Forests and Climate Change Working Paper 2

Adaptation of forest ecosystems and the forest sector to climate change

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Foreword

Issues regarding land use, land-use change and forestry have being receiving increased attention in the multilateral negotiation process on climate change. Remarkable progress has been made in discussions of definitions and methodologies and in capacity building for the inclusion of forestry activities in the mitigation of climate change.

While most efforts have been directed to mitigation measures, less attention has been given to the development of practical tools for analysing vulnerability and options for adapting forest ecosystems to climate change, particularly at the national and local levels in developing countries.

The Food and Agriculture Organization of the United Nations (FAO) and the Swiss Agency for Development and Cooperation (SDC) recognize the need to provide practical tools for analysing the vulnerability and adaptation capacity of forest ecosystems and social groups that are potentially affected by the negative impacts of climate change.

This document has been prepared jointly by FAO and Intercooperation. It is intended to assist policy-makers and other professionals involved in the planning, project formulation or implementation of adaptation measures for climate change in forest ecosystems. It is of particular interest to the people who deal with national communications to the United Nations Framework Convention on Climate Change (UNFCCC).

We trust that this publication will also be useful those responsible for developing national policy frameworks for adaptation to minimize the effects of climate change, and to reduce vulnerability of societies, as part of national development strategies addressing poverty alleviation and food security.

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Acknowledgements

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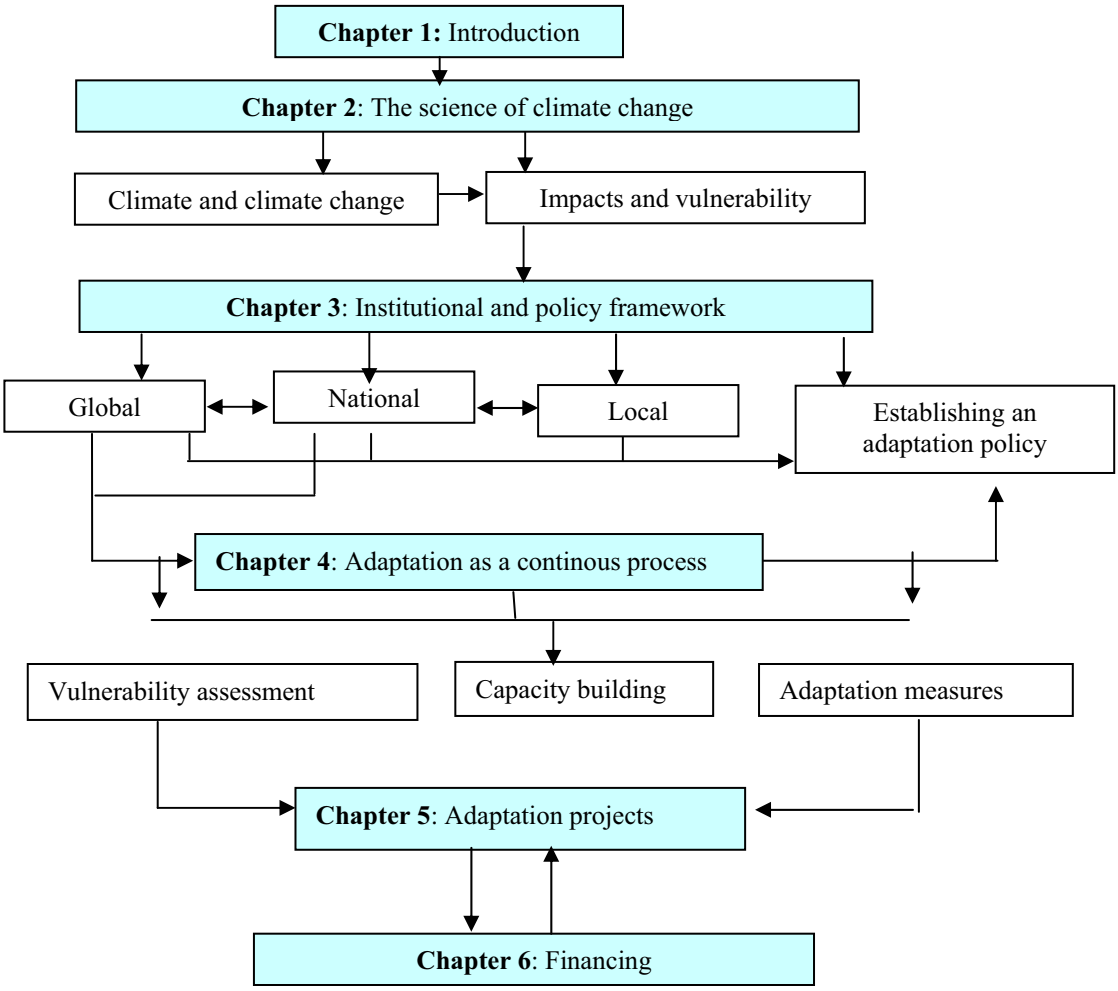
Executive summary

This document summarizes information that facilitates the definition and formulation of policies and projects aimed at decreasing vulnerability to climate change, with special emphasis on forest ecosystems and the social groups that depend on them. It emphasizes that adaptation to climate change must be part of a country's development process, and that every adaptation action should be framed within the national development policies. The structure of the document is summarized schematically in Figure A.

- Chapter 1 introduces the topic of climate change in the context of international policy-making, its relationship to sustainable development, and the most important environmental conventions of the United Nations system organizations.
- Chapter 2 provides a theoretical basis for responding to the problem of climate change, starting with a summary of the scientific knowledge accumulated so far. It also presents a description and analysis of positive and negative impacts deriving from a changing climate, with emphasis on forest ecosystems. This chapter includes a summary of methodologies for vulnerability analysis.
- Chapter 3 deals with international institutions and the challenges for institutional development at the national level, including the importance of adaptation policy as the framework for actions aimed at decreasing vulnerability.
- Chapter 4 presents stages in the process of adapting to climate change and their concrete application in the forest sector.
- Chapter 5 focuses on projects for each stage of the adaptation process. It presents examples of potential projects that cover the national, subnational and very local levels. A methodology for formulating such projects is also described.
- In conclusion, Chapter 6 deals with financing. It considers the limitations of UNFCCC and widens the spectrum to include all those entities and financial mechanisms that are interested in sustainable forest management.

Figure A
Document structure



1. Introduction

The concept that the composition of the atmosphere plays a fundamental role in defining world climate is not new. In 1827, Baron Jean Baptiste Joseph Fourier concluded that our atmosphere acts like a greenhouse glass that captures solar radiation. His theory was called the "glass effect" (*effet de verre*). His work stimulated John Tyndall (1860) to research heat propagation through gases, and Svante Arrhenuis (1890), who was the first to make projections of temperature changes on earth resulting from increased carbon dioxide concentrations in the atmosphere. However, the phenomenon of global warming was not taken seriously until the middle of the twentieth century. By then, ice samples in the Antarctic provided the scientific community with concrete information that related carbon dioxide concentrations with the greenhouse effect.

There is already ample evidence to show the relationship between increased concentrations of greenhouse gases (GHGs) in the atmosphere and climate change, such as changes in the incidence and intensity of hurricanes and droughts. This tendency of the climate to "worsen" has considerable negative impacts on the economy, natural systems and society. It is therefore necessary to work in search of solutions, even though the available information on climate change and its impacts is still relatively uncertain.

The main institutional response to the problem of climate change has been the establishment of the United Nations Framework Convention on Climate Change (UNFCCC), under which two courses of action have been defined. The first of these is *mitigation,* which focuses on the problem source, i.e. on all those activities that aim to reduce GHG emissions. The second is *adaptation,* which focuses on the impacts and affected systems, i.e. on all those activities aimed at reducing the vulnerability of society and its natural resource base. Through the convention, the governments of many countries have committed themselves to designing strategies, cooperating in technical and financial matters and implementing actions that follow these two courses of action.

Although the international community has placed greater emphasis on mitigation, adaptation is also gaining importance as governments advance in the implementation of UNFCCC, and as extreme climate events become more frequent and intense. Developing countries have undertaken a number of activities aimed at studying and analysing possible climate change impacts that may affect their future well-being. Stakeholders participating in the UNFCCC process agree that there is a need to increase adaptation efforts.

In the specific case of forest ecosystems and the forest sector,[1] adaptation represents an enormous challenge for two main reasons. The first is the lack of knowledge about the sector's vulnerability, and the second is the lack of experience in the field. Forest ecosystems are among the natural systems that will be severely affected by climate change (see, for example, Pérez-García *et al.,* 2002; Walther *et al.,* 2002; IPCC, 2001a). Unfortunately, the impacts of climate change on forest ecosystems and the forest sector have been evaluated in only very general terms.

CLIMATE CHANGE AND INTERNATIONAL POLICY

Sustainable development and the conventions

The term "sustainable development" was already in use in the 1970s, but sustainable development itself did not become a worldwide strategic objective until 1987, the year in which the World Commission on Environment and Development was established (better known as the Brundtland Commission). The Brundtland Commission recognized that there is a relationship between economic development and the environment. Its report, entitled *Our common future*, can be considered the

[1] In this document the term "forest sector" refers to the whole sector, while forest sector includes only the administration.

starting point for multilateral work concerning environment and development topics. This report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The concept of sustainable development acknowledges that any development process should keep in mind the interactions among social, environmental and economic issues. The definition of sustainable development is based on the principle of equity among generations, and highlights the fact that future generations depend in great measure on the present generation's capacity to maintain a healthy environment, a solid economy and a stable society.

The concern for environmental deterioration and its implications for social and economic development laid the foundations for the first summit on the environment and development, better known as the Earth Summit, in Rio de Janeiro (Brazil) in 1992. The most important results of this summit included Agenda 21 and two conventions: the Convention on Biological Diversity (CBD) and the UNFCCC.

The second Earth Summit took place in Johannesburg (South Africa) in 2002. Its objective was to review progress on the activities and goals agreed to during the Rio Summit. Among many other agreements, the participating governments ratified UNFCCC as the main instrument for addressing climate change.

The importance of multilateral processes as an international policy instrument is that they create a space for action in which decision-makers, policy-makers, researchers, non-governmental organizations (NGOs), financial organizations and others interact with the common objective of addressing a specific problem. The establishment of such processes includes the design and implementation of a series of commitments to achieve specific objectives. The following are among the most important of these:

- technical cooperation;
- capacity building;
- financial support;
- national communications and reporting;
- networks and exchanges of experts;
- monitoring of activities;
- other concrete actions (e.g. establishment of protected areas, reduction of GHG emissions).

Box 1.1. What is a convention?

In legal terms, a convention is a group of contracts, treaties, pacts or agreements resulting from the consensus of two or more parties. Conventions arise from the recognition that a problem exists and that there is a need to unify efforts to solve it. They specify the tasks and commitments that are required to achieve a specific objective. Examples of conventions related to environmental issues include the Basel Convention on Toxic Waste, the United Nations Convention to Combat Desertification (UNCCD), and the Convention on Biological Diversity (CBD).

Conventions under the United Nations deal with global problems whose solutions require the participation and commitment of as many parties (e.g. governments) as possible. As well as environment and development, problems such as poverty, biodiversity loss, desertification and global warming have been identified as being of particular importance, and the need to unify the international community's efforts to tackle these has become evident. Frameworks and multilateral policies provide the means for signatory countries to commit themselves to generating opportunities for national stakeholders to implement activities conducive to compliance. From a practical point of view, the decision-making process is the main tool of the international policies under a convention. Decisions are agreements that cover specific issues (e.g. a requirement to report on the state of forest ecosystems, and stipulation of how to do so). They are designed and negotiated during the meetings of the units that make them.

In all conventions, decisions are formulated and adopted by a series of bodies that are comprised of government delegates and experts. The following bodies are part of UNFCCC:

- The Conference of the Parties (COP) is the highest authority of a convention and is in charge of decision-making (i.e. of adopting policy documents).
- The Subsidiary Body on Scientific and Technical Advice (SBSTA) is responsible for preparing policy documents. It responds to the directives of the COP.
- The Subsidiary Body for Implementation (SBI) is responsible for reviewing the implementation of agreements and decisions approved by the COP.
- A Secretariat is in charge of facilitating and providing logistical support to the meetings of the COP and subsidiary units. The Secretariat also gathers policy information (decisions) as well as information on implementation (national communications and inventories of GHGs).

Box 1.2. The Conventions on Biological Diversity and to Combat Desertification

The Convention on Biological Diversity (CBD) was presented in 1992 during the summit at Rio. It deals with biodiversity loss throughout the world. Its objectives are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. It is important to point out that CBD works under the "ecosystem approach", which integrates economic, social and environmental issues. As for most conventions, CBD establishes a framework for technical and financial cooperation to support signatory countries in their efforts to comply with the tasks and objectives of the convention. Additional information is available from www.biodiv.org.

The United Nations Convention to Combat Desertification (UNCCD) has the objectives of combating the advancement of desertification processes, and mitigating drought effects in those regions that are particularly vulnerable to this phenomenon. As Africa is the region that is most affected by these problems, the convention places particular emphasis on Africa, and also supports Asia and Latin America. The commitments made by the parties to this convention are directed towards technical and financial aid. Additional information is available from www.unccd.int.

Some conventions are supported by groups of experts responsible for assessing and compiling scientific information. In the case of UNFCCC, this group is the Intergovernmental Panel on Climate Change (IPCC). IPCC is an independent entity that is not part of UNFCCC, although it has been recognized as the most important scientific institution for the convention. Among other tasks, IPCC is in charge of producing reports that gather the most up-to-date scientific and technical information on climate change and its impacts and on mitigation and adaptation. In addition to compiling this information, IPCC also elaborates methodological guidelines for reports, such as inventories of GHGs.

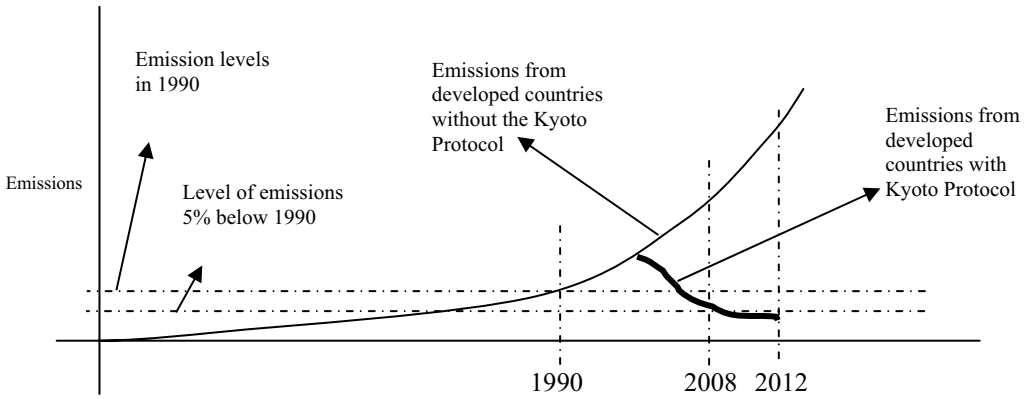
The United Nations Framework Convention on Climate Change

UNFCCC is a group of contracts, pacts and agreements that respond to world governments' interest in dealing with human-induced changes in the climate system and that institutionalize the consensus of a large number of countries. Its objective is to achieve "stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".[2] At present, it has 188 member countries (or parties) and has promoted a great deal of technical cooperation on renewable energy, protection of sinks (e.g. conservation of forest ecosystems), financing of scientific study of the impacts of climate change, and adaptation.

[2] The objectives, task and other elements of UNFCCC can be found on the convention's Web site at http://unfccc.int/resource/docs/convkp/convsp.pdf.

During the first Conference of the Parties (COP 1), which took place in 1995 in Berlin, parties concluded that the commitments under the convention were not sufficient to achieve its objective and that it was therefore necessary to negotiate a protocol that established specific possibilities for the reduction of GHG emissions. Two years later, during COP 3, the Kyoto Protocol was agreed. Through this instrument, the industrialized countries committed jointly to limiting their emissions to a level that is 5 percent below that of 1990 (Figure 1.1). This goal will be reached during the first commitment period between 2008 and 2012.

Figure 1.1
The Kyoto Protocol



Activities carried out by UNFCCC: Two options to achieve the convention's objective were defined during the negotiation process. *Mitigation* refers to all those activities aimed at the reduction and capture of GHGs. For this purpose, the convention encourages activities such as promoting energy efficiency, using renewable energy, and carrying out related research, cooperation and technology transfer. It also promotes activities aimed at carbon capture and fixation (e.g. conservation of forest ecosystems and reforestation activities).

The second option, which is the focus of this document, is *adaptation*. It refers to those measures aimed at reducing the impacts of climate change on the social, economic and environmental systems of a region or country. UNFCCC has developed a framework that promotes technical cooperation (especially aimed at developing analysis methodologies and monitoring systems), training and financing. It has also promoted research activities that have been carried out by universities, NGOs and the private sector.

Who might be interested in UNFCCC? Developments within the framework of UNFCCC are of interest to professionals who work in the forest sector, and social groups that are dependent on forest ecosystems or are linked to the forest sector for the following reasons:

- Within mitigation activities, the importance of forest ecosystems' capacity to capture and fix carbon is well known. The conservation of forest ecosystems and reforestation activities are included in the text of the convention.
- Adaptation activities within forest ecosystems and the forest sector consider the importance of such forest services as soil conservation and water cycle regulation.
- UNFCCC offers opportunities for technical cooperation and technology transfer.
- UNFCCC establishes financing sources for capacity building, institutional development and the implementation of adaptation projects.

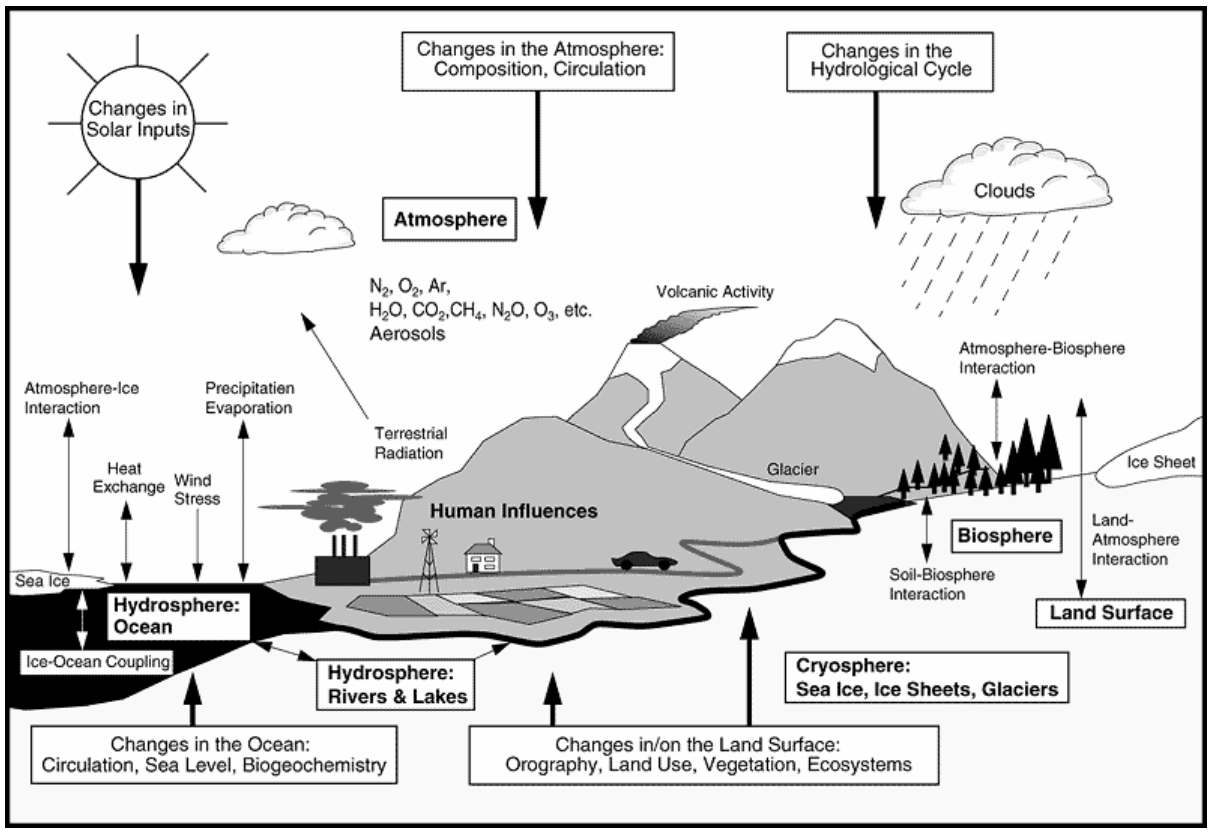
2. The science of climate change

CLIMATE AND THE CLIMATE SYSTEM[3]

The terms "weather" (hot weather, bad weather, rainy weather) and "climate" are used indiscriminately to describe the conditions of temperature, precipitation, humidity and wind present at a given time in a given area. Climate can also be defined as the average value of those variables in a given region at a given time.

Climate is determined by the interaction of the components of the climate system (the atmosphere, the hydrosphere, the cryosphere, the earth's surface and the biosphere) with external factors such as the sun and human activities (Figure 2.1). Some of the solar radiation that penetrates the atmosphere is reflected back into space and some is absorbed by the different components of the climate system (the atmosphere, cryosphere and hydrosphere warm up or cool down, and the biosphere uses solar energy in the process of photosynthesis). This energy exchange within the components of the climate system defines the temperature, wind, precipitation level and other climate variables. For the earth's climate to be stable, there must be a balance between the energy reflected towards space and the energy absorbed by the climate system.

Figure 2.1
Schematic view of the interactions among the components of the global climate system



Source: IPCC, 2001a.

[3] This chapter is based on IPCC, 2001a (edited by J.T. Houngton, Y. Ding, D.J. Griggs, M. Noguer, P.J. der Abut, X. Dai, K. Maskell and C.A. Johnsohn).

One of the most important phenomena to determine the earth's climate is the greenhouse effect. This has operated naturally since the earth's atmosphere first existed. The effect consists of some solar radiation being trapped in the atmosphere by a series of trace gases (GHGs) that reflect it on to the earth's surface, thereby preventing the energy from returning to outer space. The presence of GHGs in the atmosphere is the cause of the earth's pleasant average temperature of 14 °C.

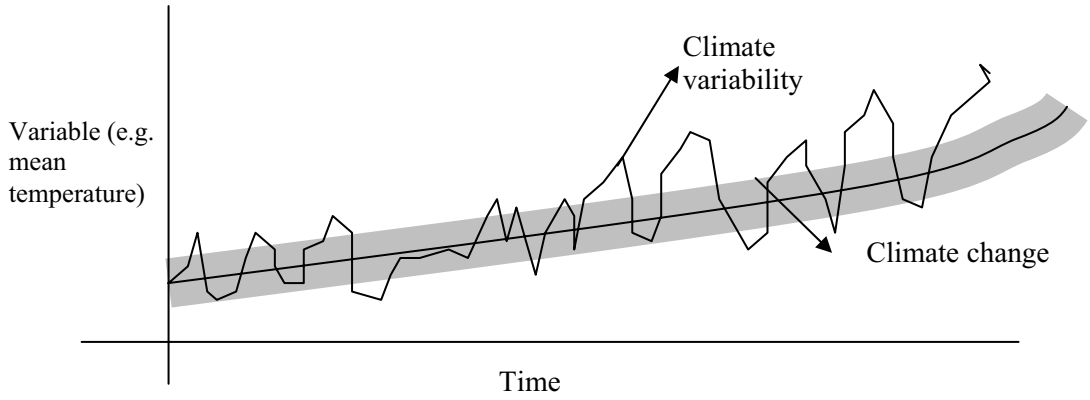
Climate varies according to latitude, altitude and such factors as vegetation cover, type and topography. It also varies from season to season, between years and over longer cycles, such as glacial eras. These variations are the result of natural phenomena, such as fluctuations in solar radiation, as well as anthropogenic activity.

The climate change problem that this publication is concerned with regards the modifications to the greenhouse effect that human activities have caused. Since the industrial era began, human activities have been altering the chemical composition of the atmosphere through increased emissions of carbon dioxide, methane and other gases, mostly from the burning of fossil fuels and changes in land use (deforestation and agriculture). This change in the composition of the atmosphere causes an increased greenhouse effect that can result in modifications to the planet's overall climate, such as temperature increases and changes in precipitation regimes, as well as in the intensity and frequency of extreme climate events.

CLIMATE VARIABILITY AND CLIMATE CHANGE

The impacts generated by climate variables have been studied for two time scales (Figure 2.2): variability of climate events (shorter-term), and significant changes in climate patterns (longer-term).

Figure 2.2
Climate change vs. climate variability



Source: Smit *et al.,* 2000.

The shorter-term "*climate variability*" refers to variations in the mean state of climate variables, such as deviation from mean values or changes in the frequency and intensity of extreme events. Climate variability is the result of the interaction of climate variables over the short term and does not necessarily represent a trend. Such variability is associated with probability in the distribution of peak events, such as the occurrence of maximum and minimum values of climate variables, for example abnormal heat waves, torrential rains and hurricanes, at a specific point in time.

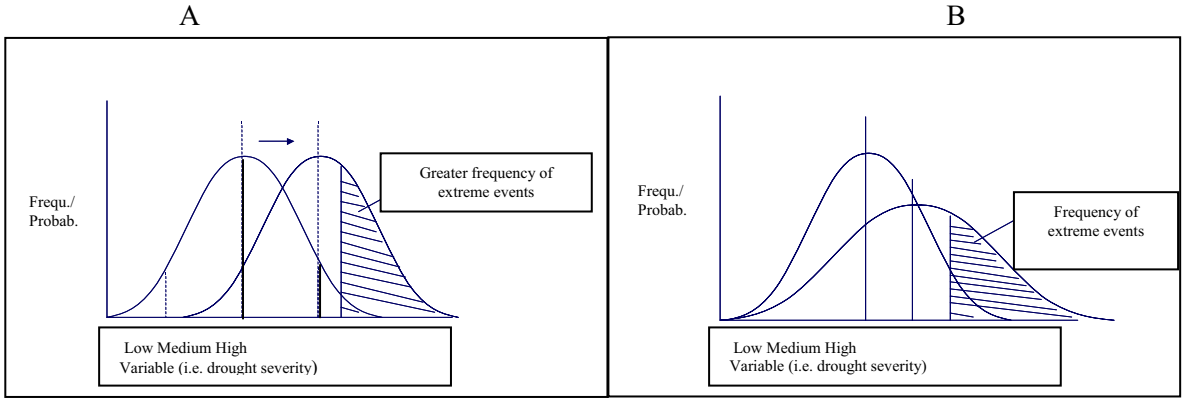
A well-known example of such variability is the quasi-periodic variation in climate extremes of drought and storms caused by the El Niño South Oscillation (ENSO) phenomenon, which is a response to the interaction between the atmosphere and the ocean in the tropical Pacific. The resultant El Niño and La Niña are events that generate worldwide impacts on weather and climate. Another example is the North Atlantic Oscillation (NAO), which has great influence on climate variability in Europe and western Asia, especially during the winter.

Variability of climate is greater at the regional or local levels than at the hemispheric or global ones. This is because regional or local climate variations are compensated for by variations in other regions, as a result of the interactions between atmospheric circulation and land and ocean surfaces. In other words, hemispheric or global climate variability is an average of the different climate variations at more restricted scales.

In the longer term, *climate change* is a significant statistical variation in the median state or climate variability that continues for a long period (measured in decades or longer). In other words, climate change represents a trend in the change of a climate variable, for example, the trend in temperature increase. For the purpose of international policy, UNFCCC has defined climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, in addition to natural climate variability over comparable periods". It is worth pointing out that UNFCCC differentiates between the alteration in atmospheric composition that is attributable to natural causes and the alteration that originates from anthropogenic activities.

Climate change can be represented graphically by plotting the displacement of the frequency and severity of climate events. Diagram A in Figure 2.3 shows a displacement of severity probability. This statistical displacement implies a greater probability or frequency of a determined extreme event (e.g. drought). Diagram B in Figure 2.3 illustrates the amplification of the range of extreme events. In this case, the range of extreme events is extended.

Figure 2.3
Variations in the frequency or probability of climate events



Source: Smit *et al.,* 2000: 234.

Climate change and temperature

The most studied climate variable in the context of climate change is temperature. Its average value has increased by approximately 0.6 ºC from the end of the nineteenth century. The warmest decade since data have been registered was the 1990s (Figure 2.4). Most of this increment took place during two periods: between 1910 and 1945, and from 1976.

