5 Current Adaptation Measures and Policies

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Abstract: As stated in earlier chapters, the possible impacts of climate change on forests and the forest sector are considerable, and many impacts have already been observed. As forest conditions change, there is an inherent need to change management and policy measures to minimise negative impacts and to exploit the benefits derived from climate change. This chapter highlights trends in existing policies and management measures that promote the adaptation of forests to climate change, and barriers to implementation. An investigation into existing policies indicates that they often serve multiple purposes and are not introduced solely in response to climate change; that local forest-related knowledge is an important and under-utilised resource which should be better recognized; that countries have yet to overcome all the barriers to implementing adaptation policies; and that existing policies tend to be reactive rather than proactive and reflect national socio-economic and environmental circumstances.

Keywords: adaptation, management, local knowledge, policy, UNFCCC, national communications, NAPA

5.1 Observations of Human Adaptation to Climate Change

5.1.1 Forest Practices as Adaptations to Climate

Several aspects of contemporary forest management and policy can be viewed as adaptations to climate (Spittlehouse 2005). For example, common practices such as planting trees and harvesting products have been adapted to local climate conditions, including seasonal patterns of temperature and precipitation. However, local forestry practices are often based on an implicit assumption that local climate conditions will not change (Guariguata et al. 2007).

Appendix 5.1 presents selected examples of human adaptations to climate. The examples suggest that adaptation to climate and its impacts on ecosystems must be tailored to local conditions. Options for adaptation vary among geographical regions and forest types. Furthermore, adaptations in commercial forestry operations are very different from those made by communities in developing countries that depend on forests for subsistence.

Most adaptations to local climate conditions serve more than one purpose. For example, people in several developing countries are planting and tending drought- resistant trees with edible fruits to enhance food security and nutrition, reduce erosion and provide an additional source of fuelwood (Appendix 5.1).

Some countries and private companies have made substantial investments in forest genetics research and tree-breeding programmes. These investments have enabled major improvements in the growth rate and disease resistance of planting stock for several tree species (Burdon and Libby 2006, Kanowski and Murray 2008).

Actions that restore and conserve biodiversity are a means of increasing ecosystem resilience to climate change and other stress factors (Tilman 1999, Noss 2001). In many situations, efforts to adapt to climate change and mitigate greenhouse-gas emissions in the forest sector are compatible with efforts to tackle the associated threats of habitat destruction, fragmentation and degradation (Krankina et al. 1997, Williams 2000, Noss 2001).

5.1.2 Local Knowledge and Traditional Adaptation Strategies

In many forest-dependent communities with subsistence economies or in a tenuous transition towards market-based economies, local forest-related knowledge continues to play a vital role in meeting basic livelihood needs. Local knowledge and associated forest management practices have sustained local and indigenous communities throughout the world under changing environmental, social and economic conditions, long before the advent of formal forest science and 'scientific' forest management. Local forest-related knowledge is usually closely linked to traditional land-use practices, local decision-making processes and governance institutions, and beliefs about the relationships between community members and forest environments.

Many forest-dependent communities are well known for their knowledge of the natural world, and often possess keen insights into meteorological phenomena, animal behaviour and forest phenology. Accustomed to inter-annual and longer-term variability in climate, most indigenous and other forest-dependent communities have acquired sufficient knowledge of plant and animal species and their management and use to enable them to cope with changing abundances of preferred species used for food, medicine and other purposes.

Particularly relevant in the context of adaptation to climate change are traditional forest and water management practices aimed at maintaining water quality and conserving scarce water resources. Many of these practices are well known and described in the scientific literature. In semi-arid and arid regions, for example, a wide variety of local technologies have been developed to harvest and conserve scarce water resources in traditional silvopastoral and agroforestry systems (Laureano 2005, Osman-Elasha et al. 2006). In north-eastern India, the soil and vegetation management practices developed over generations by local communities have been shown to enhance soil fertility and minimize erosion losses in shifting cultivation areas (Ramakrishnan 2007).

