only some of the four questions	Focus on the four key questions in roundtable format: 1. List the adaptation policies. 2. List the identified capacity gaps that need to be developed for the successful implementation of the identified adaptation policies. 3. List the key priorities of a road map to implemented the identified adaptation options. 4. List the estimated costs of adaptation options compared to the cost of inaction to help justify the need for actions.

*Consider using this exercise if you are conducting a one-and-a-half day training seminar, or you plan to skip some of the exercises

Suggestions for integrating vulnerability, climate change and adaptation into IEA process

Climate change is becoming a reality and we need to be able to assess present and future vulnerabilities and to identify adaptation responses. Below, we outline key areas of integration of issues related to climate change into the IEA process. For more information on the overall IEA process, see IEA Module 2.

Stages of the IEA process	**Activities**	**Integration of climate change, vulnerability and adaptation**
Stage 1 Start-up (4–6 weeks)	*Secure legal mandate for environmental assessment and reporting. *Identify a local technical team within the lead agency. *Develop a basic outline for conceptual framework and process, capacity, time and resources required. *Hold start-up meetings to discuss, adjust and finalize the process and institutional arrangements. *Secure commitment for resources and in-kind contributions.	Include vulnerability, climate change impacts assessment in the conceptual framework Invite institutions with access to climate change projections.
Stage 2 Institutional set-up (1–3 months)	*Define roles and responsibilities of the political and technical partners. *Establish mechanisms of coordination among partners and collaborating institutions. *Define an institutional framework. *Discuss the elements for the impact strategy. *Prepare a stakeholder map.	When preparing the stakeholder map, also consider people who have information, resources or expertise required for climate change impact and vulnerability assessment, policy formulation and strategy implementation.
Stage 3 Scoping and design (2–4 weeks)	*Clarify methodological issues. *Establish geographic boundary and detailed timeline for producing the report. *Identify key environmental issues. *Identify indicators, data requirements and sources of information. *Draft an outline of the report. *Identify the target audience. *Develop the impact strategy. *Discuss the elements for a communications and outreach strategy.	Identify key areas of vulnerability (exposures and sensitivities) in the selected location. Identify current coping strategies and policies in supporting or halting them.
Stage 4 Planning (4–6 weeks)	*Define activities in the process, assign responsibilities and identify expected outputs. *Allocate financial and human resources. *Review and adjust the impact strategy and define indicators of impact. *Develop a communication and outreach strategy. *Establish a monitoring and evaluation system.	Include vulnerability, climate change and adaptation communication and outreach strategy and the monitoring and evaluation system.
Stage 5 Implementation (10–12 months)	*Validate priority environment/development issues and their connection according to the IEA framework. * Collect, process and analyze data and information. *Present and discuss preliminary results with relevant partner organizations.	Validate identified areas of high vulnerability, impacts of climate change and prioritized adaptation options

	*Write draft report, organize peer review and finalize report based on feedback. *Translation and publication (hardcopy, CD, website, etc.).	
Stage 6 Communication of results & outreach (1–2 months)	*Promote different IEA products and messages. *Organize interviews with the media. *Organize presentations for stakeholders.	Include audiences and sectors that need to consider the impacts of climate change and adaptation presently and in the future.
Stage 7 Monitoring, evaluation and learning (1–2 months)	*Evaluate the process. Identify lessons learned. *Evaluate the impact of the process in terms of contribution to policy planning, capacity building and public awareness.	Focus on examples of adopted adaptations and their effectiveness, new climate change projections.

For further details on the IEA process see IEA Module 2

Examples of the IEA Report Content with Included Vulnerability, Climate Change and Adaptations for Regional or Sub-National Reports

In IEA Module 2, an example of the list of content for the IEA report is provided. We modified this list of content by adding suggestions for where to include issues on vulnerability, climate change, impacts and adaptation actions. However, this list of content is only indicative and each country team needs to decide about the specific content reflecting on the country priorities.

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Data and metadata sheets

Sources of further information

UNFCCC resources:
Meeting website:
http://unfccc.int/adaptation/nairobi_work_programme/workshops_and_meetings/items/4742.php
Nairobi work programme on impacts, vulnerability and adaptation to climate change:
http://unfccc.int/adaptation/nairobi_work_programme/items/3633.php
Adaptation planning and practices
http://unfccc.int/adaptation/nairobi_work_programme/programme_activities_and_work_areas/items/3991.php
Gateway to the UN System's Work on Climate Change:
http://www.un.org/wcm/content/site/climatechange/gateway
UN International Strategy for Disaster Reduction http://www.unisdr.org/

Intergovernmental Panel on Climate Change (IPCC) provides information on the organization's meetings, reports, speeches and presentation materials. Full assessment reports, a summary for policy-makers and a technical summary of the Working Group II Report, *Impacts, Adaptation and Vulnerability*, can be accessed at: http://www.ipcc.ch.

Food and Agriculture Organization (FAO) on the United Nations website describes adaptation measures and provides links to information on win-win adaptation: http://www.fao.org/clim/adaptation_en.htm.

World Health Organization (WHO) provides information on linkages between climate change impacts, disease occurrence and related vulnerabilities: http://www.who.int/topics/climate/en/.