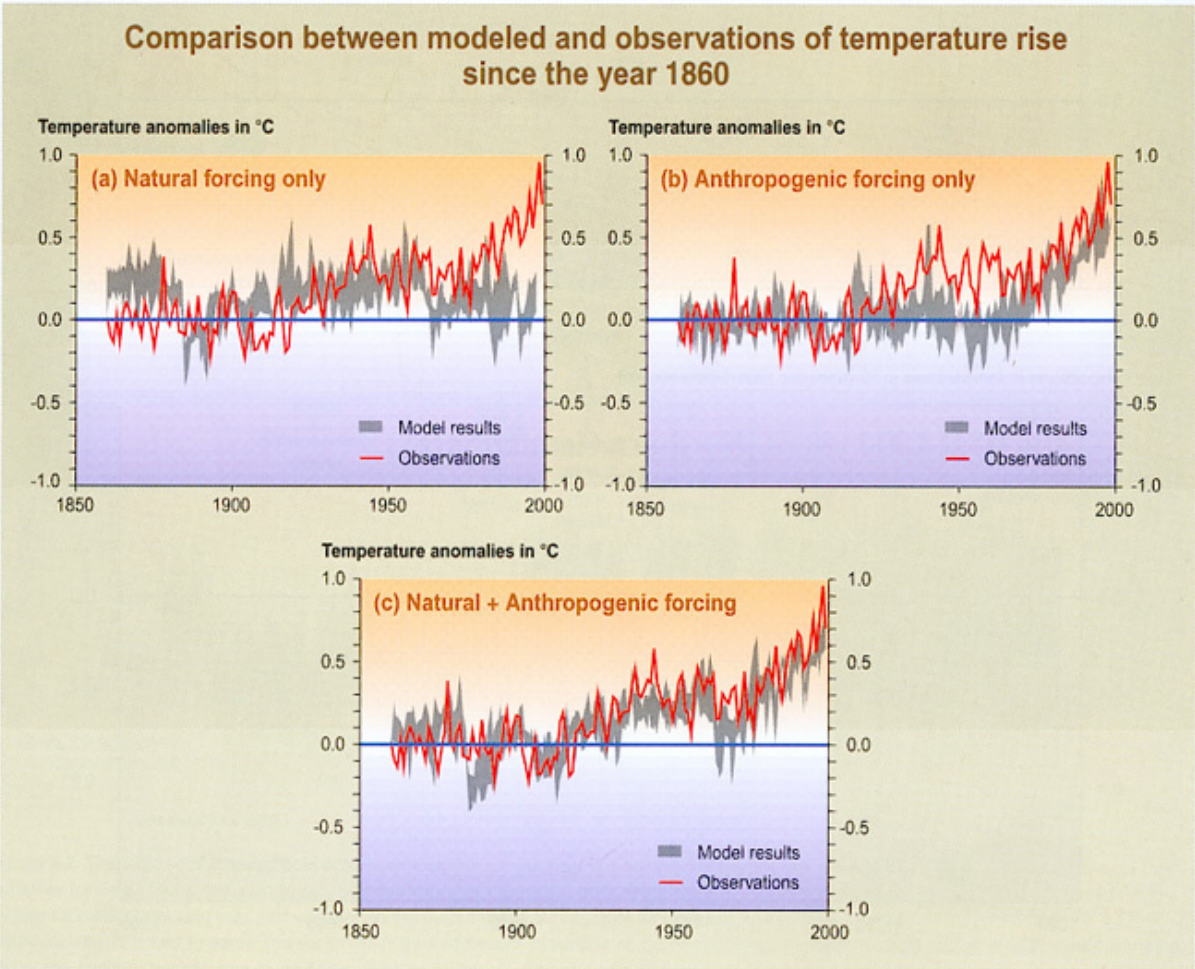
Even though the warming that started in 1976 has been global, the greatest increments occurred in the high and middle latitudes of the northern hemisphere. During this period, the following phenomena were observed:

1. *Changes in precipitation regimes and air humidity*, in particular increments in annual precipitation at high latitudes of the northern hemisphere, except for East Asia. Average rainfall in the subtropical belt has decreased. Precipitation in the tropics has increased slowly, but a measure of the increase has not been apparent in recent decades. At the same time, the water vapour in the atmosphere seems to have increased in many regions of the northern

hemisphere. There was also a cloud coverage increment of approximately 2 percent during the twentieth century, at high latitudes of the northern hemisphere.

2. *Changes in snowcaps and glaciers:* Reductions in the snowcap and the size of glaciers are related to warming of the earth's surface (the higher the temperature, the larger the decrease). Satellite images show a 10 percent reduction of the cap since the 1960s.
3. *Sea level changes:* Monitoring data show that the sea level has risen by about 1 to 2 mm per year, with a mean value of 1.5 mm/year. This rise in sea level is due mainly to thermal expansion of water (water expands with increasing temperature).
4. *Changes in the patterns of atmospheric and oceanic circulation:* Since the 1970s, changes have been observed in the behaviour of ENSO and NAO.
5. *Changes in the frequency and magnitude of extreme events:* New analysis has demonstrated that in regions where the total precipitation has increased, the incidence of extreme precipitation may also have increased. A recent example of this is the floods generated by rivers overflowing in Poland and Germany during the autumn of 2002.[4] There is also registered evidence of the opposite occurring, such as droughts in areas where the average rainfall has decreased.

Figure 2.4
Temperature changes combining the annual anomalies of the earth's surface, the air and the ocean surface between 1850 and 2000



Source: IPCC, 2001c.

[4] These floods were partly the result of the management regime applied to riverbanks in the regions concerned. However, had there not also been an impressive rain increment in just a few weeks, the floods would not have occurred.

Natural causes of climate change

Climate change variations can be the result of natural phenomena that influence the balance of energy on earth. These phenomena include changes in solar radiation and changes in the interactions among different components of the climate system (e.g. changes in the composition of the atmosphere due to volcanic activity or an increase in cloud coverage). The speed of response to such phenomena is different for each component of the climate system. While the troposphere reacts in a matter of days or weeks, the ocean responds over decades, centuries or even millennia owing to its thermal capacity. The biosphere can respond either rapidly, especially to extreme events such as droughts, hurricanes or floods, or slowly, to progressive variations.

Anthropogenic causes of climate change

Since the beginning of the industrial era, human activities have generated changes to some components of the climate system. First, changes in the atmospheric composition have occurred mainly because of fossil fuel burning. Second, changes in land use (e.g. deforestation) have interfered with the balance of GHGs between the atmosphere and the biosphere. Land-use changes have resulted in two important consequences for the present discussion: 1) an evident increase of GHG emissions; and 2) a change in vegetation and ecosystems that affects the physical and biological properties of the earth's surface, along with their speed and way of interacting with other climate system components.

Although still subject to debate, there is consensus among many scientists that the increment of GHGs in the atmosphere (mainly carbon dioxide and methane) is the main cause of the climate changes experienced. As already indicated, the occurrence of these gases is mainly due to the burning of fossil fuels (approximately 80 percent) and changes in land use. However, the geographical distribution of these causes differs for each activity, the burning of fossil fuels being greater in developed countries, while deforestation is greater in developing countries, particularly the tropics.

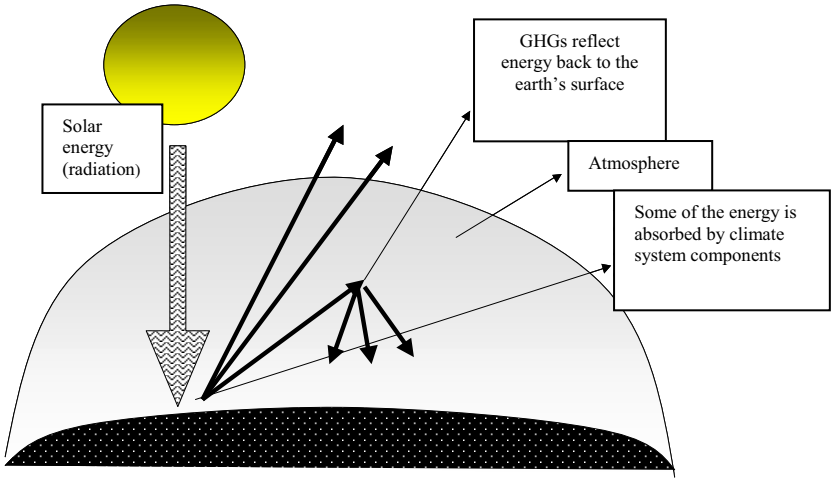
As already discussed, anthropogenic global warming occurs as a result of an imbalance in the amount of energy that the planet receives. When solar rays penetrate the atmosphere, the climate system components absorb some of their energy (partly as heat at sea and on land), while another part of the energy is reflected back towards space. Later on, part of the energy absorbed by the climate system components is also liberated. However, increasing concentrations of GHGs in the atmosphere decrease the amount of energy that is reflected back to space, thereby causing an imbalance of the energy on the planet and thus affecting global temperature (Figure 2.5). The effects of GHG emissions, added to the internal processes of the climate system, could end up generating a worldwide average temperature increase of between 1.5 and 4 °C.[5] To appreciate the magnitude of the effects that such a change could have, it is worth noting that the difference in mean temperature between the recent glacial era and the present interglacial era is between 5 and 6 °C.

The greatest impacts on the climate system caused by anthropogenic activity are summarized in the following:

- *Disturbance of the atmospheric composition:* For more than a thousand years before the industrial revolution, the amount of GHGs in the atmosphere remained relatively constant. Since then, the amount of carbon dioxide has increased by more than 30 percent, and continues to increase at a rate of 0.4 percent per year owing to the use of fossil fuels and to land-use changes. In addition, emissions of other GHGs, such as methane or nitrous oxide, continue to increase. It has been proved that the chlorofluorocarbons and other halogen compounds that have been introduced into the atmosphere by anthropogenic activities have a negative effect on the ozone layer and a high potential to increase the greenhouse effect.

[5] A global temperature increase does not imply a proportional local increase. Climate behaviour will be different in each part of the world, according to such variables as physiography and altitude.

Figure 2.5
The greenhouse effect



- *Land-use changes:* This term refers to changes in the use or management of land that result from the expansion of agriculture, changes in watering systems, afforestation and reforestation, as well as urbanization processes and the construction of roads and energy infrastructure (highways, railway lines, hydroelectric dams, electric interconnection lines, etc.). The processes of land-use change over the last two centuries account for 20 percent of global carbon dioxide emissions. Besides emissions, an important consideration for understanding the role of land use in climate change is the potential to sequester carbon from the atmosphere through photosynthetic activity. Activities promoting sequestration can help to mitigate climate change.
- *Effects caused by aerosols:* So far, it has not been possible to calculate in detail the effects of aerosols on climate change, although it is known that they have a direct effect on the dispersion of solar radiation back into space. In some cases, but only locally, this effect could counteract the greenhouse effect. However, owing to the short life span of aerosols and the complexity of the interrelations among the components of the climate system, it is very difficult to forecast the outcome of the relationship between these effects, as well as their interrelations with other components of the climate system.

IMPACTS, VULNERABILITY AND ADAPTATION

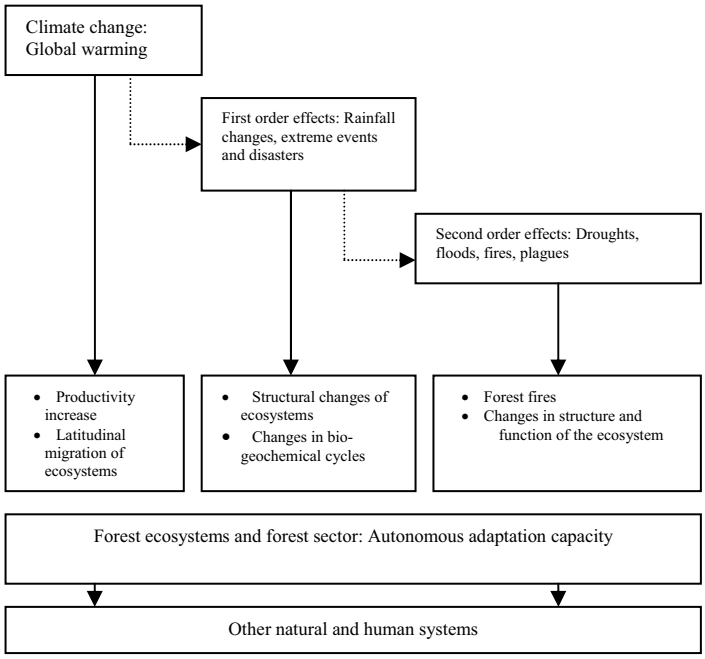
Overview

Impacts are the negative or positive consequences that result from an event. In the case of climate change, the increased concentration of GHGs in the atmosphere causes disruptions in the climate system such as changes in precipitation regime and the frequency and severity of extreme events (hurricanes, typhoons, etc.) or changes in the rhythm and intensity of such phenomena as El Niño (Figure 2.6). Owing to the multiplicity of geographical, environmental, social and economic conditions, an effect may bring positive consequences to one social group and negative consequences to another. For example, a rainfall increase can be beneficial to people who live in areas where water is scarce, but not for those who live in areas affected by floods.

The degree to which a system is expected to be affected by climate change depends on a series of determining factors. The first is the *magnitude* of the change: impacts are likely to be greater if the temperature increases by 3 ºC rather than by 1.5 ºC. Another determining factor is the *probability* that a change occurs, as well as the probability of its intensity. A third factor is the *rate of change*: the faster a change occurs, the greater the impact will be (e.g. the experience of a temperature increase of 5 °C over 50 years is different from that over 100 years). The fourth factor is the *duration of the*

change; for example, a heat wave, although temporary, can last for weeks or months, and the longer it lasts, the greater the impacts will be. A final factor is the *characteristics of the system*, referring to its tolerance and capacity to adapt to changes.

Figure 2.6
Effects of climate change at different levels



Vulnerability and adaptation

All systems have the capacity to react to a stimulus. In many cases, a response aims to reduce the negative consequences that the stimulus may produce on the system. Climate change represents a group of changes to the climate variables, which become stimuli that force a response from the systems they affect.

Experts have developed basic concepts for understanding the topic of adaptation. The first is *adaptation* itself, which can be defined as any adjustment by a system in response to climate stimuli. *Adaptation capacity* is the degree to which a system has the capacity to generate such adjustments. A third concept is *vulnerability,* which refers to the degree to which a system is susceptible to the negative impacts of climate change. These latter two concepts are strongly interlinked because a system's vulnerability is determined by its capacity to adapt: the greater a system's adaptation capacity, the less its vulnerability.

Box 2.1. Global impact of climate change

Scientists around the world have been researching and compiling information that makes it possible to understand climate change and its potential impacts on society and ecosystems. Among the changes expected are those affecting rainfall regimes, marine currents, water cycles and biochemical cycles (carbon and nutrients). Systematic monitoring activities in some regions have demonstrated impacts such as glacier recession, changes in the freezing and melting cycles of lakes and rivers, increases in the distribution of subtropical species in temperate areas, declines in the abundance of some species, and changes in the reproductive behaviour and metabolism of animal and plant species. IPCC's Third Assessment Report (IPCC, 2001a) concludes that ecosystems are highly vulnerable to climate change. With regard to forest ecosystems, the impacts mentioned previously, added to those generated by indiscriminate tree cutting, pollution and so forth, result in even higher vulnerability.

Autonomous adaptation: Autonomous adaptation refers to the automatic responses that every system generates to respond to a stimulus. For example, plants react to temperature changes by increasing or decreasing their transpiration. Such responses are automatic and their purpose is that the system involved withstands the change, provided that the minimum required environmental conditions are maintained and the changes do not occur too quickly for autonomous adaptations to take place. A system's vulnerability is determined by its autonomous adaptation capacity in such a way that:

vulnerability = potential impacts – adaptation capacity.

An illustration of this is a forest ecosystem that is affected by increments in droughts. A potential impact would be an increased risk of fire, so that any event that could trigger fire could severely damage the forest. The vulnerability of the system is determined by the impacts *per se* and the forest's capacity to overcome them (e.g. root structure, seed properties and so forth).

Planned adaptation: Human beings have the capacity to foresee impacts and generate responses aimed at minimizing them. The set of strategies and conscious actions to minimize impacts is called planned adaptation. Planned adaptation supplements autonomous adaptation, especially in cases where the system does not have sufficient autonomous capacity to overcome an impact, or where the autonomous adaptation responses generate a cost that could be reduced.

Planned adaptation determines the vulnerability of a system in the following way:

vulnerability = impacts – autonomous adaptation capacity – planned adaptation.

Continuing with the example above, the forest's autonomous adaptation capacity can be supplemented by planned adaptation aimed at reducing the vulnerability of the system. For example, a fire response plan is one of many strategies to support the adaptation of a forest.

The planned adaptation capacity of a social system is intimately bound to the degree of development of that system. Box 2.2 summarizes the factors that determine planned adaptation capacity.

Box 2.2. Factors that determine planned adaptation capacity

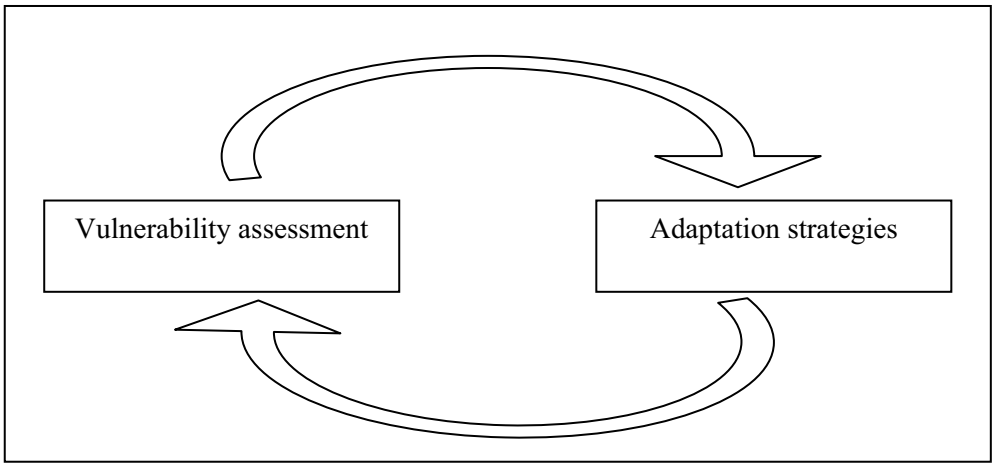
- ***Economy and equity:*** Economic activity is important because it generates resources for development investment and cash flow for consumers. An equitable, healthy and strong economy is less vulnerable and can allocate more resources for adaptation. A less vulnerable economy is one where enough resources are generated, and where these resources are equitably distributed among social groups and individuals.
- ***Technological development:*** This allows better technologies to be applied to responding to the impacts of climate change. The benefits of technology include cost reduction and the efficient use of resources.
- ***Technical capacity/human resources:*** Adaptation measures are designed, planned and carried out by humans. Adaptation strategies require an interdisciplinary group of people with detailed knowledge of the causes of the impacts, the characteristics of the affected systems and the possible solutions.
- ***Infrastructure:*** The development of activities related to an impact study and the determination of vulnerability requires means of communication, highways, etc. Infrastructure is of great importance to the response capacity for disasters and unexpected climate events.
- ***Institutional development:*** Institutions include the set of rules and laws, the administrative and political structure of a country, the rights and duties of citizens, financial mechanisms, and the government, non-governmental and academic organizations. The role of institutions in adaptation is to unite society, provide a common objective and facilitate the financial, technical and legal mechanisms that enable the society to adapt. Institutions provide scientific, technical, political and financial support to the adaptation process.

Adaptation process: Experience demonstrates that species adapt autonomously to environmental conditions and changes. Planned adaptation should be viewed as a dynamic process that leads to

improving the adaptive capacity of a system as the science and technologies that support it advance. Such a process should integrate economic, institutional and social development.

An adaptation process starts with a vulnerability assessment, which connects the expected impacts of climate change to the social, environmental and economic realities of a region, thus leading to identification of the needs and priorities for action. The vulnerability assessment enables a society to implement an adaptation process within the context of its own economic, technical and social possibilities. A cycle ends with the implementation of the actions identified (Figure 2.7).

Figure 2.7
Dynamic adaptation process



The need to generate adaptation processes that seek continuous improvement arises from three main factors: 1) the set of technical and economic limitations of a society, which can be an obstacle to the implementation of some or all of the required adaptation measures; 2) the fact that social, environmental and economic systems change over time, which may cause some strategies to become obsolete; and 3) the uncertainty regarding climate change and the evaluation of impacts and costs generated, which require the continuous re-evaluation of assumptions over time.

Methodologies, scenarios and tools for impact and vulnerability studies

Methodologies to assess climate change impacts and vulnerability are based on methods developed in several disciplines. Advances in the fields of ecology, forest sciences, meteorology, economics and social sciences have been of vital importance for the preparation of these methodologies.

In short, a methodology makes it possible to analyse the impact of climate change by superimposing a climate scenario (the set of climate variables for a point in the future) and a social scenario on to a biophysical scenario (a region and its ecosystems). The scenarios are selected and the results analysed by means of a series of tools. The following sections briefly describe the main methodologies, scenarios and tools for studying impacts and vulnerability. For further information, refer to the documents cited.[6]

[6] The UNFCCC Web site provides methodologies and tools that can be of interest, at http://unfccc.int/program/mis/meth/view.html.

Methodologies

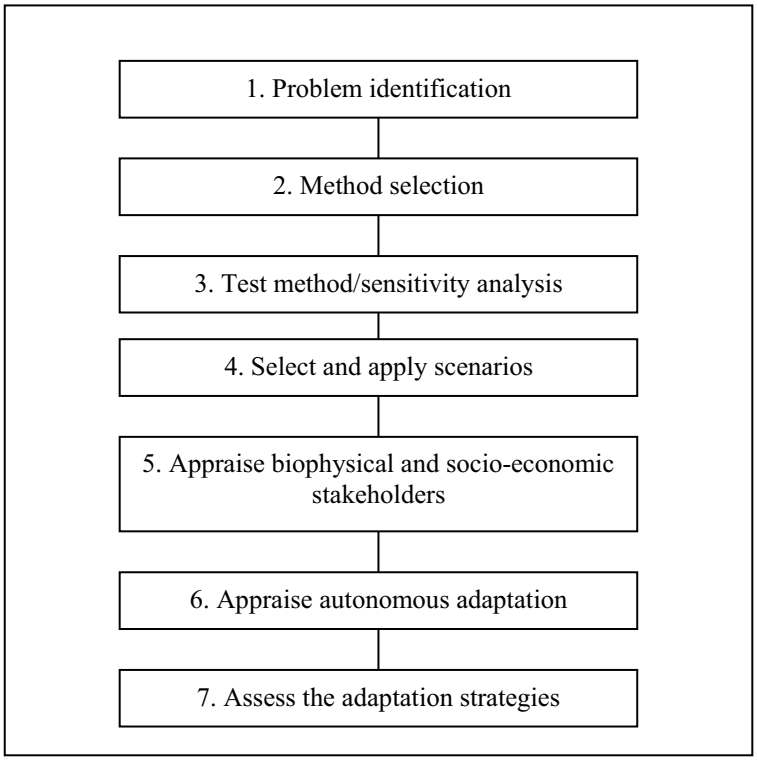
Methodology of the Intergovernmental Panel on Climate Change (IPCC): The 1994[7] IPCC technical guidelines to estimate climate change impacts and adaptation measures are used by the UNFCCC's member countries to report their vulnerability. The IPCC methodology proposes the following three approaches to analysis:

- *The impacts approach* is the simplest of the three and is based on a cause–effect relationship. Its output is limited to the identification of changes in specific climate variables and the analysis of their possible effects on the system units exposed to them.
- *The interaction approach,* as well as climate change impacts, includes processes that can interact to exacerbate those impacts, thereby extending the vulnerability assessment to other factors that cause negative impacts on the system.
- *The integrative approach:* the units under study must be integrated into a system that is integrated with a sector so that all the possible interactions among the systems and their elements affected by climate change can be analysed.

Selection of the focus and tools depends on the technical capacity and available resources of the group in charge of the study. If these are limited, it is better to perform a good impact study rather than a mediocre integrative study.

The IPCC guidelines describe the seven steps necessary to evaluate impacts and adaptation needs. These steps must be followed for each of the three approaches described above (Figure 2.8).

Figure 2.8
IPPC seven steps to assess impacts

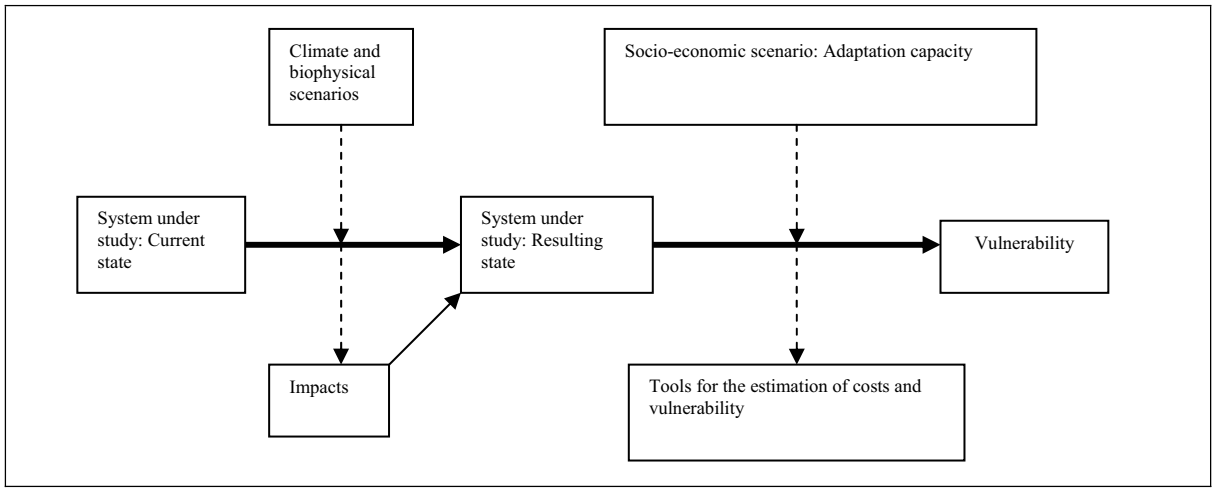


[7] Available from the IPCC Secretariat. The document reference is: T.R. Carter, M.L. Parry, H. Harasawa and S. Nishioka. 1994. *IPCC technical guidelines for assessing climate change impacts and adaptations with a summary for policy makers and a Technical Summary.* London, Department of Geography, University College, and Japan, Centre for Global Environmental Research, National Institute for Environmental Studies. pp. 59.

Methodology of the United Nations Environment Programme (UNEP): Together with the Environmental Studies Institute of Vrije University (the Netherlands), UNEP issued the *Handbook on methods for climate change impact assessment and adaptation strategies,* the second edition of which was published in 1998.[8] This handbook presents a structure similar to the IPCC methodology and includes specific sections on analysing adaptation for water resources, coastal areas, agriculture, forest ecosystems, the energy sector, health, fishing, biodiversity, and animal husbandry.

The UNEP methodology allows for impact assessments to be carried out at different levels (regional or local). The handbook provides guidance for the selection of tools and methods, as well as climate and socio-economic scenarios (Figure 2.9). The section on forest ecosystems includes general explanations of the tools and methods required for the vulnerability study.

Figure 2.9
UNEP methodology for vulnerability assessment



Scenarios: A scenario is a coherent description of the future state of a system, particularly the series of variables that determine its state in a given area and time. Assessing the impacts of and vulnerability to climate change requires the following three main types of scenario:

- *Climate scenarios* represent the basis for assessing climate change impacts, as they provide information on the expected changes in climate variables. Climate scenarios can be of three types: incremental, which are based on trend changes; analogous, which are those that have already been applied in other similar systems; and models (see following subsection on Tools). It should be noted that climate scenarios are often subject to high degrees of uncertainty. In addition, climate scenarios derived from models do not have the necessary resolution to be applied at the local level. Given these uncertainties, some vulnerability studies have analysed vulnerability for three different scenarios: pessimistic, medium and optimistic.
- *Socio-economic scenarios* have a dual function. The first is to illustrate the future conditions that determine GHG emissions, for example, by projecting population and economic growth and the resulting energy needs. The second is to determine the sensitivity, adaptation capacity and vulnerability of a social group. Parameters and variables such as education level, gross domestic product (GDP), land tenure patterns, markets and forest service functions (supply and demand, price, etc.), technological and institutional adaptation capacity, water use, and conservation policies are important for the forest sector and forest ecosystems. As an activity of the National Communications Support Programme, the Global Environment Facility (GEF)

[8] Available at http://130.37.129.100/english/o_o/instituten/ivm/research/climatechange/handbook.htm.

and the United Nations Development Programme (UNDP) have produced a handbook on the preparation of socio-economic scenarios. Its first version is available on the Internet.[9]

- *Biophysical and environmental scenarios* deal with the set of physical and environmental variables that are susceptible to the impacts generated by the climate scenario.

Conventional assessments of climate change impacts and vulnerability have been undertaken by superimposing these scenarios and speculating on the interactions among their variables. For example, in order to study the impacts of climate change on forest production in a defined area, the assessment should begin with a climate scenario that provides information about the expected changes in temperature and rainfall. These changes are then applied to the biophysical scenario so that their consequences on the different components of that scenario (e.g. tree species) can be studied separately. Depending on the scope of the study, the results could be analysed further within the socio-economic scenario.

Tools: A series of tools are used in the selection and development of scenarios and the analysis and interpretation of results. This subsection includes a summary of the most important of these.