In response to expected climate-induced changes in forest structure and species composition, local knowledge of the uses of a wide range of forest plant and animal species enhances possibilities for meeting forest-dependent peoples' needs by substitution of increasingly rare species with those that may become more abundant. For cultivated forest species, local knowledge and traditional tree and forest management can play a key role in maintaining forest/tree productivity (and food security) in the face of climate change. This has been documented e.g. in Italy, where centuries-old practices for managing chestnut orchards have enabled local communities to cultivate this important woodland food source on sites well beyond the natural climatic limits of the species (Agnoletti 2007).

Although local knowledge represents an important element of adaptive capacity for local and indigenous communities to cope with climate change, it is important to recognize its actual or potential limitations (FAO in press). Such knowledge is rarely codified and often restricted to a few members of local, particularly indigenous, communities, which increases its vulnerability to inter-generational loss. While it has been shown to be dynamic, its capacity to adapt quickly enough to the more dramatic climate-change impacts on forests envisaged for some regions cannot be assumed. Furthermore, local and indigenous knowledge is already disappearing in many parts of the world for a number of reasons.

The expansion of increasingly globalized market economies in previously self-sufficient rural areas, the impact of infrastructure development and greater exposure to mass media, government policies and regulations within and outside the forest sector that restrict access and traditional use of forest resources – these have all contributed to a general erosion of traditional cultures and of associated land and forest management knowledge and practices. They have also contributed to declining interest in traditional lifestyles among the younger generation in these communities. The negative implications of this loss on livelihoods, cultural and biological diversity, and the capacity of forested landscapes to provide ecosystem goods and services remain poorly understood, largely unappreciated and undervalued by policy-makers and the general public in most parts of the world (Cox 2000, IAITPTF 2005).

However, opportunities exist to revitalize local knowledge and develop appropriate strategies for adaptation of forest resource management to climate change that combine local and scientific forest knowledge (Kruger 2005). For example, local knowledge can complement formal science in monitoring the effects of climate change (Vlassova 2002). The translation of local forest knowledge into the language of formal forest science is an important step towards adaptation and application of local forest knowledge to new or changing environmental, social and economic contexts. It may find important applications in forest rehabilitation, restoration and adaptive management of forests in the face of climate change (Berkes et al. 2000, Parrotta and Agnoletti 2007).

Achieving effective synergies between local and scientific forest-related knowledge to deal with the impacts of climate change on forests will require broader participation of local and indigenous communities, and a better understanding by decision-makers and the scientific community of the knowledge and wisdom of forest-dependent communities on

John Parrotta: Himachel Pradesh, India

Photo 5.1 Local forest knowledge can contribute to forest rehabilitation, restoration and sustainable land management in the face of climate change.

issues related to forest landscape conservation and management. Interdisciplinary, participatory research and development may play a key role in this process, and help to reverse the ongoing erosion of local forest-related knowledge, practices and social institutions that threaten indigenous cultures and knowledge systems worldwide, as well as their capacity to adapt to climate-change impacts on forest ecosystems.

5.1.3 Barriers to More Effective Adaptation

Forest-sector responses to extreme climate events and longer-term changes in climate patterns have been reactive in most cases. Efforts to encourage proactive adaptation must address forthrightly the reality that stakeholders in the forest sector have diverse values and interests that can impede efforts to reach consensus on goals for adaptation (Spittlehouse 2005, Adger et al. forthcoming). The values that underpin adaptation decisions become more diverse and complex as one moves from smaller to larger scales with increasing numbers of stakeholders. Adaptation strategies must give explicit attention to normative issues such as trade-offs among competing values and interests, distribution of costs among stakeholders, and potential for changing preferences and unintended consequences over time.

Proactive adaptation strategies must also deal explicitly with uncertainty in projections of future climate changes and their impacts. Uncertainty per se should not necessarily be a reason for inaction (Dessai and Hulme 2004). However, climate- change projections are perceived by many forest managers as too uncertain to support long-term and potentially costly decisions that may be difficult to reverse. Similarly, uncertainty over future policy developments may also constrain action. In Sweden, for example, uncertainty exists over the future of certain conservation and social policies that may expand areas in which logging is prohibited. This can create uncertainty among stakeholders. They can feel that they have no control over the future of their forestry operations and thus no incentive to plan for adapting to uncertain climate changes (Keskitalo 2008).