Experts' opinion: The opinions of experts can be useful when selecting scenarios and models and analysing the relationships among the scenarios and the units of a system exposed to climate change impacts, as well as other impacts such as those from clear-cutting. Experts' opinions can also be used to support assumptions in climate and socio-economic models in order to develop future climate scenarios, among other results.

Models: A model is a representation of the real world. Models have countless uses in studies of vulnerability and adaptation. For example, climate scenarios can be elaborated, or the impact of a climate variable (e.g. temperature) on a biophysical one (e.g. primary productivity) can be predicted. Many of the models that are frequently used in environmental sciences are based on mathematical equations that relate two or more variables. For example, a model to estimate tree growth over time is known as a "gap model". It is a mathematical equation that relates time with the height or biomass of a tree. Models similar to gap models can be adjusted according to climate variables in such a way that a tree's growth can be forecast on the basis of different climate scenarios. Models that are more complex can incorporate such parameters as rainfall and nutrient availability.

Climate models have played a significant role in climate change-related studies. These are better known as general circulation models (GCMs), which in the context of impact and vulnerability assessment are used for obtaining climate scenarios. GCMs are mathematical representations of the atmosphere, ocean, glaciers and terrestrial surface that use carbon dioxide concentration as the basis on which to simulate the climate in a specific region. In recent years, the use of GCMs in developing national communications has increased. The UNDP Support Programme for National Communications has developed a generator of climate scenarios that consists of two programmes: MAGICC (for the calculation of global climate change) and SCENGEN (to generate world and regional climate scenarios).[10]

In addition to these, several biophysical, biogeochemical, bioclimatic, socio-economic and environmental-economic models are useful for studying the possible impacts of a changing climate, particularly when the results of a climate scenario are the input for an ecological model, for example. An example of these is an ecological model called FORET, which can be used to predict changes in the succession of a forest given a range of climate variables.

Tools to estimate costs: As in other fields, the estimation of costs is relevant for evaluating the possible damage of climate change in monetary terms, as well as for identifying the available adaptation alternatives. Moreover, information on costs is essential to decision-making related to

[9] Available at www.undp.org/cc/pdf/documents/undp%20socioeconomic_sp.pdf.
[10] Programmes and manuals available at: www.cru.uea.ac.uk/~mikeh/software/.

whether actions are worth undertaking and, when they are, assessing which could be the most effective in terms of the cost–benefit ratio. Damage appraisal allows an effective use of resources.

Regarding ecosystems and their service functions, the appraisal may imply some complications, particularly with the monetary estimate of benefits, because there is no market for such benefits (e.g. biodiversity protection). Some appraisal methodologies called "*contingent valuation"* allow a monetary value to be assigned on the basis of the question: "How much would you be willing to pay?". The use of monetary measures is not necessary when the value can be expressed in terms of qualitative or quantitative indicators (e.g. diversity indices, important characteristics of a species, or preference scales).

Geographic Information Systems (GIS): GIS are computer packages that allow a wide range of information to be handled on a cartographic basis. GIS allow the digital processing of satellite images, and are very useful for impact assessment over large areas. Some GIS can even run models and simulations that make it possible to visualize environmental impacts and examine adaptation strategies.

Databases and historical files: The availability of climate, ecological, economic and social data, as well as systems for data handling and search, is a basic need for impact and vulnerability assessment. Data can be used to adjust models, develop statistical designs and project scenarios (e.g. historical data can indicate trends that can be projected into the future).

Holdridge classification of life zones: Holdridge's life zones (1947) correlate rainfall with temperature to define the type of ecosystem for each combination of these two variables. This tool has been broadly used in the development of national communications in developing countries. It provides an overview of the expected changes to the structure of forest ecosystems resulting from temperature and rainfall increases or reductions. For example, a drop in annual rainfall from 4 000 to 2 000 mm may cause conditions that change a rainforest, converting it into a humid forest.

In some cases, the use of models or the application of Holdridge's life zones do not take species' adaptation to climate changes into account. Caution should be exercised when incorporating results from these tools in the vulnerability assessment.

SYNTHESIS OF CLIMATE CHANGE IMPACTS

The following is a summary of climate change impacts for several areas, according to information in IPCC's third assessment report.

Hydrology and water resources

Rainfall is the most important factor affecting water balance in a region. Expected changes in rainfall regime resulting from a changing climate can severely affect the hydrology of the planet. Even though future changes in rainfall regimes are uncertain, it is foreseen that runoff flows and groundwater recharge will be reduced in many regions, especially in areas that have already been affected by droughts. This problem will be compounded by an increase in water demand caused by population growth. While drought affects some areas, floods are likely to increase in others.

The relationship between forest ecosystems and the water sector is two-way. On the one hand, given ecosystems' role as water cycle regulators, deforestation and the degradation of forest ecosystems increase the vulnerability of the water sector. On the other hand, low water availability affects forest ecosystems and forest-based activities. A reduced water supply implies that farming and forestry activities will have to compete for this resource in the future.

Agriculture

The greatest research efforts to study vulnerability and speculate on its consequences have been dedicated to agriculture. It is expected that agricultural productivity responses will vary, largely depending on regional and local rainfall regimes and temperature changes, as well as soil properties and levels of technological development. Although it is expected that an increase in carbon dioxide concentrations will stimulate an increase in productivity, this may be counteracted by droughts or annulled by floods or other abnormal climate events. It is expected that production yields will increase in temperate countries, while the opposite occurs in the tropics.

Ecosystems

Changes in climate variables will cause modifications in the structure and functioning of most ecosystems. These changes for the specific case of forest ecosystems are described in a later section.

In addition, it is expected that sea level rises will produce negative impacts on coastal areas, affecting a large number of human settlements and increasing coastal and beach erosion. It is also expected that some mangrove ecosystems and wetlands will be lost, and some estuarine and coastal systems will be affected by the intrusion of saltwater. Increased carbon dioxide concentrations, together with temperature increases, will increase coral whitening. The negative impacts on these systems could have consequences on fish populations.

Human settlements

Climate change will affect human settlements in three ways: the first regards effects on the *economic sectors* that support settlements; the second is the way in which climate change (especially natural disasters such as storms, hurricanes and sea level rises) can affect *infrastructure;* and the third regards the impacts to health deriving from extreme weather and/or migration.

Health

The effects on human health will be of two main types: 1) the direct impacts of temperature increase on health, particularly related to heat waves, which could be exacerbated by pollution or humidity levels; and 2) viral and bacterial diseases, as temperature increase creates conditions that are appropriate for vectors in places where they did not exist before.

Synthesis of climate change impacts on forest ecosystems

The presence of a given type of ecosystem is primarily determined by a combination of temperature and rainfall patterns. A change in climate variables therefore implies a change in the structure and functioning of ecosystems.

The impacts of climate change can be studied at several levels, from changes in the physiology and metabolism of plants (e.g. photosynthetic activity, respiration and transpiration) to changes in the structure and functioning of ecosystems due to both physiology and extreme events, such as droughts, hurricanes and fires (Figure 2.10 and Table 2.1).

Changes related to metabolism and physiology: Physiologic changes resulting from a changing climate are related to cellular processes that control the use and exchange of matter and energy. According to laboratory studies, changes in rainfall regime, temperature and carbon dioxide concentration in the atmosphere can significantly affect these processes. Although responses depend on the species under study, in general, all plant species will experience metabolic and physiologic changes as a consequence of climate change. These changes will occur in both the short (changes in

productivity and evapotranspiration) and long terms (modifications of nutrient reservoirs and new plant communities adapted to the new conditions).

Figure 2.10
Flow of climate change impacts

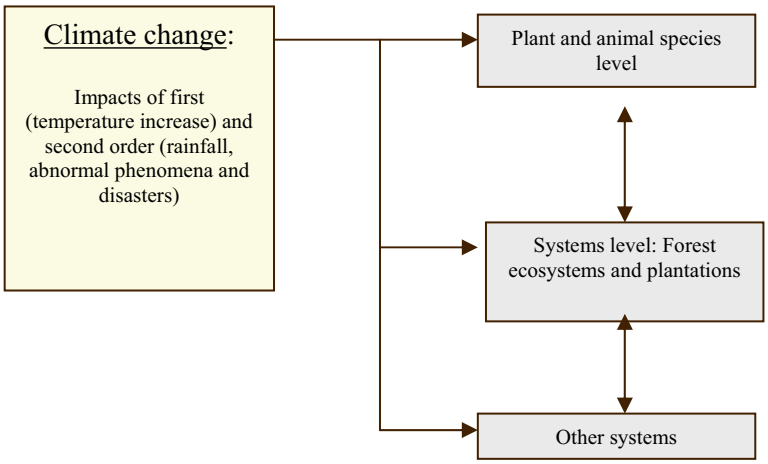


TABLE 2.1
Summary of climate change impacts on forest ecosystems

Climate factor	Cell level	Organism level	Species level	Ecosystem level
CO_2 increase	Photosynthetic rate increase	Growth rate increase	Decreased seed mortality	Biomass production increase
	Stomatal conductance reduction	Water use efficiency increase	Increased recruitment	Alterations in species competitiveness
		Seed production increase	Period for individuals to reach maturity	Changes in species composition
			Changes in individual density?	
Temperature increase	Photosynthesis increase or decrease	Primary production positive or negative changes	Regeneration rate changes	Alterations in species competitiveness
	Photosynthetic period can increase	Seed production changes	Possible increase in tree mortality	Species' composition changes
	Transpiration increase		Negative consequences for species sensitive to temperature changes	Soil mineralization increase
Rainfall regime changes	Growth rate decrease	Seed mortality rate increase		Alterations in species competitiveness
			Increase of mature individuals' mortality rate	Species composition changes

Source: Meer, Kramek and Wjik, 2001.

Temperature: Temperature increases, particularly those that are short-lived or occur at a slow rate, may not cause a significant direct effect on plant species owing to plants' adaptive capacity, although some studies have demonstrated that photosynthetic rates may increase with temperature (Kirschbaum, 2000). The most significant temperature increase effects are related to water availability and transpiration. The latter will increase, causing water loss (Kellomäki and Wang, 2000).

Rainfall regimes: Rainfall increases or decreases have the greatest effect on plant species. Because photosynthetic processes are directly related to water availability, rainfall pattern changes produce

direct changes in plant productivity and survival. A decrease in rainfall can also affect seed production and the survival of young trees.

Concentrations of carbon dioxide in the atmosphere: In order to study the effects that increased carbon dioxide concentrations may have on plant species, some species have been subjected to different concentrations of the gas in laboratories. Results show that in the short term the plant's response depends on the minerals that are present in the soil. In some species, the response is positive: photosynthetic activity increases as carbon dioxide concentration increases, although it tends to stabilize over the longer term.[11] However, studies have also shown that some plant species undergo tissue changes, which can have effects on metabolism and, potentially, on productivity (Körner and Arnone, 1992). Other studies have shown that high carbon dioxide concentration results in higher water use efficiency by plants. This produces lower transpiration rates, which means that plants become more tolerant to lower water availability.

Changes at the ecosystem level: The combination of mean rainfall and temperature values partially determines the type of ecosystem that can develop in an area. A change in these variables implies that the ecosystem will change its composition to adapt to the new conditions, as described in the last section. For example, temperature increases and decreases in rainfall tend to increase dry-type life zones.

The results of some climate models indicate that towards the middle of the twenty-first century, temperatures in tropical forest ecosystem areas may have increased by up to 2 °C from their 1970 levels. Such temperature change, added to rainfall changes, could produce severe impacts on tropical forest ecosystems. The national communications of some Central American countries point out that some humid and very humid tropical areas are likely to disappear as a consequence of rainfall decrease, and that these systems are likely to change to dry-type premontane and montane areas.

The impacts of climate change on forest ecosystems include (Scholes and Linder, 1998):

- changes in the location of areas suitable for the growth of certain species (shift or disappearance of some productive systems);
- increases or decreases in the production of timber and non-wood forest product (NWFP) production per unit area;
- changes in the types and incidence of pests and diseases affecting tree and plant species;
- altered ecosystemic functions (biochemical cycles);
- increased or decreased nutrient retention;
- changes in species' reproductive cycles;
- changes in the value of a system as a tourist attraction.

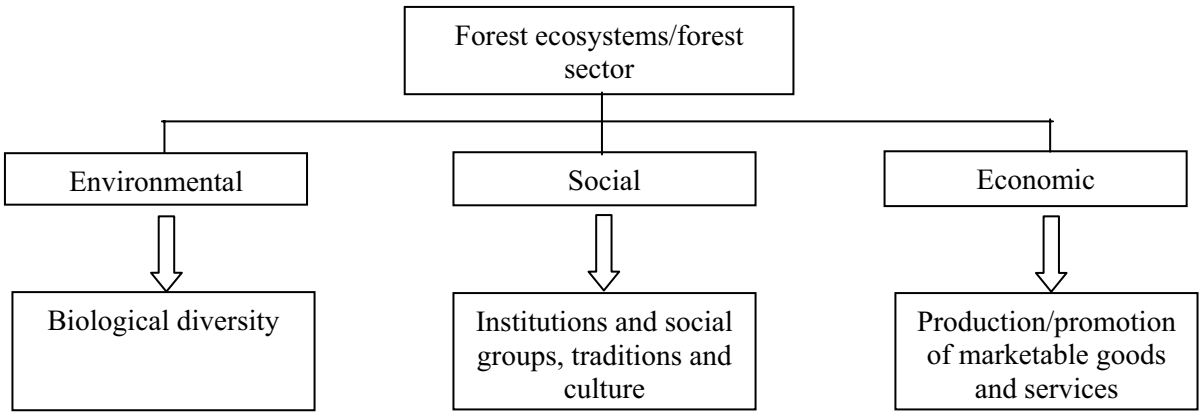
However, even though climate change is likely to occur, its possible impacts on forest ecosystems may not be as great as the impacts of other processes (such as indiscriminate deforestation and pollution). Policies and actions related to adaptation and vulnerability must therefore take these other processes into account.

Forest ecosystems and vulnerability

With vulnerability defined as a system's degree of susceptibility to the negative impacts of climate change, this section explains the concept of vulnerability in relation to forest ecosystems. As for sustainable development, a given society's vulnerability affects and is affected by its environmental, social and economic dimensions, as well as the relations among these (Figure 2.11).

[11] See, for example, the results of various experiments carried out by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), available at www.unibas.ch/botschoen/07/01/e.shtml.

Figure 2.11
Vulnerability and adaptation in three dimensions



Environmental dimension: The environmental dimension consists of the relationships among the components of the ecosystems that are present in an area, as well as the relationships among the ecosystems themselves. It is difficult to establish a link between the degree of complexity of a system and its vulnerability, as much depends on both the impact type and the affected system.

The vulnerability of forest systems is not just related to the direct and indirect impacts of climate change. The interrelations among natural and human systems imply that impacts on one system will affect other systems. A clear example of this is the pressure exerted on forest ecosystems by the demand for agricultural land. If climate change results in soil degradation and this leads to some soils becoming unsuitable for agriculture, further deforestation will be necessary to provide new farmland. Alternatively, some mitigation strategies could be beneficial in reducing pressure on the use of forest ecosystems. For example, communities that exploit the forest for fuelwood could be supplied with solar or another type of renewable energy.

Social dimension: The social system is made up of social groups, institutions and the relationships among and within them. Some of its variables are population growth, institutional development, education level and citizen participation mechanisms. As forest ecosystems generate many goods and services (Box 2.3), which may also have cultural and religious significance, different social groups depend on them in different ways.

Forest ecosystems: Decreased forest goods and services imply negative impacts on society that are for the most part direct. Decreased forest ecosystem services, especially water cycle regulation, soil protection and conservation of biological diversity, may imply increased social vulnerability. Social variables such as population dynamics (growth and its determinants – births, mortality and migrations) may be indirectly affected by decreases in forest goods and services. For example, in a community that lives off the exploitation of resins and honey, alternatives for revenue and employment generation could be affected by the decreased quantity or quality of these resources as a consequence of climate change.

Box 2.3. Uses of forest ecosystems

- *Direct use:* Forest goods and services for direct consumption. For example, timber and NWFPs, recreation and scientific research.
- *Indirect use:* Environmental services. For example, water cycle regulation, biodiversity protection and carbon sinks.
- *Passive use:* The importance of conserving forest ecosystems so that future generations can benefit from them.
- *Use options:* All those uses not yet exploited or discovered that may acquire value in the future.

Source: Secretariat of the Convention on Biological Diversity (2001).

The forest sector: It is difficult to separate social from economic aspects in the forest sector. Depending on global market trends, as well as the prices and quantities of forest products, such variables as employment and migration can also be affected, as can land tenure and land prices.

Economic dimension: The economic dimension is represented by the market. The supply of and demand for products and services originating from and/or related to forest ecosystems, as well as the policy elements and certain social variables, determine the quantity and price of the goods produced and consumed. Economic players react to market prices and adjust their decisions accordingly. If prices increase, consumers may change their consumption patterns and look for substitutes, and producers change or improve their production activities to increase competitiveness. Economic activity generates jobs and economic resources that can be used in social welfare or investment. An active economy promotes local development.

The forest sector: Several studies have demonstrated that changes in climate can influence timber production and consumption by affecting growth in forest ecosystems. Pérez-García *et al.* (2002) conclude that climate change is likely to increase timber production and lower market prices in general, but the increases in production will certainly not be evenly distributed throughout the world; some areas will experience better conditions than others. For example, it is likely that areas with low forest productivity due to drought will face further decreases in productivity, while areas where temperature limits productivity may benefit from rising temperatures.

The economic vulnerability of the forest sector has two main sources. The first is related to impacts on production caused by changes in the structure and functioning of ecosystems and plantations (due to temperature changes and rainfall regimes) and extreme events and disasters (hurricanes, droughts, fires and pests). These factors have a negative effect on the productive function of forest ecosystems, which directly affects local economies, especially those that are particularly dependent on forest ecosystems.

The second source of economic vulnerability is related to changes in international markets that are triggered by modifications to the production functions of different producing countries. Because the impacts of climate change are unevenly distributed over the planet, an advantage for some countries may be a disadvantage for others (e.g. owing to shifting in wood production).

The forest sector's economic vulnerability depends on its importance in the regional and national economies. National policy may or may not prioritize the forest sector. One of the main reasons that this sector receives little attention in many developing countries is that it appears to make only a low contribution to GDP. In many areas, the reason for this apparently low contribution is that only end products (timber exported, fruits and seeds marketed) are accounted in the forest sector, while other products (such as poles) are either accounted in other sectors or do not enter formal markets (medicinal plants, food, etc.).

Vulnerability and forest ecosystems in some national communications

By June 2005, most developing countries had sent a first national communication to UNFCCC. The following is a synthesis of the information on vulnerability and adaptation of forest ecosystems and the forest sector that was included in some national communications.

Costa Rica: The vulnerability of forest ecosystems was assessed on the basis of three climate change scenarios (optimistic, moderate and pessimistic). This methodology made it possible to develop a map of forest ecosystems in the future. The climate scenarios show mean annual temperature increase and rainfall decrease, which in combination will change the extent and proportion of forest type in the country. The changing conditions may cause a decrease of primary forest ecosystems in the most affected areas. However, this will be counteracted by an increase in the total area of secondary forest ecosystems. The effect on humid and very humid tropical ecosystems will, in turn, have impacts on

biodiversity. In conclusion, Costa Rica estimates that climate conditions in the future could favour agriculture, which may lead to increased land-use change activities. Analysis of the consequences in the forest sector was not carried out. (National communication prepared by Ministry of Environment and Energy, Costa Rica, 2000.)

Bolivia: The climate scenarios used by Bolivia show general rainfall increase during wet periods and warming during dry periods. Assessment of forest ecosystem vulnerability was based on the idea that the main problem affecting forest ecosystems in Bolivia is their level of fragmentation. The national communication concludes that humid tropical and subtropical forests will be the most affected; for example, the scenarios indicate that an average temperature increase of 2 °C, combined with a 10 percent increase in rainfall, could cause humid tropical forests to increase by 65 percent, to the detriment of humid subtropical forests. The adaptation activities considered include sustainable forest use, improved efficiency of industrialization processes, and development and growth of the forest sector. (National communication prepared by Inter-Institutional Council on Climate Change, Bolivia, 2000.)

Congo: The climate scenarios used by the Republic of Congo indicate increases in both mean temperature and rainfall, particularly in coastal regions. The national communication includes a flood risk analysis, which shows that floods are one of the main climate change-related impacts in this country. With regard to forest ecosystems, Congo analysed salinization effects in coastal areas and effects in mangrove areas over a large part of its territory. It also analysed the consequences of rainfall decrease and temperature increase in the Niari valley, and the relationship between these changes and the proliferation of fire, as well as changes in the structure and functioning of forest ecosystems present in that area. (National communication prepared by Ministry of Industry, Mines and Environment, Congo, 2001.)

Malaysia: The national communication of Malaysia includes a study of climate change effects on rubber, palm oil, agroforestry and timber production, and forest ecosystems. The vulnerability assessment was based on the IPCC scenarios for Southeast Asia. The study showed that drought could reduce rubber production by 15 to 30 percent and the area suitable for palm plantations by 12 percent. However, increased forest production is also expected to result from rising temperatures. The communication points out that the impacts on biodiversity are uncertain, as are the effects of those impacts on forest production and the provision of other forest goods and services. (National communication prepared by Ministry of Science, Technology and Environment, Malaysia, 2001.)

3. Institutional and policy framework

Among the many challenges that climate change imposes on society, perhaps the most important is approaching climate change holistically, by considering the impacts on a wide range of systems and on the interests and problems of many stakeholders. The need to unify global efforts arises from three factors: 1) climate change impacts will be exerted on every sector of society and on the systems that support its development; 2) the distribution of these impacts has been, and always will be, unequal – some people will be affected more than others; and 3) there is a lack of understanding of climate change and its effects.

An institution can be defined as the group of rules that set the actions and interactions of a society (North, 1990). Institutions play a fundamental role in the coordination and direction of international and national efforts to approach the problem of climate change. Some of the most important institutions include the legal base of a society, its constitution and laws, policies and programmes, and the organizations in charge of implementing policies.

This chapter provides a brief summary of the institutional developments and challenges related to adaptation and vulnerability, acknowledging that these developments initially took place at the global level, before emerging gradually at the national and local levels.

GLOBAL LEVEL

Global institutions related to climate change have experienced rapid development resulting from international interest in this issue. The most important institutional developments have taken place at the international level, as evidenced by the creation and articulation of three institutions: UNFCCC, whose role is to generate and coordinate global policy; IPCC, which is in charge of technical and scientific support to UNFCCC and other organizations; and GEF, the institution in charge of administering and allocating financial resources to implement UNFCCC activities in developing countries. In addition to these three institutions, this document mentions an international effort for monitoring activities: the Global Terrestrial Observing System.

Adaptation in UNFCCC

The fact that UNFCCC is the main international policy instrument on climate change also makes it the main institution to address adaptation from the global standpoint. From the beginning, the convention has encouraged a large number of initiatives related to assessing the impacts and costs of climate change, developing methodologies for vulnerability assessment and building capacity. Although mitigation has received more attention in the multilateral negotiation process, as demonstrated by the Kyoto Protocol, interest in adaptation has been growing over the past two years. Recent experiences, such as the increment of natural climate disasters or heat waves, highlight the urgency of strengthening and energizing the political process related to adaptation. Interest has also increased as a result of developing countries' active participation in the negotiations and development of national communications.

The international interest in adaptation issues is reflected in UNFCCC's text. Its initial paragraphs mention that changes in climate variables and their adverse effects are a common global concern. It also recognizes that countries with low coastal areas, those that suffer droughts and floods, those located in arid and semi-arid areas, and those that have fragile ecosystems are especially vulnerable to climate change. As an objective, the convention refers to adaptation when it states: "That level[12] should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate

[12] The term "level" refers to the concentration of GHGs in the atmosphere (UNFCCC, Article 2).

change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."

Several articles of the convention provide a road to addressing adaptation. For example, Article 3 gathers the principles that guide countries to fulfil the adaptation objective. Its section 3 states that the parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects.

Article 4.1(b) establishes that the parties should formulate and implement measures that allow appropriate adaptation to climate change. In practical terms, this means that every member country of the convention has committed itself to: 1) assess its vulnerability, including its adaptation needs; 2 communicate these results to the convention (Box 3.1); and 3) implement these measures within its territory, as part of its climate change policies. Article 4.1(e) establishes that signatory countries will cooperate in the development of plans for coastal zone management, water resources and agriculture, and the protection and rehabilitation of areas affected by drought, desertification and floods. Section 4 of the same article calls on developed countries to assist developing countries in meeting the costs of adaptation. Section 8 specifies that highly vulnerable countries are a priority for technology transfer, financing and cooperation. Such countries are:

- small islands;
- countries with low-lying coastal areas;
- countries with arid and semi-arid areas or that are exposed to forest deterioration;
- countries with zones that are prone to natural disasters;
- countries with zones that are exposed to drought and desertification;
- countries with high urban air pollution zones;
- countries with fragile ecosystems.

These articles of UNFCCC's text have been regulated by a series of decisions that have, among other outputs, identified the direction of vulnerability assessments and established the convention's funds and rules. Annex 1 includes a list of the most relevant decisions regarding adaptation.

Besides the preparation of international policies on financing, other activities related to adaptation include the process of National Adaptation Programmes of Action (NAPAs), whose focus is least-developed countries (LDCs).[13] Through NAPAs, which are financed by the LDC fund (Chapter 4), LDCs communicate their needs for capacity building, institutional development, financing, etc. Decision 29/CP.7 established a group of experts to help LDCs in this process.[14]

Box 3.1. National communications

All countries that are parties to UNFCCC should elaborate and publish a national communication that compiles information related to activities aimed at compliance with agreed commitments, including inventories of GHGs, and policies and measures for their reduction. For developing countries, the communications have had a different focus. First, the inventories of GHGs are less rigorous and strict; and, second, there is more emphasis on the adaptation component. UNFCCC uses the resultant information to analyse national and local problems from a global perspective. The most important points to be included in the national communications include:

- information on vulnerability;
- affected sectors and population;
- stakeholders;
- measures needed for adaptation, identifying the highest priorities;
- measures implemented to reduce vulnerability.

[13] A list of these countries is available at http://unfccc.int/text/program/sd/ldc/countries.html.
[14] Additional information is available at http://unfccc.int/text/program/sd/ldc/index.html.

Box 3.2. Decision 5/CP.7 *

The so called "Marrakesh Agreements" include mainly decisions that regulate the Kyoto Protocol, but also a few important decisions regarding capacity building, technology transfer, financial issues and adaptation. Decision 5/CP.7, entitled "Implementation of Article 4, paragraphs 8 and 9 of the convention", is one of the most important decisions on adaptation.

This decision states that the adaptation process should be guided by the circumstances of each country, so that adaptation responds to specific vulnerability needs. The decision recognizes that the main channel for information transmission is the national communications and that all actions and strategies, including those at the international level, should be based on the information contained in them.

The text specifies the types of activities that will be financed by GEF. For adaptation and vulnerability these include:

- support to activities for vulnerability assessment;
- institutional development to ensure that adaptation is included within sustainable development programmes;
- encouragement of the transfer of adaptation technologies;
- capacity building in preventive measures, adaptation, contingency plans and other activities to confront natural disasters;
- establishment of early alert systems.

The decision includes adaptation activities that will be financed with convention funds. These include:

- management activities in the areas of water, soil, agriculture, health, fragile ecosystems (including mountain ecosystems) and integrated coastal management;
- improvements in disease monitoring;
- support to capacity building for the adoption of preventive measures to confront disasters;
- establishment and/or improvement of centres and networks for gathering and storing information on climate and climate impacts.

* These decisions are of public domain and can be read at www.unfccc.int.

Another important activity related to adaptation is the compilation of methodologies and tools to assess vulnerability and adaptation strategies, which is carried out by the UNFCCC Secretariat. Many organizations have sent their methodologies and tools, in the hope of participating in this process. People who are interested in using the methodologies and tools can access the information directly on the Internet at the convention's Web site (http://unfccc.int/program/mis/meth/view.html). The database includes different methodologies and analyses for various sectors. No specific tool is currently available for forest ecosystems and the forest sector. However, it is expected that the information will be upgraded during 2005.

The Intergovernmental Panel on Climate Change (IPCC)

IPCC is the main channel for transmitting scientific and technical information to UNFCCC. Its main objective is to evaluate the scientific, technical and socio-economic information necessary to understand climate change and its impacts. The panel originated through the work of the World Conference on Climate (1979), out of which the World Climate Programme emerged. This latter consisted of a series of international workshops that collected a significant amount of scientific information concerning the anthropogenic greenhouse effect. Based on this work, UNEP, the World Meteorological Organization (WMO) and the United States Government identified the need to establish a multilateral mechanism for scientific and technical assessment of the issue, and this led to the creation of IPCC in 1988.

Three characteristics have made IPCC a credible institution: 1) its intergovernmental character, which assures that issues of interest to the countries are approached; 2) the wide participation of experts from all over the world, which ensures that scientific material from all over the world is considered; and 3) its reviewing process, which is carried out by experts and governments from all over the world in order to ensure that the contents reflect the actual state of science (Lohan, 2003). The text of UNFCCC recognizes the need to interact with IPCC so that policy is led by credible and up-to-date scientific information. This interaction occurs in two ways. The first is the preparation of assessment reports for the convention's consideration. The Third Assessment Report (TAR) and the methodological guidelines for the national GHG inventories are two examples of this.

The second way deals with UNFCCC organizations' invitations to IPCC to produce technical materials and reports according to the needs of the political process. Recently, COP invited IPCC to elaborate a manual of good practice guidance for the compilation of GHG inventories from land-use change activities.[15]

IPCC is structured on three levels (Figure 3.1): the Plenary, the working groups (together with the technical support units), and the Secretariat. The Plenary is the main body and is in charge of making decisions related to the activities of the working groups and of adopting the material produced by these groups. The technical support units are in charge of supporting the working groups' work. The Secretariat supports IPCC meetings and programmes its activities.

The substantial scientific work within IPCC is carried out by three working groups and a special programme that is responsible for preparing methodological material on GHG inventories: Group I is in charge of evaluating the scientific material on climate change; Group II deals with the evaluation of climate change impacts and adaptation strategies; and Group III collects the latest available information on mitigation strategies.

Box 3.3. IPCC outputs

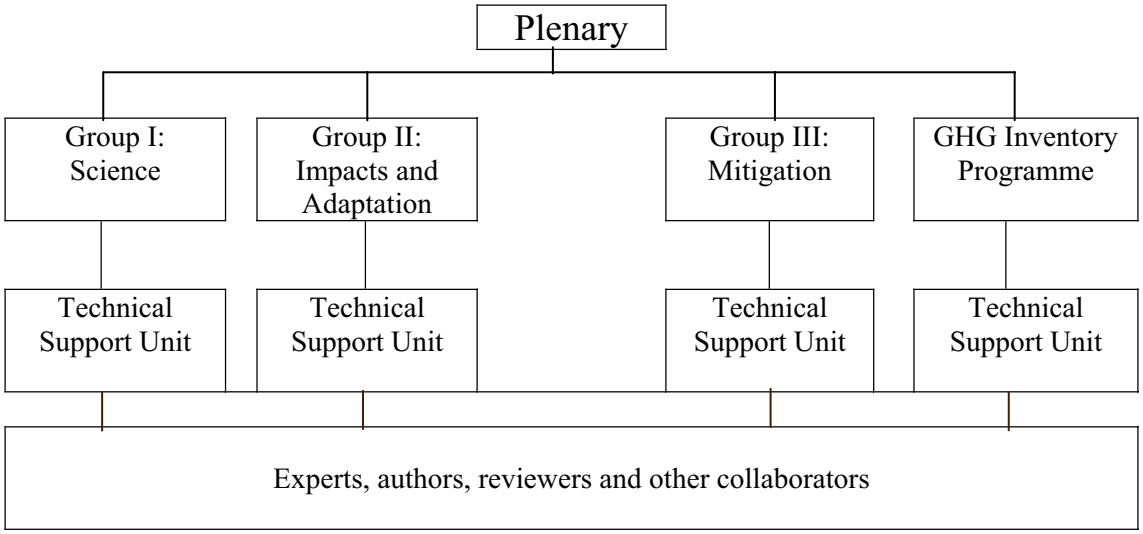
With the purpose of transmitting scientific and technical information to UNFCCC, IPCC develops the following documents:

- *Assessment reports:* These provide a thorough evaluation of the available scientific and technical material. They are produced in three volumes: the scientific basis, impacts and adaptation, and mitigation. IPCC completed its third assessment report in 2001.
- *Summaries for policy-makers:* These summarize the information contained in the assessment reports, highlighting the most important points for policy-makers.
- *Special reports:* These analyse specific problems, land use, land-use change and forestry.
- *Synthesis reports:* These contain questions and answers relevant to the political process and are based on the information contained in the assessment and special reports.
- *Technical documents:* These respond to specific policy needs, and are prepared on the basis of assessment and special reports.
- *Methodological guidelines:* These are specifically prepared to provide governments with technical material, such as guidelines for vulnerability assessment.

IPCC's work on adaptation is of crucial importance to developing countries for two reasons: 1) it includes considerable scientific and technical material that can support adaptation activities; and 2) it includes a wide representation of governments, which ensures that national interests in the scientific and technical information produced are balanced and the material produced is relevant to the countries that participate in IPCC activities. It is therefore of vital importance that countries and their institutions and organizations participate in the nomination of experts to IPCC and in the draft review process.

[15] IPCC's *Good practice guidance for land use, land-use change and forestry* complements the methodologies used by the parties to report inventories of GHG emissions and removals. More information available at http://www.ipcc.ch.

Figure 3.1
Structure of IPCC



Although IPCC seeks to have representation for all countries at its meetings, the participation of experts from developing countries has been limited owing to a lack of national resources to support their participation in workshops and meetings. In addition, developing countries have low capacity in scientific knowledge compared with developed countries. In response to this inequality, IPPC has created mechanisms to increase developing countries' participation in its activities. As well as representation quotas, it allocates a significant amount of money to financing the participation of experts and representatives from developing countries.

Box 3.4. Participating in IPCC activities

There are several ways to participate in the preparation of IPCC documents. The first is direct participation in the working groups experts who have been nominated by their national governments. The nomination process differs from country to country. In general, the focal point or national authority in charge of nomination also manages issues related to WMO. A second way of participating arises in the IPCC document preparation procedures, which require comments from experts on each issue and governments. IPCC uses the experts whose details it has in its database to review documents, which are also sent to member governments so that their national experts can evaluate and analyse them.

The Global Environment Facility (GEF)

GEF was created to assist developing countries with the financial resources needed to implement activities compatible with the objectives of international conventions (particularly CBD and UNFCCC). In practice, it finances the incremental costs of local projects in areas of global interest, such as biodiversity, desertification, water, and climate change. GEF responds to the conventions' needs and follows up on the decisions of their COPs.

GEF established its operational strategy for project financing in 1995. This strategy includes four areas: biodiversity, climate change, international waters, and multifocal (Table 3.1).

TABLE 3.1
GEF operational programmes by focal area

Biodiversity	Climate change	International waters	Multifocal
Arid and semi-arid ecosystems Coastal areas, and marine and freshwater ecosystems Forest ecosystems Mountain ecosystems	Energy efficiency barriers Removal of barriers for the use of renewable energy Reduction of long-term costs for the development of low GHG-emission energy. Promoting sustainable transportation	Operational programmes for water bodies Integrative programme for soil and land Operational programme on pollutants	Integrated ecosystems management

GEF is described in greater detail in Chapter 4.

The Global Terrestrial Observing System (GTOS)

The continuous monitoring of environmental variables and impact studies are essential elements in a country's adaptation process. Article 5 of UNFCCC considers the importance of monitoring and research efforts, and invites parties to support initiatives related to them. Included among these efforts are tools for information exchange networks, global monitoring systems and national and international research programmes on climate behaviour.

At the institutional level, the Global Climate Observing System (GCOS) is the main mechanism for the global monitoring of climate. GTOS also provides a route for the exchange and compilation of global information that supports the preparation of policies, programmes and activities for adaptation to climate change. GCOS was established in 1992 and currently has the support of WMO, the Intergovernmental Oceanographic Commission (IOC) and the International Council for Science (ICS).

GCOS is not directly responsible for establishing monitoring systems or generating data. Its main mission is to stimulate, support, coordinate and facilitate data collection and the establishment of international systems for monitoring and measuring parameters related to climate change. It operates in the atmospheric, oceanic and terrestrial domains, the last of these being the most relevant to vulnerability assessment in terrestrial ecosystems. The Terrestrial Observation Panel for Climate is responsible for the terrestrial domain, and monitors a considerable amount of information on ecological variables from all over the world. The panel has designed a strategy for terrestrial observation, which specifies the variables to be monitored, monitoring systems, and tools for gathering, compiling, filing and analysing the information. This strategy is coordinated by GTOS.[16]

NATIONAL LEVEL

The national-level framework is based on national government institutions and their relationships with national organizations and decentralized government agencies. As for environment and development, the central axis of the national institutional framework should be national development policy, which identifies goals regarding this issue and creates conditions that are conducive to fulfilling specific objectives (e.g. social development itself).

Because of its cross-cutting character, addressing climate change at the national level starts with considering it within the context of national development policy. On the one hand, the impacts of climate change may hinder the fulfilment of development policy, while on the other there are close

[16] GTOS is a programme for the observation, modelling and analysis of ecosystemic information, aimed at supporting sustainable development activities. Its goal is to provide data to the scientific community and those responsible for developing policies related to sustainable development. It operates under FAO. Additional information available at www.fao.org/gtos/.

links between the adaptation capacity of a society and its level of development (Box 2.2). Furthermore, considering adaptation to climate change from the broader point of view of development policy may help to avoid conflicts at the sector level whenever programmes or projects for one sector conflict with those for another (Box 3.5).

Box 3.5. Examples of conflict of interest in policy design

This example is based on an agricultural region that is affected by a substantial decrease in rainfall levels. In this region, people's need to have access to water may conflict with policies aimed at assuring a water supply for hydroelectric power during drought periods. It may become necessary to decide which sector to prioritize, or to plan alternative strategies. The impact of a rainfall decrease would be worse if, for example, urban development policy led to increased demands for water. In this case three sectors (agriculture, energy and urban development) would have to compete for a decreasing resource. Coordination among sectors, and the adaptation of plans therefore become crucial in ensuring development.

Forest ecosystems and the forest sector

Most countries recognize the importance of the forest sector and forest goods and services, and have established policies and programmes to promote forestry activities, sustainable forest management and/or forest ecosystem protection. There is usually a political division between the forest sector as an economic activity, and forest ecosystems, which are related to environmental issues. This division can lead to different types of institutions being created for each issue, and even the assigning of different issues to different government entities.

Chapter 2 summarized the main impacts of climate change on forest ecosystems and stressed that their vulnerability also affects those social groups that are dependent on forest goods and services. The national institution concerned with forest ecosystems should incorporate this issue and create a space for actions aimed at increasing the adaptive capacity of the forest sector. As the impacts of climate change can put the productivity of the forest sector at risk or diminish the supply of goods and services from forest ecosystems to society, adaptation to climate change should be included in sector decision-making. This should consider not only timber but also forest ecosystems, and therefore NWFPs and forest services, as well as biological diversity.

The institutional framework for adaptation of forest ecosystems and the forest sector should be formulated considering relationships with the following sectors:

- *Energy:* especially as it relates to the impacts on forest ecosystems of generating, transmitting and distributing different types of energy, as well as to the need to conserve ecosystems, thereby guaranteeing the existence of natural resources.
- *Tourism:* especially natural parks with forest components that are attractive to tourists.
- *Industry:* the forest sector is important to the national economies of some countries.
- *Agriculture:* adaptation measures can consider the development of specific territorial development policies and plans, as well as land-use changes.

A policy framework for adaptation

The adaptation process depends on having a strong and coherent institutional base. Institutions provide or identify financial, technical and human resources, and set up organizations responsible for developing specific objectives. Generally, addressing social and development at the national level starts with the establishment of a policy. In the case of adaptation, as an alternative to designing a specific adaptation policy, it is also possible to establish a policy framework that generates institutional space for including adaptation as an essential element of existing national and sectoral policies. This approach both recognizes the cross-cutting nature of climate change and contributes to more efficient use of resources and existing institutions.

The concept of creating policy frameworks for adaptation is relatively recent. Initially, studies on adaptation and vulnerability focused on the relationships between climate change and the systems affected. These studies used assumptions about climate behaviour as the basis for describing the impacts on a system. The analyses were then used to identify what activities and strategies could be used to minimize specific impacts of climate change. More recently, work on adaptation, particularly regarding institutional development, has changed its emphasis in recognition of the need to consider social development. In other words, the starting point for adaptation processes should not be the assumed impacts of climate change, but rather the society that is likely to suffer from them. Under this perspective, adaptation is linked to development and the factors that drive it (Box 2.2). As a result, adaptation strategies are bound to overall policies rather than to isolated measures. In addition, the existing effects of changes in climate variables on a society are taken into consideration and given as much weight as future projections of these variables. In other words, direct experience and current vulnerabilities set the priorities of the adaptation process (see, for example, Burton *et al.,* 2002).

A national policy framework for adaptation should be designed according to a country's existing institutional, social and economic situation, so that it can link up with current policies. It should provide the outline for a national strategy to reduce vulnerability and coordinate actions related to climate change with actions in other sectors. OECD (2002) recommends including elements that lead to capacity building, the identification and establishment of financial resources, and the preparation and launching of adaptation projects. UNDP and GEF have been promoting this new approach. The Adaptation Policy Framework (APF) is "a structured approach to formulating and implementing adaptation strategies, policies, and measures to ensure human development in the face of climate variability and change. The APF links climate change adaptation to sustainable development and global environmental issues". The principles underlying the framework concept include the following:[17]

- Short-term adaptation activities for extreme events are the starting point for reducing vulnerability to longer-term climate change.
- Adaptation policies and measures should be framed within overall development policy.
- Adaptation should be pursued at different levels (national, regional and local).

The effectiveness and success of policy frameworks for adaptation depend on several conditions, including those described in the following paragraphs.

Decentralization: Policy frameworks for adaptation to be implemented at the local level are more effective when they are guided by a national adaptation framework. However, the local or regional socio-economic and environmental situation, as well as the expected climate change impacts, may vary considerably within a country. Decentralization can increase management efficiency because it transfers some of the responsibilities for design and implementation to smaller political divisions of the country. At the regional and local levels, socio-economic and environmental variability is smaller and the implementation of adaptation measures and strategies can be both effective and efficient: effective because their design is specific to regional and local conditions; and efficient because the resources used generate better benefits. Decentralization plays a fundamental role in the management of natural resources, especially those of forest ecosystems. It increases local stakeholders' sense of ownership over the resource and their responsibility towards it. The management and use of forest ecosystems, as well as the decision-making process, must be based on local knowledge of regional and local priorities. Therefore, an adaptation policy framework must be flexible enough to allow the decentralized implementation of adaptation measures.

Political willingness: Government commitment is vital if a policy framework is to achieve its objectives. Political leadership stimulates the implementation of adaptation policies and measures. A strong institution committed to providing support generates trust among the stakeholders and they

[17] More information available at www.undp.org/cc/whatsnew.htm. This link was operational during the development of the present document, but may change in the future. The APF is available from Cambridge University Press.

become more willing to commit themselves to cooperate and participate actively in the implementation of policies. One of the main obstacles regarding the institutional framework is the low importance that central governments give to forest ecosystems in their development plans. Political willingness is the basis from which governments acknowledge the importance of forests within the national context, so that adaptation policies create room for action at the local level.

Participation of civil society: In the development and implementation of policy frameworks, the participation of civil society increases social support for the policies and is therefore one of the determinants of their success. Adaptation measures directly concern local stakeholders who, as well as being the most affected by climate change impacts, also have the need and responsibility for adaptation. The direct knowledge and experience of those who directly depend on forest ecosystems is a valuable element in the design and implementation of adaptation measures. Similarly, adaptation processes must respond to the needs and vulnerabilities of citizens. Therefore, it is necessary that citizens join the process.

Level of awareness: The local-level acceptance of and support for the policy depends greatly on the extent to which local people understand climate change problems, perceive the need for adaptation measures and accept their own responsibility for implementing them.

Transparency in the policy framework development and implementation process: Support to the administration can be increased if all the information related to the design, objectives, scope, implementation state, resources and so forth is within easy reach of the stakeholders who participate in the adaptation policies. A transparent policy increases the public confidence level. The World Bank recognizes that transparency is a crucial requirement for good political management, as well as for obtaining the support and greater participation of stakeholders in the implementation of a policy.[18]

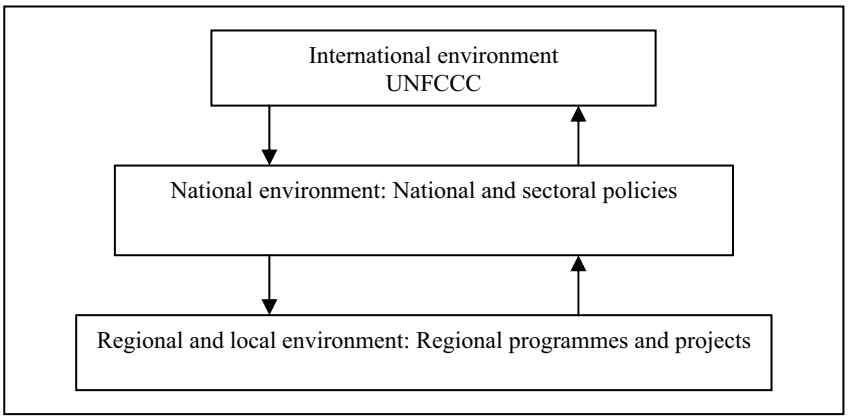
Articulation at the national and international levels

The relationship between the national and international institutional frameworks is two-way (Figure 3.2). On the one hand, there is a national requirement to comply with the commitments of the convention, including the COP decisions. For the particular case of adaptation, these commitments mainly include establishing policies and measures to reduce vulnerability and preparing the national communications. On the other hand, the negotiation process, *per se,* can be influenced by national contexts. A country can add elements to the negotiation agenda that it considers necessary for its adaptation process. In recent years, international negotiations have been dedicated to preparing guidelines for financial mechanisms, national communications and reference frameworks for capacity building and technology transfer. These guidelines have been written in general terms to allow a range of different national and local resources to use them. The effectiveness and scope of national interest depend, in good measure, on building up a solid position that clearly identifies the priorities of each country.

The best way of ensuring that national interests are reflected in international policy texts is for the government and its institutions to participate actively in UNFCCC meetings (workshops and meetings of subsidiary bodies). "Active participation" means keeping up-to-date regarding developments in the negotiation topics, and sending communications and points of view according to the schedules agreed at the meetings.

[18] For additional information on the policies of the World Bank related to transparency, refer to www1.worldbank.org/operations/disclosure/documents/disclosurepolicy.pdf.

Figure 3.2
Articulation of the international, national and local levels



Institutional needs relating to vulnerability and adaptation

Institutions should respond to national situations and be specific to each country. Moreover, an institutional structure that responds to adaptation needs must be generated from the country's or region's existing institutional structure. The UNDP-GEF framework process for adaptation policies suggests that the following issues require institutional arrangements for implementation:

- creating communication channels to generate and provide scientific and technical information for the adaptation process, the vulnerability assessment and the design and evaluation of adaptation strategies, programmes and measures;
- promoting and creating awareness about climate change problems, especially regarding the motivation of private sector and civil society participation;
- ensuring that an adaptation component is included in national investment and development plans;
- integrating climate change into public and private education;
- capacity building at the national, regional and local levels;
- implementing the domestic adaptation activities that are the responsibility of the UNFCCC national focal point;
- ensuring technical and financial support.

The authors of this document add the following issues:

- ensuring the continuous improvement of adaptation policies and programmes;
- serving as a link among sectors and regions for the establishment of national priorities, the exchange of information, and cooperation;
- disseminating the tools and scientific and technical information necessary for the implementation of adaptation measures, and ensuring that these are available at the regional and local levels.

Establishing an adaptation policy framework

This document has emphasized the need to establish a framework for policy or policies, which becomes the axis of an adaptation process. The policy is important because it defines priorities, identifies individual responsibilities and provides the resources for stakeholders to design and implement specific activities. The following two questions are essential for the design of an adaptation policy:

- To what extent can adaptation reduce vulnerability to climate change (in relation to its costs)?
- What institutional arrangements have to be made to develop, implement and finance the adaptation measures?

A policy is the political commitment of a government to solve a problem. This commitment can be represented by a strategy that identifies the objectives, responsible entities and positions, scope, prospective results, and resources for implementation. The policy should facilitate the start-up of programmes related to:

- training;
- vulnerability assessment;
- institutional development;
- implementation of concrete adaptation measures.

The scope of an adaptation policy depends on the level (national, regional or local) at which it is elaborated. Policies at the national level should identify national objectives and priorities, as well as creating space where regional and local activities can be implemented. The scope of a national adaptation policy should not exceed the scope of national and sectoral policies (e.g. the national development policy, national forest plans). Thus, a national policy should avoid setting specific objectives for the regional and local levels. The preparation of regional and local policies should follow national priorities and establish specific goals, objectives, strategies and activities according to the specific regional and local situations.

In some cases, it may be necessary to build capacity at the national and local levels in order to:

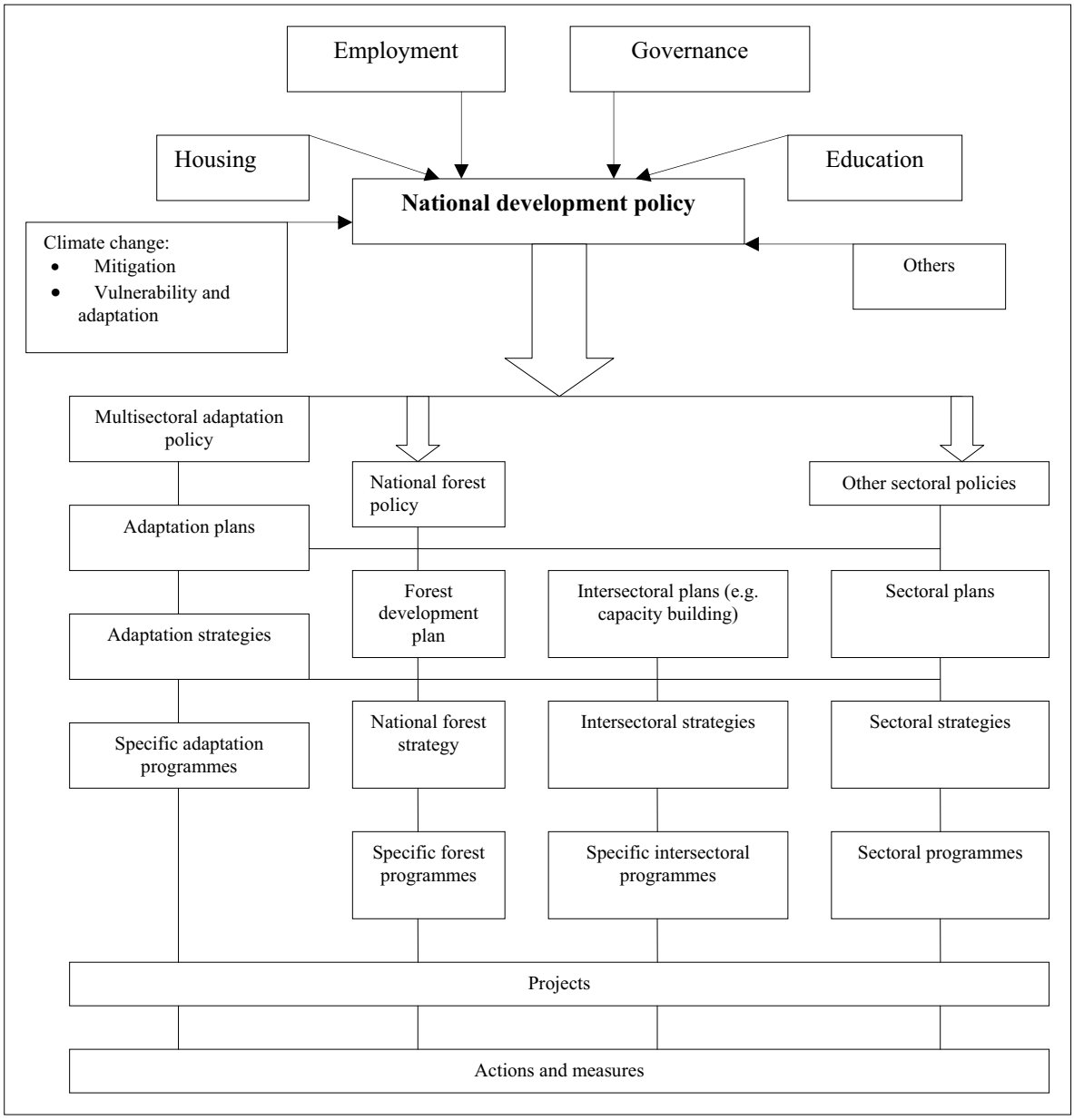
- understand the direct and indirect impacts of climate change on the forest sector and forest ecosystems;
- establish, spread and use possible synergies between the forest sector and other sectors;
- establish, communicate and solve possible conflicts with other sectors;
- promote and implement the monitoring of policies, programmes, plans and projects in the forest sector that are aimed at reducing vulnerability to climate change and variability.

The domestic institutions responsible for the forest sector, forest ecosystems and climate change must create mechanisms that allow them to coordinate actions, identify and diminish conflicts, use synergies, and communicate the knowledge and experiences acquired throughout the community.

This process constitutes a true challenge in the design of adaptation policies, or the incorporation of adaptation components into sectoral policy development. The preparation of a specific policy or of the elements to be added to sectoral policies depends entirely on the situation and priorities of the country concerned. This document limits itself to recommending that it is important to incorporate elements of resource allocation, monitoring, capacity building, etc., which will be described in more detail in the *Guidelines for the formulation of adaptation policies and projects* prepared in parallel to this document. However, it is possible to provide some ideas of how to institutionalize the topic of adaptation at the national level. Different sectors establish their own sectoral policies according to national policy. However, as previously explained, climate change, and particularly adaptation strategies, are multisectoral. Figure 3.3 suggests that the multisectoral policy for climate change adaptation be considered as an input to the definition or modification of sectoral policies. This would be convenient for the forest sector because of the magnitude of possible climate change impacts on forest ecosystems. Likewise, the definition of sectoral strategies should take into consideration the national strategies aimed at decreasing forest ecosystem vulnerability, so that the future existence of forest resources, goods and services can be guaranteed.

In this framework, the *local level* is of special interest, because this is the level at which specific projects and activities are implemented. Most integration of adaptation measures should be undertaken at the local level, by combining the reduction of expected impacts with the generation of revenues for the community.

Figure 3.3
Schematic proposal for the design of adaptation policies



Some considerations for the local level

The local level includes local institutions and civil society that deal with policy-making and implementation in smaller political divisions. Climate change generates impacts at this level. There is a two-way relationship between the local and the national environments, because the latter is merely the sum of the different local environments. On one hand, national priorities should reflect local needs, while on the other local vulnerability and adaptive capacity should be clearly incorporated in government policies and programmes.

Implementation is carried out at the local level, so local capacities in terms of human and capital resources are the main factors contributing to the success of adaptation policies. Another challenge at the local level is the integration of policies, plans, strategies and national and regional programmes into the implementation of activities.

In order to achieve this goal, the following are recommended:

- identifying factors that define relationships to forest ecosystems at the local level:
  - institutions involved in the management of forest and other natural resources;
  - social groups that depend on the forest or live in it;
  - forest environmental accounts;
  - products and forest services;
  - productive chains that depend on forest products;
- clarifying the coverage of policies, plans and programmes for adaptation at the local level;
- clarifying the coverage of policies, plans and programmes for the forest sector and those concerning forest ecosystems at the local level;
- identifying possible conflicts and synergies;
- institutional mechanisms that allow dialogue and collaboration;
- promoting project and activity monitoring at the local level.

Stakeholders

The cross-cutting nature of climate change and of the required framework for action makes it necessary to involve a large number of stakeholders in the adaptation process, including in the design and implementation of related policies. The following paragraphs provide information about stakeholders' responsibilities in this process.

National governments: The national government is primarily responsible for developing the national adaptation policy (or policy framework), as well as for providing the means for facilitating its implementation. The national government should make sure that the policy formulation and national priority identification processes have a solid scientific basis. It should also ensure the support and participation of civil society.

Regional and local governments: Regional and local governments are responsible for identifying regional and local priorities to promote and facilitate the implementation of the national policy. Depending on what is specified in the policy, local government entities may be responsible for approving adaptation projects, provided that these are in line with the national policy and local priorities. For specific cases, such as activities related to policy implementation (e.g. the establishment of priorities) and education and awareness programmes, regional and local governments may be directly involved in the implementation of adaptation projects.

The private sector: The private sector has a double function. First, because it is affected by climate change, its role is to formulate and implement its own adaptation measures and strategies. Second, it is responsible for generating financial resources for national investment in adaptation.

Civil society: The public should facilitate the adaptation process, support the policy, and participate actively in the design of strategies and projects, as well as in their implementation. Citizens' participation in adaptation activities is a key element for success.

NGOs: NGOs have diverse actions and tasks, which are aimed mostly at policy implementation and advocacy for appropriate policy formulation. Many NGOs are able to design and implement adaptation projects. Depending on the type of NGO and its proximity to field realities, these organizations can implement education and awareness raising projects. NGOs' involvement in seeking the support and participation of communities in the adaptation process is particularly valuable.

Universities and research centres: Universities and research centres are responsible for generating technical and scientific knowledge to support implementation of the adaptation policy. At the same time, the information and knowledge developed by these institutions forms the basis for formulating projects and designing adaptation measures.

Multilateral organizations: Several multilateral organizations work in the area of adaptation to climate change. These organizations work mainly in capacity building, education and outreaching, and some are also involved in designing global tools. Some multilateral organizations promote, facilitate or finance specific projects. Project implementation agencies, such as UNDP and UNEP, channel GEF funds and sometimes also provide their own funds for project implementation in developing countries. Funds and organizations such as GEF, the World Bank and regional development banks are responsible for providing financing for adaptation projects.