Arvai et al. (2006) argue that principles of 'Adaptive Management' (Holling 1978, Walters 1986) should be applied to the challenge of addressing complexity and uncertainty in climate policy. In brief, 'Adaptive Management' involves simultaneous implementation of alternative treatments (e.g. adaptation measures and policies) in different locations and comparison of results to test hypotheses about the behaviour of complex systems.

The potential for climate change to alter a system's response to treatments may be an important consid-

eration in future applications of Adaptive Management in the forest sector. For example, current theory and practice in forest biodiversity conservation often emphasize minimization of human influence on forest reserves. More active management strategies may be necessary to conserve important elements of biodiversity in some wilderness and natural areas in regions that experience rapid and severe changes in climate.

Finance is a further barrier to implementing adaptation actions in the forest sector. Climate change is one more issue facing decision-makers and competing for resources. When public or private authorities undertake adaptation measures, they will need reasonable estimates of costs and benefits to justify their actions. At present, most adaptation proposals are lacking such estimates, although this is an area currently receiving considerable attention (UNFCCC 2007, Watkiss et al. 2007, Agrawala and Frankhauser 2008).

Keskitalo (2008) noted that socio-economic and political conditions have significant influences on vulnerability and adaptive capacity. Current conditions and near-term choices about development and adaptation will have important influences on future adaptation options.

5.2 Existing Policies for Adaptation

5.2.1 Introduction

Policy programmes and instruments concerning the adaptation of forests to the predicted impacts of climate change aim at enabling forest owners and forest managers to take appropriate actions in time to ensure sustainable forest management (SFM) under the changed conditions of global warming. The information presented in the following section indicates existing trends in management and policies for promoting the adaptation of forests and the forest sector to climate change. The information is based in post-2004 national communications (NCs) and National Adaptation Programmes of Action (NAPAs) produced for the UNFCCC (United Nations Framework Convention on Climate Change) (Roberts 2008). These documents were selected for analysis as they are representative sources of information and structured within standard frameworks. Although this allows for indicative comparison of existing policies, the NCs and NAPAs provide insufficient information to assess the impacts or effectiveness of policies and management measures. Further research at the national level is needed to determine this.

No attempt was made to delineate adaptation from mitigation when the information was insufficient or when the delineation was not practical. Policy promoting sustainable forest management, for example, can assist in mitigating climate change through increased sequestration and storage of carbon, while autonomously promoting the adaptation of forests through increasing forests' natural adaptive potential.

The following information is delineated into the tropical, subtropical, temperate and boreal domains in accordance with the classification of the Global Forest Resources Assessment (FAO 2001). For each forest domain the management, policy and policy instrument options for promoting the adaptation of forests and the forest sector to climate change is presented. In the following abridged version, the policy instruments reported in the NCs and NAPAs are divided into regulatory (based on state power), economic (based on money) and informational tools (based on information), outlining the key policy trends for each domain.

*5.2.2 Tropical Domain**

Forest Management Measures: The application of community-based forest management aimed at promoting afforestation and the conservation of land, water and timber resources is commonly promoted within national reports. For example, India reports on short-term rotation species and management practices to increase the resilience of forests to climate change. SFM is also reported as a method of increasing the resilience of forests to climate change. Changes in forest management, such as harvesting and planting dates, and utilization of thinning are reported as further possible methods of adapting to climate change.

* Tropical Annex I countries include: Australia and the United States of America, with Non-Annex I countries being Brazil, Cameroon, Fiji, Gabon, Guinea-Bissau, India, Madagascar, Mexico, Nepal, Rwanda, Sao Tome and Principe, Saudi Arabia, Sierra Leone, Solomon Islands, Suriname, Tonga, Turkmenistan, United Arab Emirates, Venezuela. Countries which produced a NAPA include: Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Cape Verde, Comoros, Democratic Republic of Congo, Djibouti, Eritrea, Guinea, Guinea-Bissau, Haiti, Kiribati, Madagascar, Malawi, Mali, Mauritania, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sudan, Tanzania, Tuvalu, Vanuatu, Zambia.

Policies for Adaptation and Instruments

Many countries located in the tropical domain report a restricted ability to adapt to climate change due to limited financial resources. Overall, the adaptation options for the domain focus on reducing the anthropogenic stresses on forests through the use of regulatory, economic and informational instruments.