Bilateral cooperation: The governments of developed countries have international technical cooperation offices that were specifically created to provide scientific and technical cooperation among countries. Their activities include the exchange and supply of experts, technology transfer and funding for the design and implementation of projects. A large number of projects in developing countries are carried out by technical cooperation agencies.

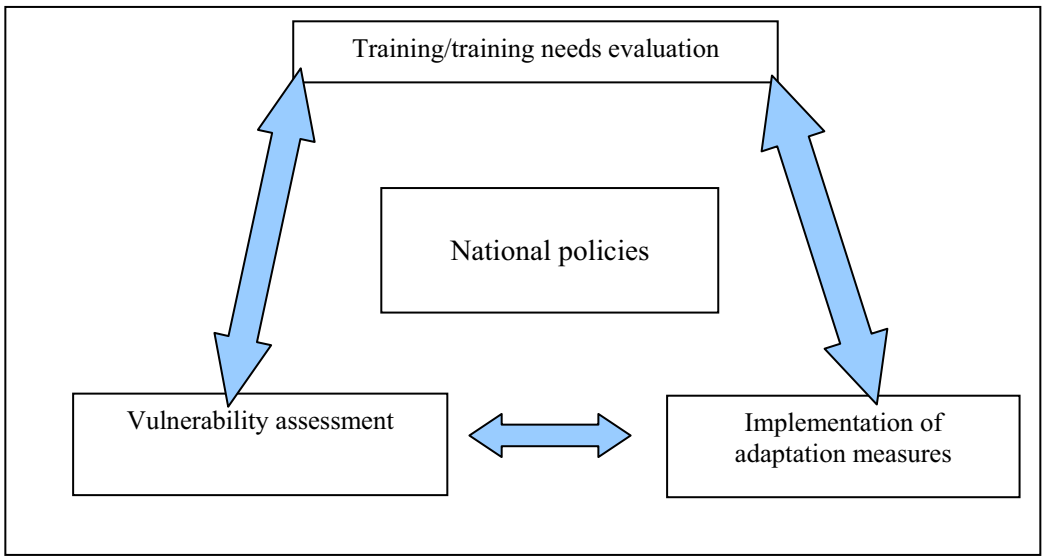
4. Adaptation as a continuous process

Adaptation is a dynamic process that takes place over time. Similar to the development process, it must be focused towards continuous improvement; in other words, it must aim to diminish vulnerability to climate change over time. The adaptation process includes three essential stages: 1) vulnerability assessment; 2) capacity building; and 3) implementation of adaptation measures.

The vulnerability assessment identifies potential impacts, characterizes the affected system (i.e. in a country, biophysical region or forest) and identifies priorities for action. Capacity building enables the social system, especially its institutions, to implement actions to adapt to climate change. The implementation of adaptation measures is aimed at directly improving the adaptive capacity of a system (natural or social).

As part of a continuous process, lessons learned at each stage provide feedback to improve the whole process (Figure 4.1). However, in many cases there is a dilemma between the need to know the level of vulnerability before establishing adaptation measures and the urgency for diminishing the current negative impacts. Discussions at the international level highlight the importance of implementing specific adaptation actions without waiting for detailed knowledge of the vulnerability at the national level, while still recognizing the importance of understanding the vulnerability of a sector, ecosystem or social system.

Figure 4.1
Steps for adaptation to climate change



Each of the adaptation stages can be implemented through specific projects at the regional, national or local level. Ideally, such projects should be part of a national adaptation policy or be included in national development policy. Responsibility for planning, implementing and monitoring these projects should be assigned to several parties, such as national and local governments, research centres, academia and civil society.

Of equal importance are the international institutions that are involved in one way or another in forest resource management. These include the United Nations Forum on Forests (UNFF), FAO, CBD, the International Tropical Timber Organization (ITTO), the Centre for International Forestry Research (CIFOR), the Tropical Agriculture Research and Higher Education Center (CATIE), the International Centre for Research in Agroforestry (ICRAF), the World Wide Fund for Nature (WWF) and the World Conservation Union (IUCN). Each of these institutions has been building its own capacity in

the topic in order to be able to respond to requests from its clients or member countries. Bilateral cooperation agencies have been promoting a process to define their criteria and programmes for adaptation to climate change, in line with the obligations and regulations agreed at the international level.

In conclusion, it is important to acknowledge the need to disseminate knowledge and exchange experiences. Forest ecosystems and the forest sector should play an important role in the process of adaptation to climate change. This is owing not only to reasons that are specifically tied to the UNFCCC process, but also to the implications that forest-related adaptation to climate change could have on sustainable development and poverty reduction.

VULNERABILITY ASSESSMENT

The vulnerability of a given system – natural or social – depends on the impacts it is exposed to and its resilience to accommodate these. Assessment of a system's vulnerability is a complex procedure that must maintain a holistic focus while generating useful information at the sectoral level. In the specific case of forest ecosystems and forest sector assessments, there is a need first to understand the three types of impacts: direct impacts, indirect impacts, and incremental impacts.

Direct impacts are those that have direct effects on forest ecosystems according to changes in the climate system, especially temperature and rainfall, and the increment of extreme events (e.g. droughts, tornadoes and torrential rains). Direct impacts can be divided into impacts related to metabolism and physiology and impacts at the ecosystems level (i.e. incidence of pests, changes in the reproductive cycle, alterations in ecosystem functions, etc.).[19] The direct impacts of climate changes on forest ecosystems, including impacts on the availability and quality of forests goods and services, are not yet well understood. The national communications on climate change offer a general assessment of the forest sector, but the quality and amount of information they provide vary significantly from country to country. At the subnational level (regions or specific ecosystems) even less information is available.

Indirect impacts are related to the development of the forest sector, including impacts on the communities that depend on forest ecosystems (e.g. impacts on the wood chain resulting from changes in the availability or quality of wood). In this case, analysis focuses on the ways in which the sector could suffer as a result of impacts on ecosystem functions. As such, the assessment of indirect impacts should cover the economic and social issues of affected groups, as well as challenges to the institutions responsible for resource management.

Some examples of this type of analysis could answer the question: Given the impacts on a certain ecosystem: a) what are the effects on a given production chain (e.g. if less wood is available in one region, what will happen to people who depend on producing wood products)? b) what are the effects on the food security of a given community? and c) what are the impacts on other livelihood issues such as health, cultural habitat, etc.?

The *incremental impacts* in the specific context of climate change refer to the increase in vulnerability due to unsustainable management of a natural resource. The greater the degrading impact of the management practices, the greater the potential negative impacts of climate change tend to be. A degraded ecosystem has fewer possibilities of responding to, and less capacity to withstand, droughts or torrential rains, while healthy ecosystems with intact structures and greater diversity generally have greater resistance to this type of event. However, these are merely generalizations to illustrate the potential importance of incremental impacts. The impacts generated by the implementation of policies and programmes in other sectors, such as energy, agriculture or water, can also be considered as incremental impacts.

[19] For a summary of the direct impacts of climate change on forest ecosystems, see ibid. Chapter 2.

At present, very few analyses of indirect or incremental impacts exist. There is concern that such impacts could generate important economic biodiversity losses for countries that depend on the forest sector, as well as creating social conflict, particularly in zones in which different social groups are highly dependent on forest ecosystems.

Although the national communications on climate change represent a very important step in understanding vulnerability at the national level, especially regarding direct impacts, there is still great uncertainty about the magnitude of climate change at the local level, as well as about the importance of indirect or incremental impacts. There is therefore an evident need to assess the vulnerability of forest ecosystems and the forest sector regarding all kinds of impacts. Chapter 3 presents some examples of adaptation projects that evaluate forest ecosystems' and the forest sector's vulnerability.

CAPACITY BUILDING

Capacity building enables the social system, especially institutions, to create adequate frameworks and develop actions aimed at adapting to climate change.[20] The main objective of capacity building is to improve the institutional framework so that adaptation to climate change can occur. The following subsections present elements of capacity building for adaptation in the forest sector.

Analysis

There is a need to analyse:

- the *implications of international negotiations* on national policies, particularly on the definition of policies for the forest sector;
- *national policies* for the different sectors: such an analysis should be aimed at establishing synergies and identifying constraints. Analysis of the implications for the agriculture, energy and water resources sectors is particularly important (as these are frequently affected by policies in other sectors);
- the *legal framework*, especially regarding land tenure and the rights to obtain and use forest resources. Any activity aimed at reducing climate vulnerability in the forest sector is highly conditioned by aspects of land tenure and land-use rights. This is an especially complex issue in the forest sector, where there are very diverse regulations with important social implications.

Chapter 3 of this document explains the importance of considering adaptation to climate change as a cross-cutting aspect of sectoral planning. In order to achieve this objective it is necessary to understand the potential impacts of climate change on current forest policies.

The results of these analyses should lead to actions aimed at obtaining concrete improvements of the institutional framework and capacity within the forest sector. These types of actions could be directed to:

- encouraging an institutional framework that promotes adaptation;
- encouraging intersectoral coordination;
- including adaptation to climate change in forest policies;
- guaranteeing conditions for adaptation at the local level;
- promoting the development of human capacity for the encouragement, planning and implementation of adaptation measures in the forest sector.

[20] Chapter 3 presents the institutional framework for adaptation at the international level, as well as an analysis of the implications and challenges that adaptation to climate change has at the national and sub-national levels.

As is the case for vulnerability assessments, there is very little experience of capacity building in the forest sector. Chapter 3 of this document presents some examples.

ADAPTATION MEASURES

Adaptation measures are concrete and specific actions aimed at reducing a system's vulnerability or improving its adaptive capacity.

The following is an analysis of the rationale of adaptation measures (including their objectives and when they should be carried out), followed by a classification of such measures that will guide the planning of an adaptation project.

Rationale of adaptation measures

Given that the objective of adaptation is to reduce the vulnerability of social and natural systems, many potential actions can be taken. The following paragraphs explain the rationale for defining which kinds of action should be considered under specific conditions. This rationale is presented in IPCC's Third Report on Climate Change (IPCC, 2001c).

***Accepting the costs**:* The first option is not to implement any action and to accept the costs of doing so.[21] The decision to accept the costs depends on such factors as the expected magnitude of the impact, the adaptation capacity of the system and the potential implementation costs for any action. If the expected adaptation costs are greater than the predicted costs of the impact, it is better to accept the impact costs. The decision to accept the costs must be based on precise knowledge of the consequences and costs of the impacts, as well as of the costs for adaptation measures. However, given the high degree of uncertainty associated with climate change impact studies, there is a significant risk of assuming higher impact costs, and in some cases impacts may be irreparable.

Sharing and/or compensating for losses: These measures aim to distribute the costs caused by climate change impacts or to compensate for them. Sharing and/or compensating for losses means that the affected person or social group receives some type of payment to cover, partially or completely, the costs of an impact. When losses are shared, the costs of an impact are shared by those not affected by it (or affected to a lesser degree). The procedures to distribute the costs must include institutional and legal elements, as well as eligibility criteria and quantification methods. Some of the institutions that implement such measures are aid organizations, cooperatives, user or producer associations, and special funds that cover the damages caused by climate change.

Preventing the impacts or modifying the circumstances: Preventing an impact means taking measures to avoid specific negative consequences of a climate-induced hazard, or diminishing the magnitude of such hazards (e.g. the washing away of a bridge by a flood). These types of measures and projects are carried out to prevent impacts on an activity or defined system. In general, these measures are designed at a very specific and local level, and depend on a detailed impact study, as well as the consideration of other alternatives. Unlike measures aimed at preventing impacts, the measures designed to *modify the circumstances* are centred on the system – be it natural or social – and seek to make changes that reduce vulnerability (e.g. the management of watersheds to reduce the risk of flood).

Searching for alternatives: The search for alternatives implies a total or partial change in a specific activity or system that is already, or is likely to be, affected by climate change. These types of measures involve looking for substitute activities, goods or services (owing to climate change impacts or the excessive costs of managing those impacts). In general, the need to change activities results

[21] Such costs vary among different social groups. The socio-political implications of accepting costs should be analysed before taking this option.

from events of great magnitude that cannot be controlled by adjustments to the system or by the prevention of impacts (e.g. extreme events can force actors to abandon forestry and take up agriculture or other activities).

Changing location: Location change is required in cases where the consequences of climate change are extreme and require that an affected system be moved from one place to another. Generally, this type of measure is applied into high-risk areas, where populations are exposed to increasing natural disasters (e.g. floods, landslides). Changing location can also refer to changing the location of one or more activities (e.g. infrastructure building or the promotion of a specific settlement). Activities that take place in a high-risk area must be relocated. Changing the location of an activity can cause negative social impacts that must be kept in mind when considering location change.

Research: Research measures aim to support the adaptation process by: 1) understanding the causes of climate change; 2) analysing the impacts of climate change on national and local systems and activities; and 3) planning appropriate and cost-effective measures to increase the adaptation capacity. Research reduces the degree of uncertainty and supports the planning and design of adaptation measures. Research projects should include and value local knowledge, because communities that have been exposed to changes in the climate system have generated successful adaptation strategies and acquired knowledge about the forest and the use of local species that could increase the success of adaptation measures.

Education, awareness creation and dissemination: These measures are intended to disseminate information and create awareness about the importance of adaptation. The extent of participation depends greatly on how each party perceives the problems of climate change. These measures are also aimed at improving understanding of climate change and its impacts on society. This helps to build capacity for the design, formulation and implementation of projects and adaptation measures. Information should be disseminated, keeping in mind the interests and existing knowledge of target social groups, and using appropriate didactic and communication means.

Classification of the adaptation measures

Perhaps the most practical way of illustrating adaptation measures and strategies, given their large number, is to classify them. This section presents a classification according to the timing, duration, scale, responsibility and specific objective of each measure and strategy of adaptation. The following paragraphs are based on Smit and Skinner (2002).

According to the timing: The first classification refers to the timing of implementation measures. In this case adaptation measures can be:

- *anticipatory,* if they aim to prevent impacts and are implemented before the environmental impact has occurred (preventive in character). Anticipatory measures are based on assessment of the likely impacts and the potential vulnerability of a system. Examples of anticipatory measures include the purchase of insurance, the establishment of buffer zones (a forest) to counteract extreme events, and the establishment of a contingency plan for floods;
- *incidental,* if the measure is designed to be implemented while the impact is occurring. Implementation is based on knowledge of the possible impacts. For example, activities to extinguish a fire are of the incidental type;
- *reactive,* if the measure is implemented after the impact has occurred or started to occur. This type of measure is designed to make up for the damages or recover the losses caused by an impact. An example of a reactive measure is the recovery of a forest affected by a fire. Because reactive measures are implemented after the impact has occurred, their planning depends less on the modelling of prospective impacts than on a later loss analysis.

According to the duration: This classification answers the question: How long does the measure or strategy have to be implemented? According to their duration, such adaptation measures could be:

- *tactical,* if the measure is of short-term application and both its implementation and results occur within five years. Tactical measures respond to objectives or impacts that are certain to occur;
- *strategic,* if the measure is designed to be implemented in the medium and long terms. Strategic measures are usually long-term programmes whose activities are aimed at developing continuous self-improvement and adaptation.

According to the scale: This classification responds to the spatial scale of adaptation strategies and measures. In this document, adaptation strategies and measures are implemented in forest areas to reduce the vulnerability of the economic sectors that depend on forest ecosystems, such as the forest and tourist sectors. According to their scale, adaptation measures can be:

- *localized*, if the measure is aimed at a specific economic sector or geographic area. In this case, the objective of activities is to increase the adaptation capacity of a zone or identified activity. Projects identify specific tasks for specific systems and components. With regard to forest ecosystems, a project could be carried out in a specific ecosystem (geographic). With regard to the economic sector, the measure could be aimed at the whole sector, a subsector (e.g. paper production) or a specific activity (e.g. tax reduction for reforestation activities);
- *disseminated,* if the adaptation measures are geographically discontinuous and aimed at addressing several communities or economic activities. Disseminated measures are of the general type, such as activities for education, planning or capacity building.

Sometimes reference is made to the "transnational environment" when a measure is implemented for the benefit of several countries or a region shared by several countries. Transnational activities are planned and implemented when the interests of several countries are similar and when the sharing out of activities and costs is the result of consensus on potential differences of interests from the social, economic or political viewpoints.

According to who has responsibility: This classification is based on the parties responsible for implementing a measure. In principle, all the stakeholders involved in the adaptation process have responsibilities (see further on in this section). Generally, if the responsibility for implementation and results lies with public entities, the measures are considered public measures, while if they are implemented within the private sector, they are considered private.

Adaptation measures in forest ecosystems and the forest sector

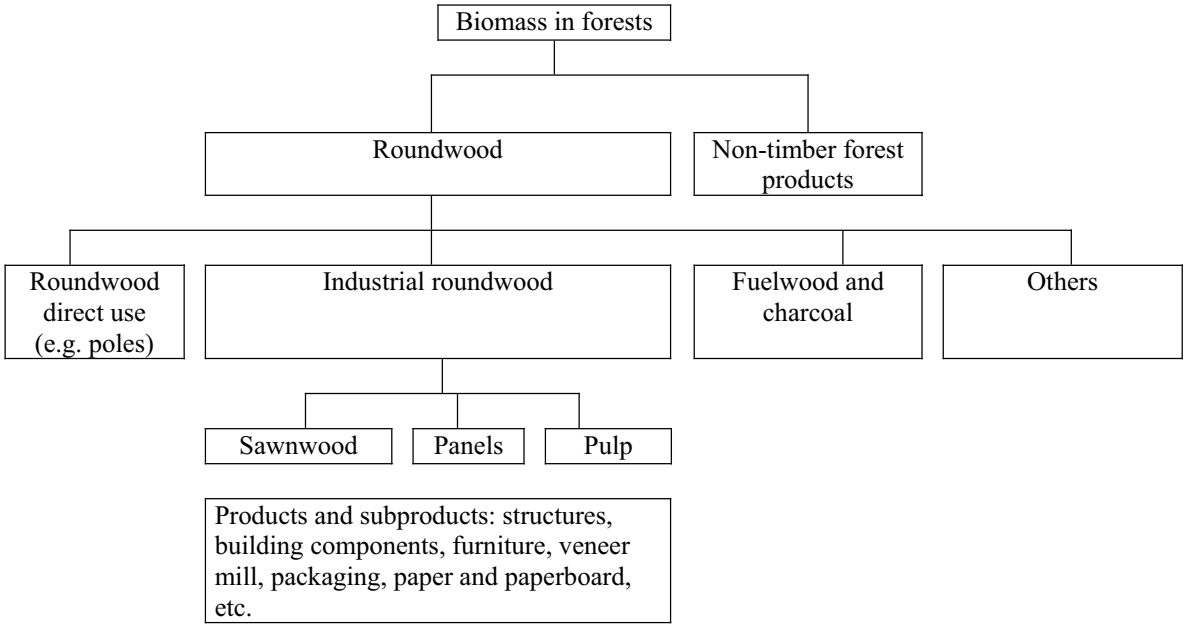
Adaptation measures are planned responses aimed at reducing the vulnerability of a system. Climate change affects forest ecosystems in their structure and morphology, thus causing an impact on their functions.

Vulnerability analysis of forest ecosystems in the national communications demonstrates that climate change can significantly affect the availability of forest goods and services in terms of quality and quantity (Chapter 2). In turn, some environmental services of forest ecosystems, such as water cycle regulation or soil stability, can directly contribute to increasing resilience. The following is an analysis of forest goods and services, and their possible vulnerability. It also provides a series of proposals for using forest ecosystems as an adaptation measure.

Forest goods: Forest goods (marketable and/or subsistence goods) are grouped as timber products, fuelwood, and NWFPs.

Timber products: Data on annual world wood production vary between 3.1 and 3.5 billion m^3 (FAO, 2001b; ITTO, 2002a). This production is put to various uses that range from paper production to energy generation (Figure 4.2).

Figure 4.2
Classification of timber products



Source: Authors compilation from FAO, ITTO and Wood Laboratory, EMPA.

Approximately 43 percent of the roundwood commercialized in international markets is produced in tropical countries (from plantations or natural forests). However, this figure represents only part of the total wood produced. Establishing the importance of timber in the global or national economy is particularly difficult for several reasons, as follow.

Only 21 percent of all the timber produced in developing countries is marketed. A large proportion of the trees cut down in Southern countries are consumed as fuelwood to generate energy (Figure 4.2). This fuelwood may be used directly by the producer or may be marketed in formal or informal markets. Of the total volume of timber harvested, only 1.5 billion m^3 are used in industrial processes, such as paper production or the timber industry.

In addition, it must be recognized that timber trade figures do not reflect reality. The figures for total exported timber do not always coincide with the total value of imported timber, indicating that part of the timber consumed is not included in production statistics. There is also a range of timber products that are not included in national accounting. Among these products are packing materials (crates) and some construction elements that are consumed directly or are disposable (e.g. mold panels or beams), and for which no figures are available.

FAO estimates that the annual industrial timber trade is about US$140 billion (FAOSTAT Statistical Database, 2001). Climate change can affect timber production, both directly and indirectly. Direct impacts can affect timber availability and quality, and could themselves produce a series of indirect impacts on the production chain because job demand could vary owing to changes in the available amount of timber. Furthermore, it could become necessary to use other technologies in order to offset changes in timber quality or species availability.

No studies have yet been made to establish the magnitude of direct impacts, nor of their indirect implications. Climate change adaptation projects that include the forest sector must consider evaluating the possible effects of changes on timber availability in the future so that appropriate strategies can be developed.

Fuelwood: Different sources suggest that in 1999 between 1.5 and 1.75 billion m^3 of timber were used as fuelwood or charcoal – 80 to 90 percent of this production coming from developing countries (according to FAO statistics for 2001 and ITTO ones for 2004). In 1998, the International Energy Agency (IEA) estimated that 11 percent of the world's energy consumption came from biomass, especially fuelwood (Nasi *et al.,* 2002). Other sources estimate that 19 percent of primary energy consumption in China, and 42 percent of consumption in India come from biomass. The total figure for developing countries is nearly 35 percent. The most important quantity of biomass consumed as fuel is by the poorest communities in the poorest countries (IEA, 1998; UNDP, 2000).

Sustainable fuelwood extraction depends on three factors: ecosystem productivity and vulnerability, extraction methods, and demand size. Fuelwood and charcoal are rarely included in national accounting figures for the forest sector and even less frequently in the international trade of forest products. It is therefore difficult to assess these products' contributions to the economy. However, fuelwood and charcoal production and consumption are to be considered when promoting sustainable forest management.

From a climate change perspective, it is expected that unsustainable practices of fuelwood harvesting and charcoal production increase the vulnerability of ecosystems. If adaptive capacity is to be increased, it is necessary to create alternatives for those social groups dependent on fuelwood so that they can satisfy their needs without increasing the exposure to climate risks. Concrete activities at the local level, such as the promotion of small plantations for fuelwood production (fuelwood plantations and agroforestry systems) or improved practices to produce charcoal, can contribute to reducing vulnerability.

These activities must be considered for adaptation projects in social systems in which the production and consumption of fuelwood are important.

NWFPs: This is a fairly heterogeneous category that covers marketed and non-marketed forest products other than timber and fuelwood. Non-wood products include food (of animal and vegetable origin), fodder, medicinal and aromatic plants, flowers, fruits, and fauna in general. The importance of these goods in the economy is particularly difficult to estimate owing to several factors: 1) a large proportion of these products are consumed directly, without entering the market; 2) they are marketed through informal markets that are not included in national accounting; 3) a significant portion of these products are exploited and marketed illegally; and 4) linking volumes or weights of the products to sustainable plant production is usually particularly difficult for methodological reasons.

Both scientific and indigenous knowledge of NWFPs should be integrated in order to realize the potential production and impacts of a given ecosystem, and anticipate the challenges created by the market in terms of quantity and quality of final products.

There is already evidence that demonstrates the importance of these products for the social system. The following are some examples:

- In the rural area of Madhya Pradesh, India, between 40 and 60 percent of the annual income comes from commercializing NWFPs (Tewari and Campbell, 1996).
- In seven study areas in Africa, the annual income from commercializing wild plants ranges from US$194 to US$1 114 per rural family (Schackleton *et al.,* 2000).
- In West Bengal, NWFPs contribute up to one-third of family incomes (Kant *et al.,* 1996).
- About 4.8 billion people use medicinal plants from forests.

- Every year, about 5 million tonnes of dry plants from the forest are used to produce medicines.
- In 1996, the approximate value of medicinal plants in the global market was US$14 billion (Ramírez *et al., 1996*). Europe was the most important consumer, accounting for 50 percent of this total, followed by Asia (36 percent). The value of the market in the United States was estimated at US$4 billion (Brevoort, 1998).
- Between 700 and 800 million people depend directly or indirectly on agroforestry or forestry activities. A main part of agroforestry production systems is aimed at direct consumption.

Little is yet known about the extent to which the availability and quality of these products are affected by climate change. The same applies to the potential that sustainable activities related to the production, treatment and commercialization of NWFPs have to increase the adaptive capacity of a system. However, many non-wood products are likely to be more vulnerable to changes in the climate system than timber production is. It is clear that for these products the indirect and incremental impacts could have profound effects on local economies, food security and health. These considerations are a further demonstration of the importance of considering climate change, its impacts and the possibilities for adaptation within the forest sector, including the knowledge that different management practices could have on reducing vulnerability.

Agroforestry: An aspect of great concern for developing countries is the impact that climate change can have on food security (IPCC, 2001a). Forest ecosystems and food production are interlinked at several levels – food originating from forest plants and animals, regulation of the water cycle to maintain waterflow in agricultural areas, and soil conservation.

In these guidelines, food production is considered as part of NWFPs, while regulation of the water cycle and soil conservation are analysed in the following subsection as two of the environmental services of forest ecosystems.

It is also of particular importance to note the important role that agroforestry[22] can play in adapting to climate change, because agroforestry systems integrate food and wood production and supply many environmental and social services.

The ad hoc group of experts on biological diversity and climate change has recommended the use of an ecosystemic focus as the basis for work on climate change adaptation. This focus implies recognition of the close relationships among different elements of the landscape, i.e. among the different natural resources and their management. This means that adaptation projects related to the forest sector cannot ignore the links to management of other natural resources, especially water and agriculture.

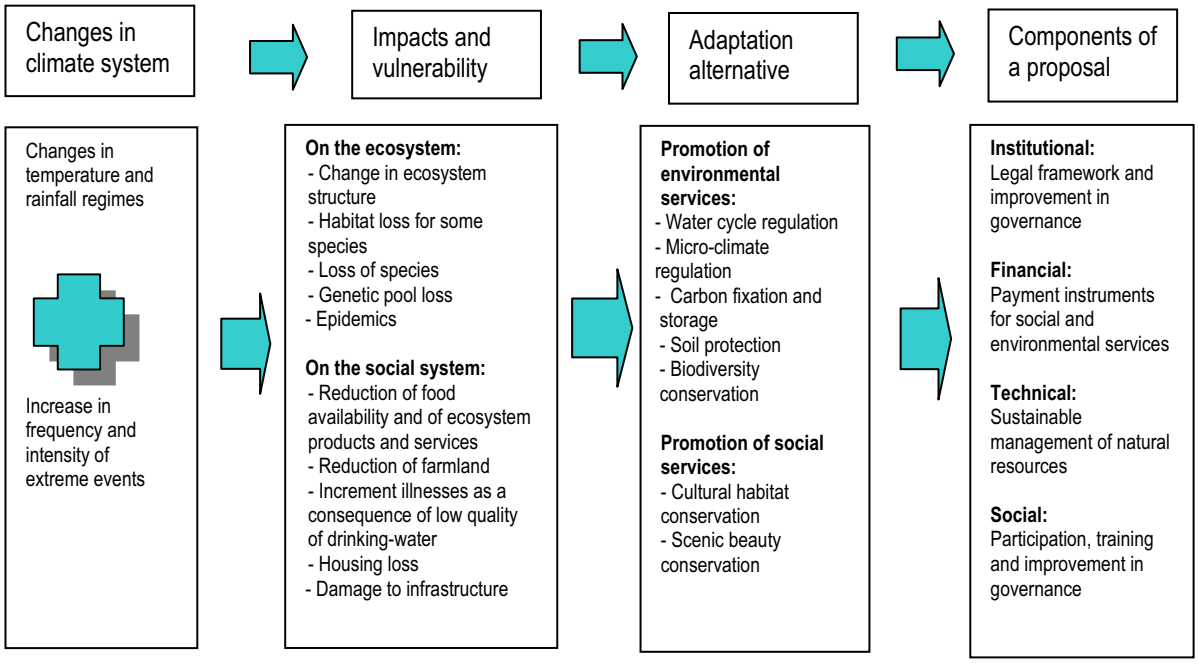
Forest services: In these guidelines, forest services are divided into environmental and social services. *Environmental services* include water system regulation, microclimate regulation, carbon fixation and storage, biological diversity conservation, and soil protection. *Social services* include the conservation of scenic beauty, the cultural habitat and religious heritage.

The environmental and social services of ecosystems have been gaining ground as means to promote sustainable management of those systems. As indicated in several studies, sustainable management of natural resources can decrease vulnerability (IUCN *et al.,* 2003; Robledo *et al.,* 2004). From the financial point of view, however, many of these practices are unfeasible. In such cases, payment for environmental services could be an adaptation alternative as long as it is used to promote natural resource management practices that improve the living conditions of local populations and reduce vulnerability to climate change.

[22] "Agroforest: A complex of tree areas within an area that is broadly characterized as agricultural or as an agro-ecosystem." (ITTO, 2002b).

In order to ascertain the relationship between adaptation to climate change and the environmental and social services of forest ecosystems, the most important climate hazard for the region concerned must first be identified (whether it be slow changes in the system or the increment of extreme events). Examples of such hazards are droughts, floods, loss of species and erosion. In some situations, environmental or social services could reduce these impacts, thus reducing vulnerability and providing an adaptation alternative (Figure 4.3).

Figure 4.3
Relationship between adaptation to climate change and the environmental and social services of forest ecosystems



Source: Compiled by the authors.

Table 4.1 shows examples of concrete adaptation options. There are other adaptation alternatives for decreasing the impacts mentioned, but the objective of this section is to elaborate on the possibilities of using the environmental and social services of forest ecosystems, recognizing that such services can also help to improve the livelihoods of local communities.

The promotion of environmental and social services of ecosystems implies work at different levels:

- *institutional:* to define the ownership of environmental/social services. In this case it is important to consider the role of local communities (i.e. customary rights), because they ultimately implement the measures at the local level;
- *technical:* to guarantee that the management practices aimed at promoting the services in a given ecosystem are well known and feasible;
- *financial:* to design and facilitate the implementation of instruments that allow adequate payment for the services;
- *social:* to promote community participation, in both the decision-making process and the design and implementation of specific projects.

Social services are closely bound to the value that certain social groups give to forest ecosystems. Understanding the importance of these social services is essential, because it influences significantly the social groups' motivation to manage forest ecosystems sustainably.

Although the importance of forest services (social and environmental) has gained recognition, quantifying these services and establishing their value has become a major difficulty to the use of payment systems as an instrument for the long-term promotion of forest ecosystem sustainable management.

TABLE 4.1
Environmental services as adaptation options

Climate risk	Impact	Environmental service	Adaptation option (examples)
Changes in rainfall regime	Droughts, floods	Water system regulation	Watershed management: plantations of species with high regulation capacity, agroforestry, etc.
Extreme events (e.g. torrential rains, hurricanes)	Damage to infrastructure, floods		
Changes in rainfall regime	Droughts and floods	Micro-climate regulation	Restoration and rehabilitation: forest enrichment, research in forestry
Average temperature changes	Change in ecosystems structure. Habitat loss for some species		
Extreme events (e.g. torrential rains, hurricanes, fires)	GHG emissions	Carbon fixation and storage	Mitigation projects in LULUCF.* Fire control
Changes in rainfall regime	Change in ecosystem. Habitat loss for some species. Loss of species (fauna and flora). Loss of genetic pool. Epidemics	Conservation of biological diversity (including pollination, seed distribution, habitat and natural pest control)	Bioprospecting studies. Sustainable management of forests: conservation, restoration and rehabilitation; sustainable plantation management
Extreme events (e.g. torrential rains, hurricanes)			
Temperature changes			
Changes in rainfall regime.	Erosion	Soil protection	Restoration and rehabilitation: forest enrichment. Plantations with soil protecting species in highly degraded areas
Extreme events (e.g. torrential rains, hurricanes)	Landslides		

* LULUCF = land use, land-use change and forestry.

Governance and adaptation in the forest sector: These guidelines do not set out to analyse the variables that determine governance in the forest sector. However, governance directly affects the possibility of implementing any type of adaptation project in the sector. Table 4.2 lists some governance factors for the forest sector that may be important for climate change adaptation. The list can be used by project developers to check the governance situation in a specific region and determine whether, in principle, any improvement measure is necessary. However, it is important to note that this list provides only an indication of aspects that must be considered, without actually rating them.

Governance must be evaluated for each project. To do so, the geographic coverage of the project should be borne in mind – local,

Box 4.1. Plantations and climate change adaptation: experience of the Khuluyu community in Bolivia

The ecosystems found on the hillsides inhabited by the Khuluyu community (in Cochabamba Department, Bolivia) are highly degraded owing to changes in land use for sheep and cattle grazing. Animal husbandry, which is undertaken by 62 families, is supplemented by the farming of basic food products. Agricultural products are marketed in Sacaba, the municipal centre. This population lives in an inter-Andean valley that supports significant agricultural activity. Assessment of climate change impacts in the area has shown a high degree of vulnerability to changes in the rainfall regime (mainly as a consequence of longer drought periods and short periods of torrential rains, which generate high erosion). During the 1980s , the community established a series of plantations (fast-growing species), and promoted the regeneration of native species (*Alnus acumminata*) in the upper watershed areas in order to assure supplies of fuelwood and decrease the risk of landslides. In 2003, the impacts of these plantations on reducing vulnerability to climate variables were assessed. The assessment revealed that the plantations had decreased the landslide risk in the community of Khuluyu, as well as in Sacaba, thus increasing the adaptive capacity. Comparing the costs of establishing the plantations with the costs of a possible landslide, the cost-effectiveness of the plantations became clear (Robledo *et al.*, 2004).

sub-national, national or international. According to this level, a project will be linked to the appropriate level of governance.

TABLE 4.2
Some indicators for the rating of governance

	Good	Fair	Poor
Regulatory and enforcement capacity of the State			
Clarity of land tenure			
Clarity of land-use rights			
Clarity of ownership of environmental services			
Transparency in markets for goods and services			
Levels of corruption	(low)	(medium)	(high)
Representation of different social groups			
Decentralization			
Presence of institutions			

EXPERIENCES OF VULNERABILITY ASSESSMENT

Assessments of Impacts and Adaptations to Climate Change

The Assessments of Impacts and Adaptations to Climate Change (AIACC) project is a global initiative developed by UNEP and IPCC, and financed by GEF, the World Bank and the governments of the United States and Canada. Its main objective is to enable developing countries to assess vulnerability, as well as to propose research related to adaptation. AIACC finances research activities focused on developing vulnerability assessment methodologies.

Some 46 developing countries have participated in this exercise, producing a total of 26 regional studies. The results vary according to the specific conditions of each country, although all have been carried out under the common denominator of vulnerability assessment and adaptation strategies as specified by UNFCCC.

The documents produced by the studies, including the tools used for their elaboration, are available at: www.aiaccproject.org.

Programme to Support National Communications

Within the UNFCCC process, UNEP together with UNDP, have been implementing a programme aimed at supporting the national communications of developing countries. This programme has the financial support of GEF and covers more than 130 countries interested in the activities of UNFCCC.

The programme puts special emphasis on the adaptation component and has contributed to capacity building of participant countries by producing technical material for vulnerability assessment and adaptation, including:[23]

- a manual for the assessment of climate change impacts and strategies for adaptation;
- tools for the elaboration of climate scenarios;
- a methodology for the design of frameworks for adaptation policies.

The programme has established a process which objective is to assist the formulation of sectoral policies covering adaptation at the national level. The purpose is to develop a new generation of

[23] Material available at: www.undp.org/cc/helpdesk por ciento20adaptation.htm.

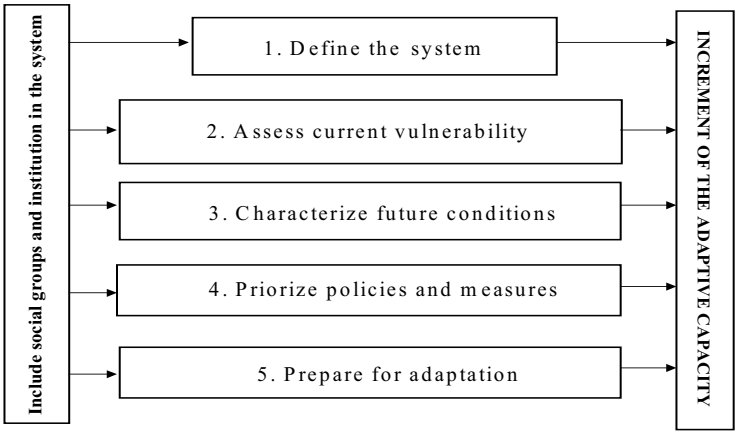
international activities on adaptation within the national communications environment in developing countries, based on the following four general principles (see Spanger-Siegfried and Dougherty, 2003):

- Recent experiences of climate variability should be kept in mind within the adaptation process.
- Climate variability and extreme events should be taken into account in the long-term policy development process.
- Present vulnerability is the starting point for adaptation in the future.
- Current development policies and investment procedures at the national level are main elements in the process of elaborating adaptation policies.

Adaptation Policy Framework

The Adaptation Policy Framework (APF) project is a process initiated by UNDP to develop a series of instruments to improve adaptation capacity. Figure 4.4 presents the focus and steps of APF. In addition to developing the policy framework, APF has been developing a series of technical documents.

Figure 4.4
APF focus and steps



The process to develop an adaptation policy framework started in 2001 and engaged a wide range of experts in policy-making, climatology, economics, ecology and other important disciplines. Manuals and guidelines have been developed through workshops and information exchange networks, and these preliminary materials will be circulated for their improvement. A series of technical documents has been available since 2003.[24]

One of the potentially useful developments of APF is the creation of a learning mechanism for adaptation, which is currently in the design phase.

UNDP-GEF experience in Central America

The Promoting Capacity for Stage II Adaptation to Climate Change in Central America, Mexico and Cuba project is a combined initiative of the governments of eight countries – Costa Rica, Cuba,

[24] All the documents for the APF are available at www.undp.org/cc/apf.htm.

El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama – with UNDP. The project is co-financed by GEF.[25]

These countries will serve as a pilot region for developing and implementing APF to prepare strategies, policies and adaptation measures. Implementation of the framework will demonstrate how the adaptation policy can be integrated into national sustainable development in at least three sectors: water resources, agriculture and human health. The project is based on stage I of the adaptation process – assessment of the vulnerability and adaptation reported in the initial national communications of the eight participating countries. The project will prepare these countries to advance towards stage III of APF – implementation of adaptation measures. Once other countries become aware of the conditions for participation, it is expected that they will adopt the framework developed for this region. The project began in 2002 and so far has produced a series of technical documents and national plans focusing on the key sector for each country. The results of the entire project will also contribute to the second national communications to UNFCCC.

TABLE 4.3
National priorities in the UNDP-GEF Central America project

Country	Priority sector
Costa Rica	Adaptation of the water sector to climate change
Cuba	Agriculture and water resources
El Salvador	Food security and the agriculture sector in the coastal zone
Guatemala	Water resources; agriculture and food security; public health
Honduras	n.a.
Mexico	Water resources, agriculture and forest ecosystems
Nicaragua	Water resources and agriculture
Panama	Water resources

Although forest ecosystems were identified as a priority only in Mexico, it is essential to keep in mind the relationship that exists among the priorities determined by the countries and sustainable forest management, especially in cases where the priority is the water resource.

The United States Studies Programme

Under the UNFCCC framework, the Government of the United States has established a support programme for developing countries for activities related to the convention. This programme focuses on the development of inventories of GHGs and the study of vulnerability and options for adaptation. The amount assigned to it is US$35 million.

More than 50 developing countries have participated in the exercise. The exercise included an assessment of vulnerability in each country, the training of experts in the use of assessment tools (e.g. climate, socio-economic and biological models) and the exchange of information among countries with similar needs and conditions. Its main tangible result has been an increase in institutional capacity. The results of the studies set the base for adaptation work within UNFCCC.

The forest study centred on analysis of the existing relationship between vulnerability and changes in the growth patterns, production and migration of species (i.e. the vulnerability of selected ecosystems to the potential impacts of climate change). The study programme produced country reports and a vulnerability assessment manual. Additional information is available at www.gcrio.org/csp/uscsp.html.

[25] Additional information at www.cathalac.org/adaptacion/index.html.

5. Adaptation projects

IPCC defines a project as a series of planned activities, carried out in a region or specific area. The three stages of adaptation – vulnerability assessment, capacity improvement and adaptation measures – are implemented through specific projects. The forest sector may be considered in each of these stages, either within an intersectoral project or exclusively in a forest project.

COMPONENTS OF ADAPTATION PROJECTS

A project is a systematic way of implementing one or several actions to solve, or contribute to solving, a problem. It follows a clear strategy and considers the social groups affected. A project also includes a detailed budget for the actions proposed and the time frame for their implementation.

The following are different components that must be considered for adaptation projects in the forest sector. Not all projects related to adaptation require activities for each component. However, they should consider all components, at least during the planning and formulation phases.

Institutional: The institutional component considers the policies, plans and programmes, the legal framework, the structure and operation modalities of the government entities, and the mechanisms of participation among government and non-governmental entities. Institutional problems are particularly important in the forest sector. Adequate consideration of legislation concerning property, access to and use of forest resources, and corruption in the sector are decisive for the success or failure of adaptation projects in the forest sector.

Economic and financial: The economic and financial component of a project must consider the implications on overall economics of implementing adaptation measures, along with the financial sources in the short, medium and long terms.

Forest management: Forest management covers forestry aspects (species, silviculture and ecosystem behaviour, etc.) and other downstream technical considerations (activities' technology and infrastructure requirements, specialized personnel needs, etc.).

Social: The social component concentrates on identifying the social groups that are involved or affected, as well as establishing mechanisms that promote their participation at different stages of the project.

Research: Because the impacts of climate change on social and ecological systems are a relatively new area of knowledge, many interactions have not yet been clearly established. The research component concentrates on explaining these interactions, as well as identifying new research areas necessary to improve the adaptation process.

SOCIAL SYSTEMS AND ADAPTATION PROJECTS IN THE FOREST SECTOR

Adaptation projects are formulated and implemented keeping in mind the different elements of the social system, i.e. those social groups directly and indirectly affected by the impacts of climate change, and the institutions that represent them. Within the forest sector adaptation framework, the following questions must be considered:

- Who are these groups?
- Who represents the institutions?
- What mechanisms are available to promote/guarantee participation?

- What is the role of each mechanism in the process of adapting to climate change?
- What elements are of special importance?

The concept of *social groups* makes it possible to divide society into more or less homogeneous groups that can be characterized according to their functioning in the system as a whole. Such a division of populations is carried out according to certain variables established *a priori*. Table 5.1 shows some examples of social groups distinguished by specific variables.

TABLE 5.1
Examples of potential division into social groups

Variable	Social groups
Landownership	State Large landowners Small landowners Communities (including indigenous communities). May be useful to separate out indigenous communities and emigrants
Access to forests resources	Owners Concession holders Users Settlers
Economic activity	Forest concession holders Tree farmers (plantation owners) NWFP producers
Position in the productive chain	Producers Consumers Processors Merchants

The variables selected depend on specific site conditions. Likewise, whichever variable is applied, the social groups assigned to it will change from country to country, and in some cases even from region to region (e.g. the variable "ownership of forest resources" would include different social groups in Colombia than it would in India because the legislations in the two countries consider different elements and foresee different forms of ownership of a given resource).

When the relevant social groups have been identified, each group needs to be characterized. In the adaptation to climate change framework, such characterization is likely to include, among other factors, the group's relationship to the resource (e.g. user, owner, etc.), as well as its vulnerability.

The second component of social systems is their institutional arrangements. *Institutions* include not only policies, programmes and plans, but also the legal framework and the organization and functioning of the institutional entities and organizations concerned. In this document, the institutional frameworks are defined by UNFCCC and its different entities and organizations.

Although the convention defines the institutional framework at the international level, the design, formulation, implementation and monitoring of projects demands that they be integrated within the individual country's institutional framework. This implies that adaptation projects have to establish a clear relationship with the priorities of sustainable development established by each party.

Adaptation projects in the forest sector must be coherent with the development strategy that a country has defined for this sector. However, such sectoral coherence is often not yet part of development policies. In many countries, adaptation to climate change is not considered a development priority, either owing to ignorance about the country's vulnerability or because such adaptation requires long-term planning and is of little interest in the political processes. Even when adaptation to climate change is considered in planning, the forest sector is seldom included in those plans.

As a consequence, adaptation projects for the forest sector face a double challenge: integrating the social groups affected, and mainstreaming the issues within institutions.

An alternative to this challenge is to ask: Who would be interested in designing and implementing adaptation projects? An easy answer would be: Everyone who benefits from the project's implementation. Such benefits refer mainly to reducing vulnerability, and interested parties are mainly those people who are directly affected by climate variability and change. A benefit could also be the implementation of objectives and adaptation policies, the interested parties therefore being local government (autonomous regional entities, environmental or development units), NGOs, and national (ministries or departments) and international entities (United Nations and bilateral cooperation agencies).

Depending on who its major stakeholders are, a project can be characterized as public, private or a public–private partnership. *Public* projects are those related to the development of policies, plans and programmes that allow a clear framework for adaptation to climate change to be established. Such projects often have the aim of institutional development in a country or region. In this type of project, social groups are considered a variable, but are not active participants.

So far, adaptation efforts by *private* actors are viewed as being autonomous adaptation, as most of them are the result of non-organized and non-institutionalized responses to reducing a specific climate risk. These efforts have not been responses to the implementation of a policy or programme to reduce vulnerability, but have rather been isolated and individual.[26] It is recommended that future initiatives in the private sector be coordinated with overall adaptation policies.

Public–private partnerships represent a very interesting area for adaptation projects. This approach has been used over the last two decades in the promotion of sustainable development at the local level. It has the substantial advantage of being able to integrate the needs and potentials of social groups with the promotion of an institutional framework that favours adaptation. The success of public–private partnerships depends on the credibility and transparency of each party and on the establishment of participation mechanisms that permit a combined decision-making process. In spite of the forest sector's enormous difficulties concerning credibility and transparency, this alternative has the greatest social potential for climate change adaptation.

CLASSIFICATION OF ADAPTATION PROJECTS IN THE FOREST SECTOR

Adaptation projects in the forest sector can be classified according to three variables: the stage of adaptation, the scale of the project, and the type of forest management. Table 5.2 synthesizes this classification.

According to stage in the adaptation process

Adaptation projects can concentrate on one stage or articulate two or more stages; the latter enabling feedback to the dynamics of the adaptation process. Table 5.3 shows some examples of possible projects in the forest sector according to adaptation stages.

Most of the projects implemented so far have concentrated on stages I and II at the national and regional levels. However, the forest sector has not been the central topic of any of these projects.

Vulnerability assessments, especially within the national communications, have considered forest ecosystems, but not necessarily the forest sector or the implications of the loss of certain forests ecosystems on other sectors. Capacity improvement projects have concentrated on the agriculture sector, as well as on water resources (UNDP-GEF project: Capacity Building for Stage II of

[26] See work done under the context of APF at www.undp.org/cc/apf_outline.htm.

Adaptation to Climate Change in Central America, Mexico and Cuba), although the relationship of water resources to forest issues has not always been included.

TABLE 5.2
Classification of adaptation projects in the forest sector

Classification variable	Project features
According to stage of adaptation	Vulnerability assessment of ecosystems and the forest sector
	Capacity for improvement in the forest sector
	Measures for improving the adaptive capacity of ecosystems and the forest sector
According to scale	Regional
	National
	Local
According to forest management	Conservation
	Rehabilitation and restoration
	Plantations
Mixed projects	Combine one or more of the previous classifications
	Intersectoral projects

TABLE 5.3
Projects according to adaptation stages

Adaptation process	Examples of projects in the forest sector
Stage I: Vulnerability assessment	Assessment and valuation of: - loss or potential appearance of species (fauna and flora) - decreased/increased timber production - impacts on micro and macro watersheds - impacts on soil erosion/degradation, especially in mountain ecosystems - increments in desertification processes - indirect effects (e.g. on employment in the timber sector, decrease of available water for power generation or irrigation)
Stage II: Improvement in capacity and design of measures	Intersectoral forest resource planning for reduction of vulnerability Capacity building among affected social groups(for understanding and reduction of vulnerability to climate change) Integration of vulnerable social groups in the sector's strategic planning Improvement of governance in the forest sector Incorporation of adaptation components into forest management plans
Stage III: Implementation of adaptation measures	According to the impact Watershed management for regulation of waterflows Plantations to reduce landslide risk Agroforestry to improve food security Selection felling and/or reduced-impact logging, according to site conditions Sustainable forest management for integrated vulnerability reduction Mangrove management for flood control

According to the scale

Classification of projects according to their scale depends on the geographic coverage of project implementation, i.e. regional, national or local. The scale can refer to specific ecosystems or to political–administrative divisions. In Table 5.4, regional projects are ones that are international.

TABLE 5.4
Examples of projects according to their scale

	Regional	National	Local	
According to ecosystems	Vulnerability assessment in the Amazon	Impact study of climate change on the forest sector in Guatemala	Vulnerability assessment of a micro watershed	Vulnerability assessment
According to political–administrative divisions	Assessment of vulnerability to climate change in the European Union	Vulnerability assessment of the forest sector in Malaysia	Study of the impact of climate change on the marketing of agricultural products in 2 departments	
According to ecosystems	Design of an adaptation policy for the Congo basin	Design of a strategy for an adaptation policy for the Galapagos archipelago	Forest management plan for a micro watershed	Capacity improvement measures
According to political–administrative divisions	UNDP-GEF project for the improvement of training on adaptation (Central America, Mexico and Cuba)*	National training plan on adaptation for the forest sector	Territorial ordering plan for the Rio Nare slopes in Colombia	
According to ecosystems	Afforestation to reduce the risk of desertification in the Sahel region	Restoration of a watershed at the national level (e.g. watershed management of the Magdalena river in Colombia)	Pilot project to pay for soil conservation in a micro watershed	Implementation of adaptation
According to political–administrative divisions	Establishment of regional biological corridors	Establishment of an Environmental Services Act to promote adaptation	Municipal regulation of payment for environmental services related to adaptation	

* This is the only existing project. The other examples are all fictitious illustrations.

According to forest management

In these guidelines, forest management is understood as being forestry practices and the related downstream and upstream technical investments (infrastructure construction, equipment acquisition, etc.). If future generations are to have access to forest resources, such management has to be sustainable.

Regarding climate change, sustainable management must include reducing the vulnerability of both the forest ecosystems and the social groups dependent on them. This implies a series of challenges ranging from understanding possible changes in forest ecosystems, to planning and implementing management measures aimed at reducing a specific vulnerability.

Three strategies of forest management should be considered for adaptation measures: conservation, rehabilitation[27] and forest plantations (Table 5.5).

The examples presented in Table 5.5 highlight the importance that forest management can have in reducing climate change vulnerability. As yet, there are no data to assess the concrete contribution that these strategies have on increasing a system's resilience. However, recent preliminary research has begun to determine the potential of such activities in the context of adaptation to climate change (IUCN *et al.*, 2003). Concrete management practices should be designed according to specific site data and considering future climate scenarios.

[27] ITTO (2002b) proposes the following definitions:
- Rehabilitation (forest): Management strategy applied on degraded forest land to restore the forest capacity to produce goods and services.
- Restoration (forest): Management strategy applied on degraded primary forest. Forest restoration aims to restore the forest to its original state before it was degraded (the same function, structure and composition).

TABLE 5.5
Examples of forest management strategies as adaptation measures

Management strategy	Potential impact of climate change	Adaptation measure
Conservation	Desertification increase	Watershed conservation
	Change in structure and morphology of forest ecosystems	Protection of seed sources
	Increase in fire events	Creation of fire barriers, collection and use of biomass
Rehabilitation	Greater exposure to torrential rains, reduced food security	Rehabilitation by agroforestry
	Change in structure and morphology of forest ecosystems	Selection of species and management practices considering future climate scenarios
Plantations	Landslide risk	Plantations with fast-growing species
	Exacerbation of impacts on ecosystems owing to increased fuelwood demand	Establishment of fuelwood orchards

METHODOLOGY FOR FORMULATING PROJECTS

This section provides a methodology for the formulation of adaptation projects. The methodology covers forest ecosystems, as well as the forest sector. It is only a general guide covering steps that could be followed, from project conception to financing.

It is worth pointing out that agencies with the capacity to finance projects use their own specific methodologies for project formulation. This guide aims to facilitate the process (formulation, financing, start-up), considering the experiences and guidelines of the UNFCCC framework and international development cooperation in the forest sector.

The methodology proposes the following six steps:

1. identifying the problem;
2. defining and characterizing the system;
3. evaluating the options;
4. establishing strategic alliances;
5. formulating the project;
6. assuring the financing.

Box 5.1 gives two examples that illustrate how the methodology works.

Identifying the problem

In adaptation, the problem can be identified through broad categories, such as the high vulnerability of a system. Another alternative is to identify specific problems, for example, the negative impacts (direct or indirect) of climate change. The framing of a problem should be clear and specific. A good way of identifying a problem is to draw up a "problem tree" (Figure 5.1).

Identifying the problem also helps to classify the project according to the classifications presented in the previous chapter. Example 1 from Box 5.1 would therefore require a project at stage I of adaptation (assessment of impacts) at the regional level; while example 2 would require a project at stage III (implementation of measures) at the local level in which, in terms of forest management, rehabilitation could be the most interesting alternative.

Project classification is essential in other steps, such as the establishment of strategic partnerships (step 4) or the identification of potential financial sources (step 6).

Box 5.1. Examples of the methodology for formulating projects

EXAMPLE 1: ASSESSMENT OF REGIONAL IMPACTS

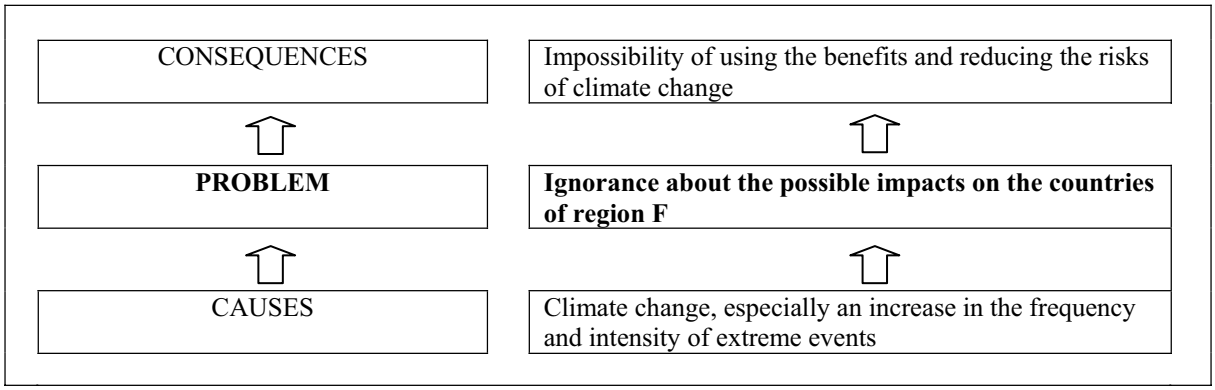
In the countries of region F there is a range of forest ecosystems with high indexes of biological diversity. Three indigenous communities live in the area. Ten years ago, some countries in the region started to exploit timber resources. In most cases, in order to guarantee harvesting sustainability, the concession holders carried out a Forest Stewardship Council (FSC) certification process, or at least presented five-yearly forest management plans. However, legal ownership of the goods and forest services in the region is not clear. As a result, there are conflicts over the ownership of land and forest resources among the indigenous population, NGOs, concession holders and government entities. Three of the five countries in the region have long-term forest development plans (of 15, 20 and 24 years, respectively). However, these plans do not clearly incorporate other elements of national or regional policies. The vulnerability of ecosystems in the region has not been evaluated, even though the region as a whole has been identified by IPCC as highly vulnerable to the impacts of climate change, especially extreme events.

EXAMPLE 2: ADAPTATION MEASURES AT THE LOCAL LEVEL

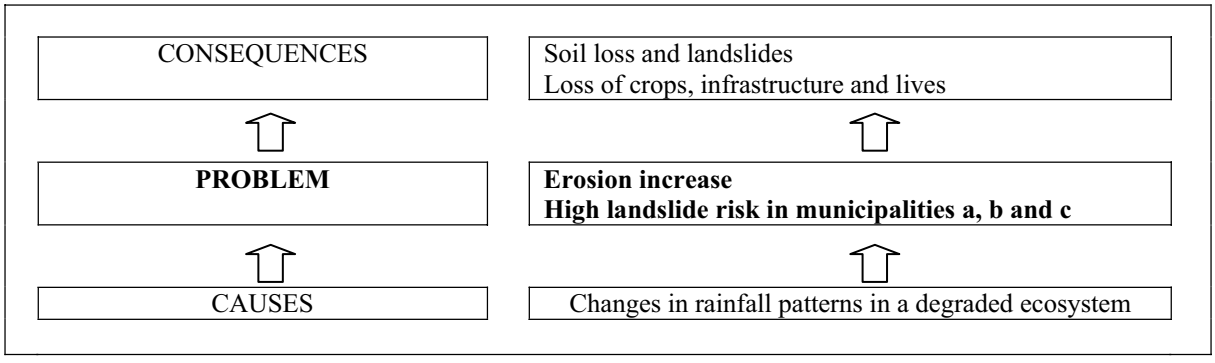
Owing to the expansion of agricultural land in municipalities a, b and c, there has been serious degradation of hillside ecosystems over the last 150 years. The population depends on traditional agricultural techniques. A vulnerability assessment has been carried out at the national level. The assessment included forest ecosystems, but not the forest sector. Studies reveal that municipalities b and c are vulnerable to landslides during the torrential rain season. The lowest areas are highly vulnerable because they contain most of the population and productive activities. There is a territorial ordering plan for municipalities a, b and c that has a forest component. However, this makes very little reference to the national plan for forest development.