Regulatory instruments: Forest conservation, in the form of formal protection areas and SFM, are highlighted as adaptation options to climate change. Regulations in place for the enforcement of such actions are often associated with national forest programmes (NFPs) or equivalents. However, throughout the tropical domain the reports mention problems with the implementation of regulatory policy, such as protective areas, due to a lack of resources for the enforcement of such measures. As a result illegal anthropogenic practices and exceeding of cutting concessions continue to degrade protected areas. Unsuitable policy coupled with insufficient means for enforcement is reported to limit efforts to combat deforestation. Consequently, institutional strengthening of departments and bodies concerned with forest management, research and protection, including their ability to enforce legislation, is identified as a necessary step for decreasing the vulnerability of forest to climate change. This is reported to be achieved through increasing the human and technological resources.

Economic instruments: The utilization of financial instruments for adaptation to climate change was comparatively limited within the tropical domain. Community- based and national afforestation projects have been initiated throughout the tropical domain. Despite these efforts, it is also reported that the level of afforestation is insufficient to compensate the level of deforestation. A possible solution to deficient law enforcement is alignment of financing mechanisms toward the 'protector receives' principle, where those who protect a resource of communal interest are rewarded. This is reported to be a suitable mechanism for environmental protection in poverty-stricken regions as financially poorer communities are more likely to respond to financial incentives (rewards) rather than disincentives (fines).

Financial incentives for SFM, reforestation and changes to non-wood-based fuels (including changes to fossil fuels) are also mentioned as a means of promoting adaptation. However it is also noted that a lack of financial resources may impede the utilization of economic instruments.

Informational instruments: In addition to NFPs, capacity building through the dissemination of information (via training, research, projects, etc.) regarding future risks and potential solutions is frequently mentioned throughout NAPAs and NCs. A limiting factor mentioned in the reports is insufficient data for baseline information regarding forests. As a consequence, the establishment of monitoring programmes to determine the current situation of forests and further research into future projections of climate change, including extreme events, are reported as important measures for adaptation. The need for the incorporation of climate change into short- to long-term planning at all levels of decision-making, from forest-management plans to the long-term policy-making process, is also identified within the NCs and NAPAs.

*5.2.3 Subtropical Domain**

Forest Management Measures: The predicted poleward migration of tree species (*see chapters 2 and 3*) is reported to require assistance by forest management. This may include measures such as the establishment of migration corridors connecting nature reserves. It is also noted that forest management should focus on reducing stress from external sources, such as extreme events and disturbances. Some additional management options reported for promoting adaptation are: high-quality genetic selection or selection of trees from specific varieties/origins; promotion of mixed-species forests; decrease of the area of monocultures; and reducing the threats of pests and diseases.

Policies for Adaptation and Instruments

Examples of policies aimed at promoting the adaptation of subtropical forests to the predicted impacts of climate change tended largely to reflect the need to address the vulnerability to desertification and increase the natural resilience of forests by improving environmental conditions and reducing external stresses.

Regulatory instruments: Implemented regulatory instruments define who is responsible for the incorporation of adaptation into local planning. As with the tropical domain, forest policies such as Forest Acts or equivalents are used to promote SFM.

* Sub-tropical countries include Annex I countries which are contained within this region and have produced a NC include: Australia, Croatia, France, Greece, Italy, Japan, Monaco, New Zealand, Portugal, Turkey and United States of America. Non-Annex I countries include: Argentina, Bahrain, Brazil, China, Mexico, Saudi Arabia, Turkmenistan and Uruguay, and countries which developed a NAPA include: Lesotho and Maldives.

Geoff Roberts: Temperate forest in Czech Republic

Photo 5.2 Examples of policies promoting the adaptation of forests to climate change introduced in the temperate domain are often reactive and form parts of National Forest Programmes or equivalents.

Afforestation, fire prevention and improvements in forest health are measures taken to reduce the vulnerability to desertification threatening many countries in the domain.

Economic instruments: Economic instruments aimed at improving the environmental and forest conditions are being applied. In Australia for example, tax incentives (deductions) for the expansion of plantations and grants for environmental plantings have been implemented. Similarly, New Zealand has a local afforestation programme which utilizes financial incentives. Although these tools are not specifically aimed at increasing the adaptive capacity of forests or adapting to climate change, they contribute to it through reducing stresses on existing forests and improving environmental conditions.

Informational instruments: The dissemination of information on the impacts of climate change on forests, such as the increased susceptibility to fire events, is seen as critical for anticipatory measures. National Forest Acts and a National Adaptation Strategy or equivalents are commonly used for dissemination of information pertaining to adaptation to climate change.

Examples of the use of information tools are given in the Italian NC which reports that through the introduction of a fire education programme, the number of anthropogenic fires could be reduced. Similarly, in Portugal, leaflets have been distributed to the general public on methods to reduce the impact of drought, fire and heat waves, although this is not specific to the forest sector.

*5.2.4 Temperate Domain**

Forest Management Measures: The management techniques outlined in the NCs concern mainly the formation of more stable forests in the face of climate change. Near-nature forest management and a move away from monocultures toward mixed forest types, in terms of both species and age classes, are advocated. In addition, natural or imitated natural regeneration is indicated as a method of maintaining genetic diversity, and subsequently reducing vulnerability. For management against extreme disturbances, improvements in fire detection and suppression techniques are recommended, as well as methods for combating pests and diseases. It is reported that through stricter quarantine and sanitary management, the impact of insects and diseases can be minimized.

As with the subtropical domain, reports state that the establishment of migration corridors between forest reserves may aid in the autonomous

* Countries in the temperate domain which have submitted a NC are Australia, Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Netherlands, New Zealand, Poland, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom and the United States of America. Non-Annex I countries are China and Turkmenistan.

colonization and migration of species in response to climate change.

Policies for Adaptation and Instruments

The adaptation policy options identified in the NCs are largely concerned with increasing the resilience of forests to climate change, through forest expansion, SFM and forest protection, although these are often secondary impacts of the policy, with mitigation being the primary objective. The policies that were introduced concerning adaptation of forests and the forest sector are often reactive and form parts of NFPs or rural development programmes.

Regulatory instruments: Strengthening national forest laws or equivalent processes aiming at SFM, and subsequently adaptation, is commonly referred to throughout the NCs. This includes the protection of forests and forest genetics as well as the setting of performance guidelines for forest management. Also reported is in-situ conservation and protective legislation against deforestation.

Economic instruments: Economic instruments, such as grants, subsidies and compensatory payments are used to promote afforestation, changes in species composition and recovery from extreme disturbances. Voluntary forest certification systems such as the Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification schemes (PEFC) are also used for providing financial incentives for SFM, and subsequently adaptation.

Informational instruments: NFPs are a common mechanism for promoting the adaptation of forests to climate change. They provide foresight to the future climatic conditions and planned as well as reactive adaptation. Furthermore, dissemination of information concerning the likely impacts of climate change, the economic and financial implications of adaptation measures, as well as guidelines for adaptation and assessing climate-change impacts and adaptation options, are portrayed as invaluable instruments when dealing with climate change. National monitoring and research programmes targeting the impacts of climate change support the national strategies. Mapping of areas and forest types which are sensitive to climate change and carrying out risk assessments are also reported as steps to promote adaptation.

*5.2.5 Boreal Domain**

Forest Management Measures: As with other domains, the establishment of migration corridors from south to north between fragmented landscapes is reported as a means of aiding the migration of species responding to changed climatic conditions. Changing the species composition to form more stable forests is reported as a management option; an example is changing the species in southern Finland from spruce and pine to birch. In a similar context, Sweden has been working on a breeding programme aimed at developing trees that would be adapted to the projected future climate. Various provinces of Canada have introduced climate-change programmes for combating the increase in major disturbances, in particular to fire and insects. Throughout Canada the introduction of prescribed burning is viewed as a viable option for reducing the risk of large-scale fire events, which are predicted to increase under the changed climatic conditions.

To adapt to shorter winter harvesting periods as well as soft soils and roads, new harvesting techniques that better suit new conditions need to be developed. It is also reported that in some regions increasing population levels of large game, in particular moose, will increase the need for game management.