Figure 5.1
Examples of problem identification

Example 1*:* First stage project: assessment at the regional level



Example 2: Third stage project: adaptation at the local level



Defining and characterizing the system

The system has two main elements: the ecosystem and the social system. Defining the ecosystem clearly identifies the project's geographical area. Characterization of forest ecosystems includes their structure, dynamics, state, functioning and uses.

Defining the social system begins by establishing the institutions and social groups that affect a project or are affected by it. These are then characterized according to such variables as education, participation in the labour market and productive activities.

As a last step, it is important to establish the relationships among different social groups and institutions. In some cases, the definition and characterization of the social system may be divided into separate institutional and social frameworks (Table 5.6).

TABLE 5.6
Definition of the ecosystem and social system

	Forest ecosystem	**Social system**	
		Institutions	**Social groups**
Example 1	Natural forest with high biological diversity	Regional and national plans and programmes Government entities (regional and national) Legal framework established or implemented (national and regional) Forest development plans Other institutional entities (research centres, associations, etc.)	Indigenous groups Settlers Concession holders NGOs Primary and secondary timber processors
Example 2	Highly degraded hillside ecosystem, grasslands	Territorial ordering plan Municipal legal framework established or implemented Government entities Other institutional entities (research centres, associations, etc.)	Peasants Intermediaries for purchase of agricultural products

Evaluating the options

The assessment of options begins with defining the alternatives as presented in Chapter 4. The first question to be answered is whether it is better to implement adaptation measures or to accept the costs. These guidelines are useful when identifying adaptation measures.

In example 1, it is clear that before evaluating the alternative measure options, the vulnerability of the ecosystem and social system (forest sector) needs to be established.

Assessment in example 2 is more complex because, as well as different alternative measures at the local level, combinations of these can also be assessed. Table 5.7 presents a list of the alternatives that could be considered.

When assessing alternatives, it is necessary to consider not only the financing of the measures, but also their respective political and social costs and overall economics. The complexity of the assessment depends on the human, technical and financial resources available.

Steps 1 to 3 (problem identification, system definition and characterization, and option evaluation) must also provide the necessary elements to justify the need for the project and to frame the project within the adaptation policies.

TABLE 5.7
Possible alternatives for example 2

	Local scale	Forest management
Compensation	Create a compensation fund Define criteria and regulations to compensate for negative impacts of climate change in municipalities a, b and c	
Impact prevention/ modification of circumstances	Improve and coordinate the institutional framework	Rehabilitate ecosystems with native species Rehabilitate with agroforestry Rehabilitate with grass and forest systems Plantations with fast-growing species
Search for alternatives	Offer training in new productive activities Credit for productive activities that contribute to reducing the impacts (e.g. production and marketing of NWFPs)	Production innovation: timber, fuelwood and NWFPs Forestry Cattle improvement Stall feeding or livestock housing
Location change	Encourage expropriation and migration (e.g. payment for land, training in other activities, offer housing in another town)	Promote natural revegetation.
Research	Calculate social cost Compare institutional frameworks at the local level	Forestry (natural, restoration, rehabilitation or plantations) Quantify and evaluate forest services
Education and awareness creation	Disseminate information on vulnerability to climate change Create awareness about the role of environmental services in reducing vulnerability	

Establishing strategic partnerships

The strategic partnerships in a project comply with two principles: 1) improving the conditions for project implementation; and 2) ensuring its financing.

To improve the conditions for implementing a project, it is advisable that strategic partnerships be established between the main social groups and the entities responsible for the institutional framework.

To guarantee project financing, it is essential to identify financial institutions that are interested in the type of project being proposed. Chapter 6 of this document offers information on the financing of projects.

Formulating the project

Most of the institutions that finance projects have their own manuals for the presentation of projects. However, it is worth considering the following common elements:

a) design a logical framework: objectives, results, activities and indicators;
b) establish participation mechanisms;
c) define the organizational structure of the project;
d) define a timetable;
e) establish the budget;
f) propose a monitoring plan.

a) Design a logical framework: objectives, results, activities and indicators: The project's logical structure must specify what, how, when and by whom an increase in the adaptive capacity of an ecosystem (forest) and/or social system (the forest sector) is to be achieved. A good way of organizing the logical framework is to start with the different components (Chapter 4). Some projects

will not include all the components. In such cases, the excluded components should still be considered in the structure.

The overall objective of a project must address both the identified problem and the relevant policies or programmes. The specific objectives are used to articulate the overall objective or goal and expected results.

TABLE 5.8
Example of a logical framework

Objective 1 (e.g. institutional)		Indicators
Result 1.1	Activity 1.1.1	
	Activity 1.1.2	
	Activity 1.1.3	
Result 1.2	Activity 1.2.1	
	Activity 1.2.2	
	Activity 1.2.3	
Objective 2 (e.g. forest management)		
Result 2.1	Activity 2.1.1	
	Activity 2.1.2	
	Activity 2.1.3	
Result 2.2	Activity 2.2.1	
	Activity 2.2.2	
	Activity 2.2.3	

b) Establish participation mechanisms: The term "participation mechanism" refers mainly to the mechanisms necessary to ensure that social groups become part of the project. In general, these mechanisms should be aimed at promoting the empowerment of social groups. When establishing participation mechanisms, it is important to consider three stages in the empowerment process: training for, and participation and decision-making by the strategic social groups.

c) Define the organizational structure of the project: The organizational structure of the project guarantees coordination among the different participants: the project team, institutions, social groups and financing entities. The organizational structure must also define the role that each participant should play in implementation of the project. As for project presentation, some of the institutions that finance projects have established their own norms for organizational structures.

d) Define a timetable: The timetable of a project is the inter-relationship of the timing of all its activities. The timetable also identifies the activities that create consumables for other activities.

TABLE 5.9
Example of a timetable

	Month 1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Activity 1.1.1									
Activity 1.1.2									
Activity 1.2.1									
Activity 1.2.2									
Activity 2.1.1									
Activity 2.1.2									
Activity 2.1.3									

e) Establish the budget: The budget is used to establish the costs of the project. Costs must be classified according to activity and to whether they are for human or technical resources. General costs, such as infrastructure, transportation, travel and project operation costs (stationery, secretary, computers, etc.), must also be included.

The budget should consider not only the total costs, but also the costs during the planning and implementation period (costs per year or semester). This is to guarantee appropriate and timely payments. For projects implemented with co-financing, a separate budget must be established for each financing institution involved.

f) Propose a monitoring plan: The purpose of a monitoring plan is to control activities and implement a follow-up process regarding the timetable and budget. Monitoring should be regarded as a project activity.

Assuring the financing

This is the last step before project implementation. The acceptance of project financing is determined by the regulations of the institution to which the project is being submitted. When seeking project financing, the donor institution's requirements and cycle should be analysed before a financing request is made. Chapter 6 of this document offers guidance on project financing.

Instruments and procedures for planning adaptation projects

Adaptive forest management: The concept of adaptive management was developed in the 1980s as a management approach to deal with cases when present and future changes to natural resources are uncertain (Walters, 1986). Adaptive forest management can be defined as a management approach that acknowledges the lack of unequivocal and definitive knowledge about the ways in which forest ecosystems work, and the uncertainty that dominates interactions with them (Borrini-Feyerabend, 2000). It is a formal process for continually improving management policies and practices by learning from their outcomes (Taylor *et al.,* 1997). Adaptive forest management has received increasing attention in recent years. In view of certain climate changes, the approach seems very suitable for the adaptation of forest ecosystems (Nyberg, 1999).

Application of adaptive forest management to climate change impacts: The rationale for applying adaptive forest management is that very little is yet known about the dimension and character of future climate change impacts on local forestry sites (Chapter 2). However, in spite of this unpredictability, forest managers must make decisions and implement plans that are based on assumptions for longer time spans than in other forms of natural resource management, such as agriculture or fishery. For example, decisions regarding which tree species to use for a plantation or silviculture intervention could set the path of land use for at least a decade. Forest management tools supporting such decisions (e.g. growth models and yield tables) were elaborated on previous assumptions of a stable climate, and hence environmental conditions, for the future. Many of these tools are no longer valid because of the impacts of climate change (Spittlehouse and Steward, 2003). Adaptive forest management is a suitable approach in the face of such uncertainty. Nyberg (1999) characterizes the approach as: "It provides a sound alternative to either 'charging ahead blindly' or 'being paralysed by indecision'", both of which can have negative social, economic and environmental impacts.

According to Sit and Taylor (1998), the key characteristics of adaptive management include:

- acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue;
- thoughtful selection of the policies or practices to be applied;
- careful implementation of a plan of action designed to reveal critical knowledge;

- monitoring of key response indicators;
- analysis of the outcome in terms of the original objectives;
- incorporation of the results into future decisions.

In view of the fact that scientific research results take many years to become applicable and operational on local sites, the notion of adaptive management postulates that forest managers themselves integrate applied research and experimentation in their daily work to generate data for immediate use (Nyberg, 1999). This entails local assessments of climate change impacts and vulnerability studies of forest ecosystems, results of which would then feed into the initial stages of the adaptive management cycle, i.e. the problem assessment and the design of implementation measures. An essential element of adaptive forest management is that knowledge generated by learning is reintegrated into the project/working cycle and hence leads to adjustment and improvement of the forest management approach.

For further reading on respective methods and concepts see the Web site of the Canadian Ministry of Forests in British Columbia, which runs an initiative on adaptive forest management (http://www.magma.ca/~evb/forest.html#anchor2419138).

Toolkit developed by IUCN, the International Institute for Sustainable Development (IISD), SEI-B and Intercooperation: In order to produce instruments to promote adaptation projects, four international institutions, which combine scientific knowledge, policy analysis and field implementation, have developed a toolkit to identify the adaptation potential of ongoing projects and provide basic elements for including adaptation measures in development projects.

Two basic types of instruments are under development: those to assess the adaptation potential within a portfolio of projects, and those to identify the potential, planning and implementation of adaptation measures.

This toolkit is currently under development and will be available to the public in hard copy and electronic media. For more information see www.intercooperation.ch/projects/p55.

The World Bank: The World Bank has a tool that is designed to assist project managers in assessing whether a project might be sensitive to the effects of climate change.

The tool also provides guidance on the best sources of information to help take potential effects into account in project design. It provides a first level of assessment based on a simple description of the project and its location.

The guidance is based on expert assessment of the risks and opportunities that arise from climate change. For more information consult http://lnweb18.worldbank.org/essd/envext.nsf/46bydocname/newsandeventskeyeventsadaptationtools.

6. Financing

OVERVIEW

An introduction to the formulation of adaptation projects would not be complete without information related to financing. The funding of adaptation activities can be pursued in a similar way to that for other sustainable development and environmental projects. However, an additional obstacle to investment in adaptation is the uncertainty regarding the impacts of climate change (whether they will happen or not, their intensity and costs). At the same time, as with other development projects, adaptation projects do not necessarily produce direct and tangible income for investors. Therefore, the identification and establishment of financing sources must be part of any institutional framework geared towards adaptation.

This chapter describes the main financing sources that could play an important role in the establishment of policies and programmes and the design and implementation of projects related to adaptation. It gives particular emphasis to activities related to forest ecosystems and the forest sector. The underlying premise is that, because adaptation is framed within sustainable development, financing should not be limited to the financial mechanisms established under UNFCCC. Rather, owing to the obstacles that those funds have encountered in the negotiation process, it is advisable to seek alternative sources.

There is a wide range of financing sources for adaptation-related activities. The selection of an appropriate option depends on the type of activity to be financed, the level at which it is to be undertaken (national, regional or local), and the stakeholders involved.

Box 6.1. Some recommendations for financial sustainability

- Formulate flexible objectives.
- Promote co-financing.
- Identify a large number of possible financing sources.
- Include project activities that generate resources.
- Engage the private sector.
- Consider the risks associated with maintenance costs, and make sure that those risks are covered by the project budget.

The first alternative is *self-financing*, which consists of direct investments by the private sector when there is a relatively high degree of certainty about the cost–benefit ratio of the investment in relation to the benefits of the funded activities. Self-financing can be made through credits and loans, alternatives that are generally of private origin and require repayments that are subject to interest rates.

Another alternative is *donations and aid*, which are of public or private origin and do not require repayment. Donations are usually awarded on the basis of specific criteria (i.e. an activity has to fulfil certain conditions to receive a donation), and projects often have to compete to obtain these funds.

A third alternative is *co-financing*, which is very common for development projects. In co-financing, the donor finances part of the activities, while the candidate obtains additional funding from other sources.

These alternatives do not exclude each other. On the contrary, depending on its size, a variety of different types of financing arrangements are sought for a development project. A single source may not be enough to finance the entire project, so the project's proponents must investigate a range of sources.

The following sections focus on donations and public aid. However, emphasis is placed on the need to create incentives for the private sector to participate in the adaptation process.

Box 6.2. UNFF recommendations for financing

The third session of United Nations Forum on Forests (UNFF) discussed the possibility of establishing a World Forest Fund, which would be dedicated to financing sustainable forest management. Although the debate on this need is intense, and its outcome uncertain, the recommendations resulting from it are valuable and could be taken into consideration by both beneficiaries and donors. According to these recommendations a financing mechanism should:

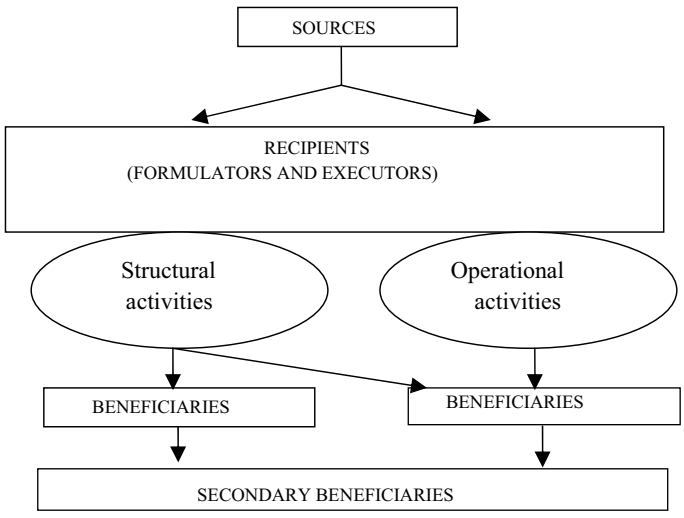
- facilitate donors' and beneficiaries' participation in decision-making regarding the use of funds;
- respond to national needs and support regional adaptation programmes;
- be based on existing financing schemes and mechanisms;
- be transparent and promote the cost-effectiveness of the investment;
- supplement other financing sources.

Stakeholders and the financial flow

The financing system is represented by the relationships among three types of stakeholders: 1) sources (or donors), which are responsible for providing the financial resources and include banks, multilateral agencies, international and national funds, donating governments and foundations; 2) recipients, who receive the funds to formulate and implement projects; and 3) beneficiaries, which include all the people who receive directly (direct beneficiaries) or indirectly (secondary beneficiaries) the benefits of a project. In some cases, project formulators and executors can also be beneficiaries. Concerning vulnerability, communities' active participation in implementing projects may make them recipients, because they are beneficiaries as well as executors (Figure 6.1).

In the case of aid, the more environmental and social collateral benefits that a project generates, the better its chances of obtaining financing. It is therefore advisable to identify collateral benefits in the project proposal.

Figure 6.1
Flow of stakeholders



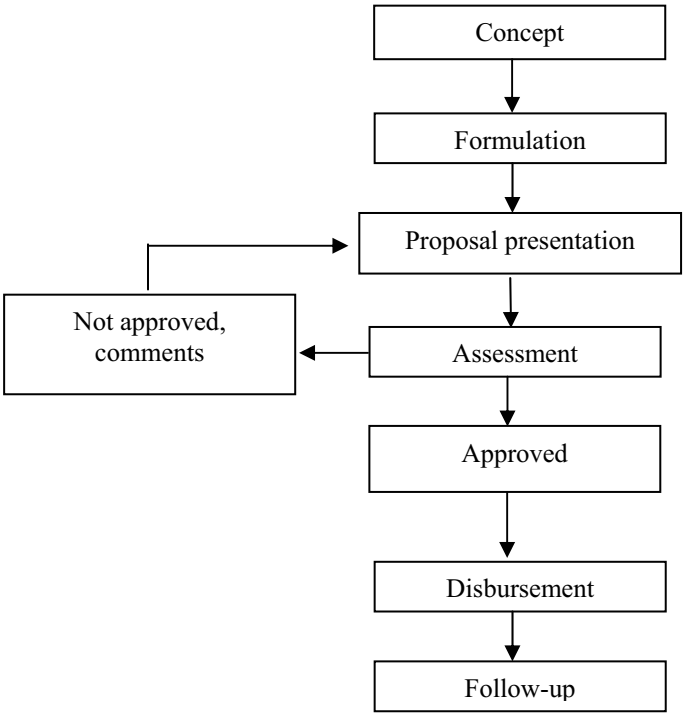
Source: Adapted from Moura-Costa *et al.,* 1999.

Project cycle

The financing process follows a series of stages known as the project cycle. This cycle begins with conceptualization of the project and ends with an assessment of its implementation results. Although

each agency has its own specifications for project evaluation, there are generic stages that all proposals should follow (Figure 6.2).

Figure 6.2
Project cycle for financing



The starting point for preparing a proposal should be the eligibility criteria of the agency to which the proposal will be submitted. The objectives of the project, or of the component to be financed, should be adjusted according to these criteria.

SOURCES FOR PROJECT FINANCING

According to their origin, financing sources can be public or private, and national or international (Table 6.1).

TABLE 6.1
Financing sources

Source	National	International
Public	Taxes and transfers Government programmes	Bilateral cooperation agencies Multilateral cooperation agencies Multilateral banks Regional development banks
Private	Forest sector investments National foundations Banks and the financial sector	Investment from multinational companies Private foundations and funds

Public financing is part of an established policy by which a government commits itself to support certain activities. Government funds and resources usually come from taxes, fees, transfers and loans. Objectives and eligibility criteria specified in government policies concerning programmes determine the destination of government funds. These resources are obtained through subsidies, funds and so forth.

In the case of financing from private sources, it is appropriate to differentiate between the source's interests and its objectives. Private funding based on interests looks for direct profits and includes loans from banks at set interest rates. Funding based on objectives is direct investment made by the private sector with the aim (for adaptation projects) of diminishing possible future economic losses caused by climate change. An example is the investments made by a forest company to change management practices in a plantation (use of different species, changes in planting and harvest cycles, and so forth). This type of financing is also known as self-financing. Self-financing can be effective, because it leaves a private company free to select from among the alternatives and needs of adaptation, and because it reduces the need for government resources, which can be used to promote social interest funds. In the context of sustainable forest management, some people believe that the private sector may not need any financial support from the government, whose role is instead limited to supporting private sector activities (Repetto and Sizer, 1996).

Other private funds are channelled through non-profit organizations, such as foundations or funds with a specific objective. Foundations finance diverse types of projects and are a response to either the private sector's altruistic interests or government incentives, such as to comply with environmental or social commitments under specific international agreements (Moura-Costa *et al.,* 1999).

Private sector investments in adaptation are of vital importance in the national context. It is important that governments create incentives for the private sector to increase its participation in adaptation issues.

Domestic financing alternatives

Financing alternatives can also be found in the national context. Owing to the circumstances in many developing countries, the government may be the most important source of financing for development projects. Domestic sources of financing include the following:

- *National budget:* Public resources that are allocated under a government policy or programme. The establishment of an adaptation policy (regional or local) implies the creation of institutional arrangements that favour its financing, including the allocation of national funds and, for donor nations, the maintenance of international funds.
- *Fees/taxes:* The establishment of fees or taxes (e.g. from petrol, real estate and bank transfers) is a way of generating resources for environmental investment. Although this alternative can be a way of sharing costs, it can also be based on the fact that climate change is likely to affect taxpayers.
- *Funds:* As well as being a financing alternative, funds are also a channelling tool for financial resources. The fund specifies the type of activities that will be financed (eligibility criteria), the requirements for obtaining financing, maximum amounts, financial conditions, and the responsibilities of project participants. An unavoidable inconvenience with funds is that their administration and operation costs may be high.

Official development assistance

In the international arena, discussion of financing resources for environment and development projects is not new. Financing mechanisms have been on the agendas of international development agreements for many years now. In 1970, the United Nations General Assembly agreed that developed countries would assign 0.7 percent of their GDP to official development assistance (ODA) in order to finance activities and development projects in developing countries. Since then, ODA has been the subject of major debate. It has been included as part of the work of multilateral agencies such as UNDP, UNEP and the World Bank. A good part of ODA is awarded to development by bilateral cooperation agencies (Chapter 4).

There are two main channels through which to obtain ODA funds. The first is bilateral in character, and involves going through the international technical cooperation agencies. The second channel is of multilateral character, and involves specific institutions established by several member countries, for example, the World Bank, regional development banks and some United Nations organizations. About 20 donor countries and 13 multilateral agencies provide resources for forest ecosystems (Chandrasekharan, 1997).

Bilateral assistance and cooperation

Bilateral assistance refers to agreements between two countries to cooperate on diverse activities and specific topics. It is not limited to financial cooperation; on the contrary, a substantial proportion of bilateral cooperation has to do with the exchange of experts, technology transfer, training (including for personnel) and other activities, all of which have the objective of promoting economic and sustainable development. An advantage of bilateral cooperation is its dynamics, because bilateral agreements are not bound to the agreements with other countries. From the donor's point of view, technical cooperation arises from a cooperation policy, which is managed by a specific organization. From the recipient country's point of view, cooperation also implies the need for organization that contacts donors, submits cooperation proposals, and approves them.

Until about 30 years ago, technical cooperation was centred on economic growth, but events such as the United Nations Conference on Human Development (1972), the Eighth World Congress on Forestry (1978) and the World Conference on Land Reform and Rural Development (1979) led to a change in the way that countries perceive cooperation. Thus, sustainable development and the environment are now incorporated as key elements of bilateral cooperation. Recently, following on from the processes that began at the Earth Summit of 1992, concern for environmental issues within sustainable development has been paving the way for bilateral assistance to include forest sector development and the conservation and sustainable management of ecosystems.

In the 1950s, the first cooperation projects for forest area development began through the Extensive Technical Assistance Programme (ETAP), and later the United Nations Special Fund for Economic Development. Initially, bilateral assistance concentrated on the former colonies of donor countries, but this priority has changed.

Bilateral assistance funds are channelled through agencies in donor countries. Based on international agreements and national policies, these agencies prepare the priorities and eligibility criteria for projects. Additional aid is channelled through multilateral agencies and NGOs. In 1990, bilateral assistance represented about 60 percent of international cooperation for development (81 percent of it being made through grants). Annex 2 provides a list of the principal international cooperation agencies.

Multilateral financing

The following paragraphs describe the main multilateral financing agencies concerned with forest ecosystems. Although most of these do not have a specific component for adaptation, their general focus on sustainable development allows a large number of adaptation activities and projects to be financed through these organizations. The following summary emphasizes the World Bank's role in financing development and does not include GEF, which is described in its own section at the end of this chapter.

UNDP: The objectives of UNDP include poverty reduction, governance and sustainable development. In practice, UNDP operates as an international support network for development. Regional offices are located throughout the world and have a certain degree of autonomy for allocating financial and other resources.

Resource allocation for development projects funded by UNDP is guided by the criteria established for each thematic fund, which include governance, poverty reduction, energy, and environment. The financing of projects related to forest ecosystems in general, and specifically to forests and the environment, is guided by the objectives established under the environment theme.[28] This thematic area takes into account such global problems as degradation of forest ecosystems, desertification and the future impacts of climate change. UNDP support for the resolution of these problems is channelled through three lines of action:

- integration of environmental issues into national development, which includes such aspects as analysis of the relationship between poverty and environment, citizen participation and institutional development;
- reinforcement of governance at the local level, which includes such aspects as access to environmental goods, environmental management and projects for demonstrating local policies;
- attention to regional and local problems, which includes such aspects as vulnerability and adaptation to climate change.

Projects financed by UNDP vary in nature, duration and amount of funding. Financial resources oscillate from US$100 000 to US$3 million, and project duration is up to five years.[29]

ITTO: ITTO was created in 1983 and operates under the United Nations Conference on Trade and Development (UNCTAD). It brings together the producers and consumers of tropical timber. It has 59 member countries and represents 95 percent of the international tropical timber trade.

In 1994, ITTO adopted the International Tropical Timber Agreement (ITTA), which guides the institution's work towards sustainable management of tropical forest ecosystems and timber production. The body that governs ITTO is the Members' Council, which meets twice a year. Through the Secretariat, four committees support the council's work: Economic Information and Market Intelligence, Reforestation and Forest Management, Forest Industry, and Finances and Administration.

ITTO recognizes the importance of climate change for forest ecosystems, as well as the possible influences that sustainable forest management may have on mitigation and adaptation. During the past four years, it has financed pilot projects that contain a component of Clean Development Mechanisms (CDM) in the forest sector, in order to develop knowledge about the real potential of CDMs for forest activities in member countries.

ITTO has a mechanism to finance forestry projects. Most financing is in the form of grants of less than US$1 million. Financing is bound to the objectives of the organization's different committees, whose emphasis in past years has been sustainable forest management. In order to obtain financial resources from ITTO, interested parties should prepare a proposal following the instructions described in the handbook for project formulation, which can be obtained by writing directly to the ITTO Secretariat.[30]

The World Bank: The World Bank is the most important multilateral organization for financing in the world. Its main objective is to support economic growth and eradicate poverty, but it also has a policy and financing alternatives for environmental and development issues through credits and loans.[31] Although there are some types of grants, most resources come from outside the bank or are managed

[28] The relevant document is available at www.undp.org/trustfunds/environment-english-final.pdf.
[29] Additional information available at www.undp.org/trustfunds.
[30] Additional information available at www.itto.org.jp.
[31] A guide to the options offered by the bank is available at http://siteresources.worldbank.org/projects/resources/lendinginstrumentbrochure.pdf.

in association with other organizations, including the financial resources of GEF, of which the World Bank is an operative agency. The following are the financial instruments of the World Bank.

Loans and investment credits: Dedicated to financing goods and services that support economic and social growth through projects in a wide range of sectors and with durations of between five and ten years. The use of these funds has evolved over past years and the World Bank has been emphasizing institutional and social development, as well as investment in public infrastructure. The projects financed under these instruments include urban poverty reduction, regional development, integrated management of natural resources, water and sanitation, and education.

Loans and adjustment credits: These are dedicated to supporting institutional reforms through projects that last for less than three years. They are applied through projects for political reform, market structure reform, incentives for private sector investments, and so forth.

Grants and aid: The World Bank allocates aid and grants through various funds. The objectives of these resources are to motivate innovation, support citizen participation processes and facilitate cooperation between international organizations and the countries or country concerned. The following are some of the most important funds for development and environment:

- Development Grant Facility;[32]
- grant resources for civil society organizations[33] dedicated to creating local capacity for the implementation of projects in diverse areas, including the environment and education. NGOs and the private sector have access to the resources of this fund;
- GEF (Chapter 4);
- the Japan Policy and Human Resources Development Fund (PHRD)[34] dedicated to financing activities and development projects that include education, health, integrated water management, nutrition, and citizen participation;
- small-scale grants and aid dedicated to supporting the development of the poorest regions and communities. The objectives of these are to build local capacity through information dissemination and to promote associations of local communities;
- more than 850 trust funds with resources from diverse sources, both public and private. Each fund has its own objectives and eligibility criteria.[35]

World Bank financial aid and loans are granted on the basis of country-specific studies called "country assistance strategies", which are made with the government of each recipient country to identify investment priorities. These studies reflect the macroeconomic performance of the country concerned, the underlying causes of poverty and the state of institutional development and governance. The country assistance strategy is prepared in consensus with the country studied through a participative process (the World Bank seeks inputs from diverse economic sectors and social groups), and focuses on the results of the possible investment.

As have other financial entities, the World Bank has established its own project cycle, which consists of three main phases: 1) consideration of the project; 2) the active state of implementation; and 3) closing or withdrawal. Each phase has several stages, as follows.

The *project consideration phase* begins with the identification of national priorities for investment in development. *Identification* produces the country assistance strategy and documents on poverty reduction. During *preparation,* which is based on the results of the identification phase, the proponent prepares a proposal document keeping in mind the project's technical, institutional, environmental

[32] The eligibility criteria for this fund are available at http://wbln0018.worldbank.org/dgf/dgf.nsf/docs/eligibility+criteria?opendocument.
[33] Additional information available at http://wbln0018.worldbank.org/dgf/dgf.nsf/docs/eligibility+criteria?ppendocument.
[34] Additional information available at www.worldbank.org/rmc/phrd/phrd.htm.
[35] Additional information available at: www.worldbank.org/rmc/tf/index.htm.

and financial criteria.[36] The following stage is *evaluation,* in which the World Bank analyses the proposal, and works with the recipient to solve doubts and acquire any additional information. The last stage of this phase is *negotiation.* If the project fulfils all the requirements and "passes" the evaluation, it is approved.