Policies for Adaptation and Instruments

As implied in the tropical domain, a country's ability to adapt to climate change will depend largely on financial, human and institutional capacities; thus the more developed regions may adapt more easily than regions within less developed countries. As the boreal domain consists of comparatively few countries with well- developed economies, there are good grounds for adaptation. However, there was limited evidence of existing policies to promote the adaptation of forests to climate change, with the exception of informational instruments. Finland reports that past research efforts have focused primarily on the impacts of climate change on forests and the forest sector, with a relatively low level of research into adaptations. It also states that a lead time of 10 to 100 years is required for planning and implementing adaptive strategies for forests.

Informational instruments: Informational instruments prevail in promoting adaptation in the boreal region. It is reported that the main aims for policy

* Countries which have submitted a NC include: Canada, Finland, Iceland, Norway, Russia, Sweden and the United States of America.

on adaptation are to: raise awareness of adaptation; facilitate and strengthen capacity for coordinated action on adaptation; incorporate adaptation into policy and operations; promote and coordinate research on impacts and adaptation; support knowledge-sharing networks; and provide methods and tools for adaptation planning. Finland has launched a National Adaptation Strategy which also includes forestry. The proposed instruments aim at anticipatory and reactive policies of public administration and the private sector. The individual policies are indicated as immediate (2005–2010), short-term (2010–2030), and long-term (2030–2080). However, there was no information on policy implementation concerning the adaptation of forest to climate change. Under a similar premise, Norway and Canada are reported to be developing a National Adaptation Strategy or equivalent. In addition, Canada has introduced provincial action plans and strategies for reducing the vulnerability to fire, including the introduction of prescribed burning to alter fuel loads in forest. These initiatives have successfully reduced the forest area burned and the occurrence of large-scale forest fires.

5.3 Conclusions

- Adaptation to climate change has started to be incorporated into all levels of governance, from forest management to international forest policy. Often these policies are not adopted solely in response to climate, and may occur in the absence of knowledge about longer-term climate change. They often serve more than one purpose, including food and fuel provision, shelter and minimizing erosion, as well as adapting to changing climatic conditions.
- Local forest-related knowledge, practices and associated social institutions, developed under changing environmental conditions by indigenous and local communities over generations, represent an important source of adaptive capacity for local forest-dependent communities in the face of climate-change impacts on forest ecosystems. Greater recognition of local institutions and the individual actors involved in decision-making processes for planning adaptation may enable successful adaptive forest governance.
- Although local forest-related knowledge is declining in most regions of the world, its importance for strengthening local and indigenous community adaptation to climate change should be recognized, and supportive actions taken to preserve, protect and foster its further development. Equitable collaborative efforts between the holders and users of local knowledge and scientists and forest managers can help to elucidate underlying ecological principles that may enable wider application and further development of local knowledge and associated forest resource management practices to cope with climate-change impacts.
- Overall, the existing policies, as identified in the NCs and NAPAs, reflect the different priorities and circumstances, both environmental and socio-economic, of countries and general conditions of domains. Although there are many similarities, country/domain differences have also led to the formation of contrasting policies. Often, reported adaptation policies are built on existing forest-policy frameworks, reiterating the point that policies are devised not only in response to climate change, but serve multiple purposes. Further research is needed to investigate the effectiveness of these policies.
- Similarities in policies between domains include the use of SFM as a means of adapting to climate change. It is commonly promoted through National Forest Acts or equivalents. However, most NCs and NAPAs fail to identify the more specific policies or specify the necessary changes for adaptation which are embodied in the concept of SFM, rather relying on the generalized term. In a similar context, the existing policies are often attributed to general vulnerability to climate change rather than specifics and tend to be reactive to observed events rather than proactive (anticipatory adaptation). This indicates programme deficits, as there are noted vulnerabilities without corresponding policies. These deficits probably reflect the difficulties in introducing adaptation strategies which meet the diversity of values associated with forests, the potential for changing preferences, actual and potential costs, as well as uncertainty. Although the above mentioned issues pose a significant difficulty, they should not permanently impede efforts to introduce proactive/anticipatory adaptation strategies.

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Appendix 5.1 Examples of adaptations to local climate conditions and variability.

Country	Adaptation
Bangladesh	Cultivation of drought-tolerant fruit trees to diversify household income sources, ensure food security and provide shade and fuelwood (Selvaraju et al. 2006).
Bhutan	Local regulations and community enforcement encourage regeneration of bamboo resources in Bhutan by means of closed seasons (during shooting and young stage); selective harvesting; rotational harvesting; and protecting the sacred groves and areas near water sources (UNFCCC 2008a). The Monpas, a Bhutanese ethnic group, harvest wild vegetables, fruits and tubers from the forest during times of food scarcity due to erratic rainfall. 92% of households depend on forest food during food shortage from January to March (UNFCCC 2008b).
Botswana	Drought-resistant fruit trees are planted around villages. The fruit are vitamin-rich and the trees are able to produce even during drought years, and provide an additional income when traditional crops fail due to poor weather (Boven and Morohashi 2002).
Brazil	Erosion-prone areas near Rio de Janeiro are being reforested in order to control erosion and reduce the associated land-slide and flood risks to the city, particularly the vulnerable squatter settlements (favelas) (Lobo 1998).
Burkina Faso	Afforested areas with Acacia to protect against drought and aridity, and to provide firewood, fodder, tannin, pulpwood, shelterbelts and soil improvement (UNFCCC 2008c).
Canada	Indigenous ecological knowledge has been documented and communicated in Canada with the aim of informing public policy and environmental decision-making in the Hudson Bay bioregion (Boven and Morohashi 2002).
China, Loess Highlands	Reforestation using indigenous species adapted to the local conditions to control erosion and flooding problems. Fruit trees and medicinal herbs are also increasingly cultivated to increase farmers´ incomes (Wu Bin 2005).
El Salvador	Addressing drought problems by reforesting areas with fruit trees (among other measures), to protect soil from erosion caused by water and wind while augmenting the local food supply (Vega 2003).
Grenada	Growing appropriate tree species on cultivated land to reduce vulnerability to hurricanes and to provide various other benefits, including reversal of the deforestation trend (World Agroforestry Centre 2007). Top pruning to strengthen and reduce the height of trees and shrubs so that they are better able to resist hurricanes (OECS 2004).

India	In the Himalayas, where communities are faced with erratic rainfall during spring and summer, farmers have developed agro-forestry practices to ensure food security and additional income, particularly growing cardamom, bamboo groves and fruit trees (Verma 1998).
Jamaica	Alley cropping (the practice of planting trees in rows with food or cash crops between them) is used to reduce the vulnerability of the population and their environment to hurricanes and hurricane-related devastations (Thomas-Hope and Spence 2002, Spence 2005).
Mali	Farmers grow Jatropha plant for fuel and protection from damage from wind and water (Henning 2002).
Senegal	Cultivation of moringa trees that are very drought-resistant and tolerate a wide variety of soil types. They can be used to combat malnutrition by providing enriched food and by treating drinking water (Boven and Morohashi 2002).
Sri Lanka	Agro-forestry practices have been implemented in response to drought and the declining per capita availability of agricultural land (Ranasinghe 2004).
Sweden	Forestry workers have adapted to changes in climate (notably warmer temperatures) by road building and road sanding to combat early thawing (Keskitalo 2008).
Tajikistan	CARE project plants trees to stabilise eroding soils and slopes as protection from erratic rainfall (UNFCCC 2008d).
Tanzania	In the Shinyanga region in the north of Tanzania, traditional practices of conservation have been revived by a government initiative. By encouraging vegetation regeneration and tree planting, 'ngitili' has proven to help protect the environment, particularly against drought and aridity, and improve the livelihoods of communities in the region (Barrow 2002).
Thailand	Five-year Action Plan for Mangrove Management in the Gulf of Thailand preserves mangrove forests and promotes sustainable use of mangrove resources. Mangroves provide protection against disasters such as storm surges and are an important coastal protection resource. The programme's activities include reforesting and maintaining mangroves; providing training to build capacity for community forest management and increase partnerships between the local community, the government and NGOs, and reduce illegal wood harvesting and land cultivation; and to set up Mangrove Protection Zones (UNFCCC 2008e).
Zimbabwe	Deep-rooted trees are used in agro-forestry operation in order to tap more moisture from a lower depth during the dry season, in order to increase the overall productivity of land. Different crop canopies use light efficiently, and the agro-forestry systems return large amounts of nutrients to the soil, as well as provide shelter against wind erosion (Agobia 1999).