The *active implementation* phase of the project begins with credit approval for the recipient government; this is called the "effective stage". At this point, the disbursement is ready to be sent to the proponent and the World Bank submits the project for public consideration. The following stage is *implementation and supervision*, during which the World Bank ensures that the investment and expense criteria are fulfilled. During the course of the project, the proponent must send reports on project expenses and on the state of the project and its evaluation.

During the last *closing or withdrawal* phase, the audit group performs an exhaustive review of the project's achievements in relation to its objectives.

Within the new forest policy that it adopted in 2002, the World Bank's focus on forests is sustained by three main pillars: 1) forests' potential to combat poverty; 2) the integration of forests into economic development; and 3) the protection of forests as suppliers of important environmental services. Another substantial change is that now the bank focuses on forests in general, rather than on the forest sector, so the investment spectrum of its activities has been considerably extended. One of the implementation objectives of the third pillar is directly related to climate change adaptation. The World Bank has expressed its commitment to helping governments develop mitigation and adaptation measures to reduce vulnerability, particularly in the poorest communities that use forests for their subsistence.

Other multilateral banks: Regional development banks have several financing lines for development projects. Most of these are loans. Some banks have adopted a forest ecosystems policy that considers special lines for development projects. Development banks are expected to become the operative agencies of GEF funds. At present, the existing regional development banks include the following.[37]

The Inter-American Development Bank (IADB) was founded in 1959 to support economic growth in Latin America and the Caribbean. Its position concerning forest ecosystems is based on general strategies and priorities that include poverty eradication, capacity building and equity. In the 1990s, sustainable development principles were reinforced within the bank's strategy, which has made sustainable forest management one of the priorities of the Environmental Division. The financing of forest-related projects has been an IADB activity in the areas of: 1) soil conservation and reforestation of degraded areas; 2) agroforestry; 3) watershed management; 4) natural forest ecosystems management; and 5) conservation and protection of areas with special biodiversity characteristics.[38]

The Caribbean Development Bank (CDB) was founded in 1970 to promote cooperation and economic development in the Caribbean countries, with emphasis on less developed member countries. Although the bank does not have an established policy on forest ecosystems, it has financed a substantial number of projects in sustainable forest use, some of which were related to the biodiversity agreement.[39]

The African Development Bank: (AfDB) is based in Abidjan (Côte d'Ivoire). Its objectives are based on development, poverty eradication, support for agricultural activities, and sustainable management of natural resources. AfDB works exclusively in Africa and only with its member countries. In 1990,

[36] Additional information on these criteria is available on the World Bank's Web site, under the link "projects and programs".
[37] Information from the Collaborative Partnership on Forests' *Sourcebook for sustainable forest management*, at www.fao.org/forestry/foris/webview/cpf/index.jsp?geoId=0&langId=1&siteId=2225. This includes a database of financial institutions related to sustainable forest management.
[38] Additional information available at http/iadb.org.
[39] Additional information available at www.caribank.org.

AfDB adopted an agriculture and environment policy, which considers the state of deterioration of African forest ecosystems. Based on this policy, the bank finances projects for institutional development, technical support for analysis and monitoring, sustainable management, traditional use, recovery of degraded areas, and other aspects. The allocation of resources takes from one to three years. Only projects that agree with the bank's policies for the specific programme can obtain access to bank funds.[40]

The Asian Development Bank (AsDB) was founded in 1966 and its headquarters are in Manila (the Philippines). As with other development banks, AsDB's objectives are based on poverty reduction and economic growth, women's participation, and protection of the environment. A substantial proportion of the credits approved by the bank are directed to the poorest countries of the region, which borrowing capacity is limited. AsDB adopted its new forest ecosystems policy in 1995 under the prerogatives of protection, production and participation. This policy recognizes the multiple uses of forest ecosystems, and the need to capitalize on their renewable resource character and importance for biodiversity and climate change. AsDB finances projects by establishing priorities and support programmes that are designed during biannual visits to member countries. For a project to obtain AsDB financing, it must fall within its country's financing priorities.[41]

Other development banks include:

- the East Africa Development Bank;[42]
- the West Africa Development Bank;[43]
- the Bank of Central African States;[44]
- the Central American Bank for Economic Integration.[45]

Selecting a financing source

The wide range of funding alternatives implies also a wide range of responsibilities and compromises underlying these alternatives. The recipient of funds is fully responsible for the use of such resources, as well as for the results of their investment. For credits and loans, this responsibility refers to repayment of debt, while for aid and grants, the financing entities expect results (direct benefits) from implementation of the project. It is recommended that project proponents answer the following questions as part of the financial analysis of a proposal:

- Can the project proponents commit themselves to repaying a loan?
- Is the project and are the proponents able to offer compensation (for co-financing and other instruments that require a contribution from the recipient. For example, GEF funds finance only those activities that demonstrate a global benefit)?
- Is there the capacity to fulfil the requirements and commitments specified by the agency in relation to reports, analysis and monitoring of the project?
- Can the project fulfil the eligibility criteria established by the agency without substantially changing its nature?

If the answer to any of these questions is no, the proponent must consider doing without the instrument or financial agency in question.

Over time, sources of funding have been diminishing, particularly those that do not require repayment, while recipients are increasing. This implies a scenario in which recipients need to

[40] Additional information available at www.afdb.org/#.
[41] Information on the cycles and types of financing is available at www.adb.org/projects/cycle.asp.
[42] Additional information available at http://transafrica.org/eadb/.
[43] Additional information available at www.boad.org.
[44] Additional information available at www.beac.int.
[45] Additional information available at www.bcie.org.

compete for the available resources. Such competition often takes the form of a contest. An active search for funding includes such activities as:

- direct contact with institutions – direct submission of a project or project portfolio;
- participation in the initiatives, invitations and programmes established by donating agencies;
- participation in fairs and events in order to establish direct contact with representatives of agencies or donor governments;
- contact with diplomatic representatives. Countries' embassies and other diplomatic representations can be an important channel for promoting development projects.

FINANCING FOR ADAPTATION IN UNFCCC

UNFCCC's financial mechanism is dedicated to supporting developing countries' fulfilment of their commitments. Only member countries of the convention have access to its resources, provided that the activities to be financed are considered within national development policies. In addition, while using their national communications as the main channel, developing countries must identify their needs and priorities with regard to adaptation. So far, the convention's financial mechanism has been of great importance in financing preparatory activities that are part of the national communication preparation process.

UNFCCC's financial resources have been, and will continue to be, channelled through GEF, which has supported production of the national communications.

The financial mechanism was established when UNFCCC first came into effect. In its first session, the COP agreed that UNFCCC would support adaptation activities in developing countries for the short, medium and long terms, according to the following stages.

- *first stage:* planning, which includes climate change impact studies;
- *second stage:* measures directed to training and increasing adaptation capacity;
- *third stage:* measures, which include activities that allow appropriate adaptation, for example, those aimed at reducing climate change costs.

The next major landmark in developing the financial mechanism occurred six years later, during the seventh session of the COP, when the following three funds were established, two of them in the convention and one for the Kyoto Protocol:

- The *Special Fund for Climate Change* finances concrete adaptation activities, especially projects on water resources management, land management, agriculture, health, infrastructure development, fragile ecosystems such as mountain ecosystems, and coastal area integrated management.
- The *Least-Developed Countries Fund* is dedicated to least-developed countries. It finances the same activities as the Special Fund for Climate Change. Least-developed countries have access to expedition procedures for the approval of funding to support the implementation of projects in the context of National Adaptation Programmes of Action (NAPAs).
- The *Adaptation Fund* finances concrete adaptation projects and programmes in developing countries that are signatories of the Kyoto Protocol.

GEF

GEF is the most important multilateral financial mechanism for climate change projects. Its financing activities in this area are governed by the decisions of the COP to UNFCCC. However, given the link between adaptation and sustainable development, financing for an adaptation project should not be limited to UNFCCC resources. On the contrary, other focal areas of GEF, such as biodiversity, can

also finance projects on adaptation. This document recommends that a good strategy for finding financial support for projects or project components is to look for diverse financing sources.

As mentioned before, several different financing sources must be considered, especially as the political discussion on the financing of activities under UNFCCC has been relatively slow. At present, and under the focal area of climate change, GEF project financing is limited to: 1) removing barriers to energy efficiency and energy conservation; 2) promoting the adoption of renewable energy by removing barriers and reducing implementation costs; 3) reducing the long-term costs of low GHG-emitting energy technologies; and 4) supporting the development of sustainable transport. The list in Box 6.3 covers the financing of large-, medium- and small-scale projects.

Box 6.3. GEF financing alternatives

GEF offers several options to finance environmental projects, depending on the size and type of the project and the proportion of GEF resources in the total budget. These options include the following.

Large-scale projects: This programme finances projects where investment is greater than US$1 million. Such projects can be of national or regional character, and should agree with the national development priorities. Owing to their character and size, the proposals for large-scale projects are subject to complex analyses that may require extended approval and negotiation processes.*

Medium-scale projects: Grants for less than US$1 million are subject to streamlined approval procedures. Medium-scale projects are dedicated to a wider range of proponents and are of local or regional character.**

Support activities: Support activities are dedicated to financing some of the tasks agreed by countries in conventions. These include the preparation of strategies, GHG inventories and national communications.

Project Development Fund: GEF has a programme to finance the design and formulation of projects. The financing of these activities is divided into three categories: 1) for the initial identification and conceptualization activities (up to US$25 000); 2) to transform concepts into proposals (up to US$350 000 for individual projects and US$700 000 for groups of projects); and 3) for large-scale projects dedicated to support any activity that is technically, economically and environmentally viable (up to US$1 million).

Small donations programme: This programme is aimed at NGOs and local communities interested in contributing to sustainable development through small-scale projects. Financing possibilities include the analysis and formulation of projects for local communities, pilot projects on environmental issues, capacity building, information and dissemination, and political dialogue activities.***

* To support the presentation of large-scale proposals, the proponent must first contact a GEF operational agency. UNDP has produced a series of guidelines for the presentation of this type of project. These are available at www.undp.org/gef/undp-gef_grant_opportunities/sub_fp.html.

** Guidelines for the formulation of medium-scale projects are available at http://gefweb.org/documents/medium-sized_project_proposals/msp_guidelines/msp_guidelines.html

*** The GEF small-scale grants programme is coordinated by UNDP. Additional information available at www.undp.org/sgp/.

In spite of the absence of guidelines for financing specific adaptation projects, GEF has channels through which some related activities can be financed.

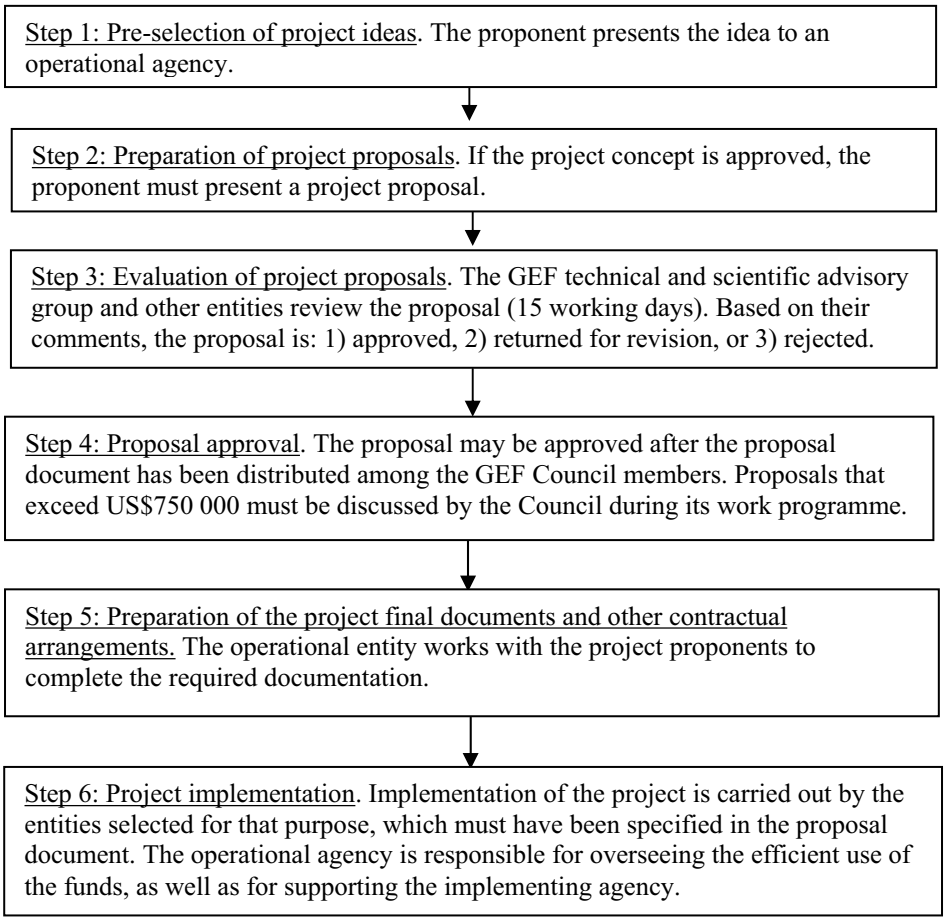
The GEF project cycle: GEF resources are allocated through an operational agency.[46] The process begins with presentation of a project concept, which is a two- to five-page document with the objectives, people involved, expected results and a summary of project activities. If the project is not eligible for full financing, or if it has additional funds, this must be indicated. If the project is

[46] Additional information on the operational agencies is available at http://gefweb.org/participants/implementing_agencies/implementing_agencies.html.

considered acceptable, the proponent can request resources from the Project Development Fund and has to complete a detailed document for presentation to the GEF Council.

Once the GEF Council has received the project document, it comments on or approves it. An approved project enters the implementation phase, which is carried out by the national government, a United Nations agency, a regional bank or an NGO (Figure 6.3).

Figure 6.3
The GEF project cycle *



* Additional information on the project cycle is available at http://gefweb.org/documents/medium-sized_project_proposals/msp_guidelines/operational_guidance_-_sp.doc.

GEF and forest ecosystems: Protection of forest ecosystem biodiversity is one of the objectives of GEF, which through its strategies aims to tackle problems such as loss of biodiversity, deforestation and forest degradation (Moura-Costa *et al.,* 1999). Projects related to forest ecosystems have a privileged position within GEF's activities owing to the importance of these systems for the focal areas of climate change, biodiversity, soil degradation, and the integrated management of continental waters, as well as for their respective operational programmes. For example, the focal area of biodiversity, regulated by CBD guidelines, considers forest ecosystems in general and puts emphasis on:

- projects that promote the conservation and sustainable use of biodiversity in environmentally vulnerable areas;
- projects that promote the conservation and/or sustainable use of endemic species.

Box 6.4 lists the operational programmes that have the potential to link GEF to adaptation activities with forest components. These activities are not limited to the provision of funds, but also include capacity building, technical support, pilot projects and information exchange.[47]

Box 6.4. GEF operational programmes related to forest ecosystems

Although there is only one GEF operational programme directly related to forest ecosystems, there are other operational programmes that, depending on the nature of the projects presented, can include forest components. These include the following:

- *Biodiversity:* Arid and semi-arid ecosystems (OP 1) and mountain ecosystems (OP 4).
- *International waters:* Integrated management of water and soil (OP 9).
- *Multi-focal:* Integrated ecosystemic management (OP 12).
- *Soil degradation:* Sustainable soil management (OP 15).

GEF recognizes that many of the activities and projects that it finances are related to adaptation and that past activities have already had positive effects on the adaptation of forest ecosystems. Some of these activities include the development and implementation of projects related to (GEF, 2003):

- institutional development, such as the establishment of policies, plantations, etc.;
- capacity building for forest management;
- local communities' interest in the sustainable use of forest products;
- demarcation of protected areas, especially those including highly vulnerable and degraded systems;
- scientific research on the impacts caused by different anthropogenic processes;
- monitoring of forest systems.

Recently, GEF published a document summarizing its experiences in financing projects related to forest ecosystems and explaining in detail its future strategy. In spite of the emphasis on conservation that has characterized funding in the past, current discussions under CBD that highlight sustainable management and equal distribution of forest benefits have influenced GEF activities. As a result, more efforts will be made on the sustainable use of productive systems and on the relationship of the latter with biodiversity protection or conservation, taking the ecosystem approach into consideration (GEF, 2004).

GEF and adaptation to climate change: In response to growing interest in adaptation within several fora and international processes, GEF has worked on the topic. The results of this work presented in a document at the COP's Ninth Session, where they were accepted by a large number of delegates (GEF, 2003). The GEF proposal has three main components.

The first component is continued *support to national communications* so that developing countries can complete and send their second communications to UNFCCC. This component is centred on providing resources for the compilation of such information, and also includes an important component of capacity building and the development of technical material for studying climate change vulnerability.

The second component is *support for adaptation pilot projects* that also generate benefits in other operational programmes (e.g. biodiversity, soil degradation and water). This component recognizes that a large proportion of the projects financed by GEF has already increased adaptation capacity.

The third component is more general and focuses on *the long-term risks of climate change on GEF projects* that are in the implementation phase, especially those related to ecosystem conservation. This component is expected to influence the way in which projects are developed and financed, in the hope that the adaptation component will be incorporated even when the project is not related to climate change.

[47] The objectives and descriptions of all the operational programmes are available at http://gefweb.org/operational_policies/operational_programs/operational_programs.html.

Glossary

This section provides definitions for the concepts and terms regarding adaptation as used in the Adaptation Policy Framework.

Adaptation – a process by which strategies to moderate, cope with and take advantage of the consequences of climate events are enhanced, developed and implemented.

Adaptation baseline – includes a description of existing adaptations to the current climate. See also *Baseline.*

Adaptation Policy Framework (APF) – a structured process for developing adaptation strategies, policies and measures to enhance and ensure human development in the face of climate change, including climate variability. APF is designed to link climate change adaptation to sustainable development and other global environmental issues. It consists of five basic components: project scope and design, assessing current vulnerability, characterizing future climate risks, developing an adaptation strategy, and continuing the adaptation process.

Adaptive capacity – the potential or capability of a system to adjust, via changes in its characteristics or behaviour, in order to cope better with existing climate variability and change. It is possible to differentiate between adaptive potential, which is a theoretical upper boundary of responses based on global expertise and anticipated developments within the planning horizon of the assessment, and adaptive capacity, which is constrained by the existing information, technology and resources of the system under consideration.

Baseline (also called project baseline) – a description of current conditions, including existing or needed information on socio-economic conditions, climate risks and hazards, and known system vulnerabilities and adaptations. See also *Vulnerability baseline* and *Adaptation baseline*.

Climate change – any change in climate over time, whether due to natural variability or because of human activity.

Climate change vulnerability – 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. See also *Vulnerability*.

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

Coping range – the range of climate where the outcomes are beneficial or negative but tolerable; damages or losses beyond the coping range are no longer tolerable, and a society is said to be vulnerable.

Cost–benefit analysis – a quantitative method that makes a detailed comparison of the costs and benefits of a particular measure, or set of measures. A decision to fund the project depends on the ratio of benefits to costs – the higher the ratio, the more attractive the investment. The major advantages of cost–benefit analysis are its verifiable bottom line and its familiarity to ministries and planning agencies. Disadvantages include limitations regarding its ability to address equity considerations directly and to represent non-quantifiable benefits.

Evaluation – a process for determining systematically and objectively the relevance, efficiency, effectiveness and impact of adaptation strategies in the light of their objectives.

Food insecurity – a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level. Food insecurity may be chronic, seasonal or transitory. More recent literature focuses on livelihood security – an expansion of food security to include multiple stresses and sectors to which livelihoods might be exposed.

Hazard – a physically defined climate event with the potential to cause harm, such as heavy rainfall events, droughts, floods, storms, and long-term changes in mean climate variables such as temperature.

Hybrid – hybrid approaches apply uniform and site-specific methods in tandem and within an iterative process to develop and assess the range of adaptation strategies.

Indicator – an item that can be characterized clearly and possibly quantified and that represents an abstract concept, such as human well-being.

Logical framework analysis approach/logframe – a project planning tool that includes project goals, objectives and activities that have specific outputs and measurable indicators of achievements.

Measure – see *Policies and measures*.

Monitoring – a mechanism or mechanisms to track progress in relation to targets during the implementation of an adaptation strategy and its various components.

Policies and measures – usually addressed together, these address the need for climate adaptation in distinct, but sometimes overlapping, ways. *Policies* typically refer to instruments that government can use to change economic and other behaviours. Policies are usually composed of taxes, command-and-control regulations (e.g. performance specifications for technologies), market mechanisms such as trading schemes, incentives such as subsidies for new management techniques, and information gathering (e.g. on the likely impacts of climate change) or dissemination (e.g. on the merits of new technologies or behaviour changes). *Measures* are usually specific actions that are amenable to implementation, such as re-engineering irrigation systems, planting different crops, or initiating a new industry. Many "projects" could also be termed "measures".

Priority system – the focus of the APF process. It is a system that is characterized as highly vulnerable to different climate hazards, as well as being strategically important at the local and/or national levels. It has been identified as a priority system through a stakeholder-driven process.

Probability – defines the likelihood of an event or outcome occurring. Probability can range from being qualitative, using descriptions such as "likely" or "highly confident", to quantified ranges and single estimates, depending on the level of understanding of the causes of events, historical time series and future conditions.

Reference scenario – an internally coherent description of a possible future without consideration of climate change. The reference scenario is used for comparison with alternative scenarios that include consideration of climate change and options for adaptation policies and measures.

Risk (climate-related) – the result of the interaction of physically defined hazards with the properties of the exposed systems – i.e. the systems' sensitivity or (social) vulnerability. Risk can also be considered as the combination of an event, its likelihood and its consequences – i.e. risk equals the probability of climate hazard multiplied by a given system's vulnerability.

Scenario – a plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline.

Sector – a part or division, such as of the economy (e.g. the manufacturing sector, the services sector) or the environment (e.g. water resources, forestry).

Site-specific approaches – seek to develop and assess detailed adaptation strategies on the basis of specific perceptions of vulnerability that have emerged from the full range of stakeholders at the site level (e.g. local communities, local projects).

Socio-economic vulnerability – an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations. See also *Vulnerability*.

Stakeholders – those with interests in a particular decision, either as individuals or as representatives of a group. Include people who influence a decision, or can influence it, as well as those affected by it.

Strategy – a broad plan of action that is implemented through policies and measures. Strategies can be comprehensive (i.e. focusing on national, cross-sectoral scales) or targeted (i.e. focusing on specific sectors, regions or measures).

System – may be a region, a community, a household, an economic sector, a business, a population group, or another system, such as an agricultural system, that is exposed at varying degrees to different climate hazards, as defined in APF's TP 4 as events with the potential to cause harm. See also *Priority system*.

Uncertainty – an expression of the degree to which a value (e.g. the future state of the climate system) is unknown.

Uniform approaches – approaches that seek to develop and assess broad adaptation strategies on the basis of a comprehensive perception of vulnerability that may exist – e.g. across sectors, across regions, across development challenges.

Vulnerability – the degree to which an exposure unit is susceptible to harm owing to exposure to a perturbation or stress, and the unit's ability (or lack thereof) to cope, recover or fundamentally adapt (become a new system or become extinct). It can also be considered as the underlying exposure to damaging shocks, perturbations or stresses, rather than the probability or projected incidence of those shocks themselves. See also *Socio-economic vulnerability* and *Climate change vulnerability*.

Vulnerability baseline – includes a description of current vulnerabilities to climate variability and events. See also *Baseline*.

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Acronyms

AfDB	African Development Bank
APF	Adaptive Policy Framework
AsDB	Asian Development Bank
CATIE	Tropical Agriculture Research and Higher Education Center
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CIFOR	Centre for International Forestry Research
COP	Conference of the Parties
ENSO	El Niño South Oscillation
FAO	Food and Agriculture Organization of the United Nations
GCM	general circulation model
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GIS	Geographic Information System
GTOS	Global Terrestrial Observing System
IADB	Inter-American Development Bank
ICRAF	International Centre for Research in Agroforestry
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
IUCN	World Conservation Union
LDC	least-developed country
LULUCF	land use, land use change and forestry
NAO	North Atlantic Oscillation
NAPA	National Action Plan for Adaptation
NGO	non-governmental organization
NWFP	non-wood forest product
ODA	official development assistance
OECD	Organisation for Economic Cooperation and Development
SDC	Swiss Agency for Development and Cooperation
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
WMO	World Meteorological Organization
WWF	World Wide Fund for Nature

Annex 1: Most important decisions related to adaptation

- ***11/CP.1:***[48] Initial guidance on policies, programme priorities and eligibility criteria for the operating entity or entities of the financial mechanism. This decision establishes the stages for adaptation financing (Chapter 4).
- ***2/CP.4:*** Additional guidance for the operating entity of the financial mechanism. This decision establishes that the financial mechanism should cover 100 percent of the costs of developing countries' national communications.
- ***2/CP.7*****:** Capacity building in developing countries. This decision establishes that the national communications are the main source of information on implementation activities of UNFCCC. The decision identifies training areas in adaptation issues, including fragile ecosystems and soil degradation.
- ***5/CP.7*****:** Implementation of Article 4, paragraphs 8 and 9 of the convention. This decision approaches the topics of adaptation and vulnerability in a general way. The decision mentions specific activities to be financed by GEF and by the different UNFCCC funds (Box 3.2).
- ***6/CP.7*****:** Additional guidance for an operating entity of the financial mechanism. The decision identifies activities to be financed by GEF. It puts emphasis on the needs of less developed countries and those with greater vulnerability.
- ***7/CP.7*****:** Funding under the convention. This decision establishes two funds to finance activities in developing countries: the Special Climate Change Fund and the Less Developed Countries Fund.
- ***10/CP.7*****:** Funding under the Kyoto Protocol. This decision establishes a low adaptation fund, to which only developing country signatories of the protocol have access.
- ***28/CP.7*****:** Guidelines for the preparation of national adaptation programmes of action. This decision contains guidelines for preparation of the National Action Plans on Adaptation (NAPAs), including their contents and emphasis.
- ***7/CP.8*****:** Initial guidance for an entity entrusted with operating the financial mechanism of the convention, for the operation of the Special Climate Change Fund. The decision elaborates on the guidance relating to the activities identified in paragraph 2 of decision 7/CP.7.
- ***8/CP.8*****:** Guidance for an entity entrusted with operating the financial mechanism of the convention, for the operation of the Least Developed Countries Fund, which aims mainly at financing the preparation of national adaptation programmes.
- ***5/CP.9*****:** Further guidance for an entity entrusted with operating the financial mechanism of the convention and of the Special Climate Change Fund. This decision reiterates the financing of developing countries' national communications and of the training promotion activities. The decision invites GEF to carry out the "Experimental application of an adaptation operational focus", according to the proposal presented by the fund during the ninth session of the COP.
- ***1/COP 10*****:** Launched the Buenos Aires Programme of Work on Adaptation and Response Measures to further implementation of actions under decision 5/CP.7.

[48] COP decisions are identified by a serial number, followed by the letters CP and the COP session number at which the decision was made. For example, decision 11/CP.1 indicates that this decision is the eleventh in a series of decisions made at the first COP session.

Annex 2: Selected cooperation agencies

Country	Agency	Links
Australia	Australian Agency for International Development (AusAID)	www.ausaid.gov.au/
Canada	Canadian International Development Agency (CIDA)	www.acdi-cida.gc.ca/index-e.htm
Denmark	Danish International Development Agency (DANIDA)	www.um.dk/danida/partnerskab2000/
Finland	Department for International Development Cooperation	http://global.finland.fi/index.php?kieli=3
France	Agence Française de Developpement (AFD)	www.afd.fr/english/index.cfm
Germany	Deutsche Gesellschaft für Technische zusammenarbeit (GTZ) (German Agency for Technical Cooperation) Kreditanstalt für Wiederaufbau	www.gtz.de/english/ www.kfw.de/en/inhalt.jsp
Italy	Ministry of Foreign Affairs Development Cooperation	www.mofa.go.ug/international.php
Japan	Japanese Bank for International Cooperation (JBIC) Japanese International Cooperation Agency (JICA)	www.jbic.go.jp/japanese/index.php www.jica.go.jp/Index-j.html
Netherlands	Netherlands Development Organization	www.minbuza.nl/default.asp?cms_item=mbz257572
New Zealand	New Zealand Agency for International Development (NZAID)	www.nzaid.govt.nz/
Norway	Norwegian Agency for International Development (NORAD)	www.norad.no/default.asp?v_site_id=2
Sweden	Swedish International Development Authority (SIDA)	www.sida.se/sida/jsp/polopoly.jsp?d=177
Switzerland	Swiss Development and Cooperation (SDC)	www.eda.admin.ch/lima_emb/s/home/devcop.html
United Kingdom	Department for International Development (DFID)	www.dfid.gov.uk/
United States	United States Agency for International Development (USAID)	www.usaid.gov/