Synergies between Conventions: An Assessment

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Introduction

The recently concluded World Summit on Sustainable Development (WSSD) in agreement with several national governments, international and multilateral organisations, stakeholders and communities, declared specific goals with regard to sustainable development. WSSD comes ten years after the Rio Earth Summit (1992) which pledged political and financial support to enhance the quality of human life through better environment and equity. WSSD also marks the 30th anniversary of the Stockholm Summit on Sustainable Development.

Despite all of these commitments, many are concerned with the lack of integrated on-the-ground work to deal with the environment. Even though Rio gave birth to three international conventions, namely the Convention on Biological Diversity (CBD), UN Framework Convention on Climate Change (UNFCCC) and the Convention to Combat Desertification (CCD), the implementation of these conventions is at varying stages. (Objectives of the three conventions are shown in Box 1). The Forestry Principles (FP) derived directly from the Rio Summit is often forgotten.

Each of these instruments focus on a particular set of problems, yet each also recognises that activities to address its own issues must also take into account those of the other instruments. Each of these instruments individually aims to achieve sustainable development. However, one element often forgotten is how ground- level integration is possible and is needed (Box 2).

At a national level, all three conventions fall under the purview of agencies looking after environment and natural resources. Yet these are dealt by separate departments and institutions, often with a high degree of disconnect. Such disconnects lead to ineffective implementation, not individually at convention level, but collectively to achieve sustainable development.

The barriers to achieve synergies are technical (lack of understanding of cross-sectoral issues, information, impact assessments etc.), political (inter-departmental conflicts, issues of territoriality lack of guiding principles and

understanding at a policy-making level) and cultural (thoughts of not overstepping boundaries and lack of insight to working at local or ground levels).

In the face of these challenges, there is a need to develop and enhance synergies between the instruments in terms of their implementation at local, national, regional and global levels. In some cases, synergies and integrated approaches exist and can be built upon, and in some cases efforts are needed to stimulate collaboration, cooperation and harmonization.

Linkages in processes

As described in Box 1, the principles of three Conventions have elements in common. In addition they have certain processes that are common or linked. Scientific and implementation linkages are discussed below.

Scientific linkages

Scientific assessments are key to informing the negotiation processes. These assessments include an estimate of the socio-economic implications of climate change, biodiversity loss, desertification and deforestation. These topics and assessments are fundamentally linked.

For example, the linkages between climate change and forests, land and biodiversity are explicit. Widespread deforestation converts forests into carbon dioxide. It also reduces the water retention capacity of the soil and increases soil erosion. This can lead to changes in temperature and topographic patterns, leading to desertification and warming. Deforestation also affects biodiversity and the livelihoods of local communities.

Actions taken to address one element of the environment can have many incremental benefits in other areas. Although we understand the scientific linkages well, operational linkages at the convention level are not well developed.

Implementation linkages

The key environmental agreements also contain many similar requirements for action, research, reporting and other necessary activities agreed upon by their signatories.

- The instruments adopt similar approaches to achieve their goals.

They recognize needs for national actions guided by international experiences. All of them recognize the need for capacity building, awareness raising and cooperation as pre-conditions to their success.

- Approaches to activities: All of these instruments promote activities of research, assessments, information exchange, training, development of strategies and action plans and inventories. However, the decisions of design and detail are left open for interpretation by individual governments.
- Subsidiary Bodies for Scientific and Technological Advice: All of the Conventions require the creation of an international body of scientific and technical expertise. CBD works through SBSTTA, UNFCCC through SBSTA and CCD through the Committee on Science and Technology. However, the linkages among these bodies are weak.
- Information, Monitoring and Reporting: The conventions have independent monitoring and reporting requirements, as well as having different methods for addressing information needs and information generation. However, the conventions fail to recognize the common reporting and monitoring needs.

How can we promote synergies and linkages ?

It is truism that we work in a world in which governments work primarily in a sector-based mode to develop and implement their policies and programmes. This needs to change. This type of change may be achieved by enhancing the institutional outlook, building capacities at both personal and institutional levels, modifying national planning processes and strengthening the information base.

Institutional outlook

There are several core activities which are particularly amenable to the issue of institutional synergies in implementing the Rio conventions and sustainable development policies. These areas include awareness raising, education, reporting, data gathering and inventories, public participation, and research and training.

Synergies in these areas may be achieved at a national level in several ways. One option is to establish a crosscutting national committee that brings

together key players. Several countries have already established National Planning Commissions that bring together these key players to develop plans and budgets. Creating a National Committee on Sustainable Development would help achieve synergies and development objectives. Another option is establishing separate institutions that have a coordinating mechanisms. Numerous countries already use this model in sectors like finance, banking and health, so extending this model to the environment may be a viable option. Finally, a single institution could be established within a country that is responsible for all of the conventions, instead of splitting responsibilities among several departments (e.g. environment, natural resources, fisheries etc.) that are often poorly linked.

At a local level, the options for improving coordination in environmental management include creating a coordinating committee representing all sectors, making locally elected democratic institutions responsible for environment and development, or using groups like community-based organizations, women's groups or religious institutions.

Building capacities

Many countries are overtaxed by the Convention's competing demands and obligatory activities. Given this, it is important for countries to enhance their capacities (Box 3). The GEF's Capacity Development Initiative (CDI) is a welcome option but falls short of addressing or supporting actual activities, and its effectiveness is further limited because only phase I of the CDI has received approval of the GEF council.

The most important capacity needs to address synergies among the conventions are the capacities to:

- Develop inventories, perform monitoring and make systematic observations;
- Develop policy, plan effectively and reform legal frameworks;
- Perform impact assessments and research;
- Improve information, knowledge and data management;
- Perform reporting and monitoring; and
- Enhance education, training and public awareness.

Modifying national planning processes

Plans to implement the conventions can foster synergies if they meet the following conditions:

1) Plans should be consistent with national development goals.

2) Plans should identify the roles of the conventions and other commitments at national, regional and global levels.

3) Plans should identify areas where overlaps and conflicts can occur and suggest means of turning them into opportunities for synergies.

Given this, there are three possible approaches to the national planning process. The first option, which is not effective and does not foster synergies, is the development of separate plans for each agreement. Unfortunately this is the approach which receives both financial and political support. The second option is to develop a new umbrella plan incorporating elements of all agreements. This is a good choice provided the necessary institutional mechanisms for planning and implementation are in place. The final option is to develop a mechanism to integrate planning associated with the instruments into existing national plans and planning frameworks. This is the best option in the current situation but the capacities to do this are currently weak.

Strengthening the information base

Strong information systems, efficient networks and intelligent synthesis of information into knowledge equip a country to regularly assess the status and progress and plans for sustainable development, and is required for successful implementation of all of the agreements. Therefore, creation of this information base, and effective design to allow its use in planning and monitoring is required.

Countries and conventions should also understand that although information is power, on its own it can achieve little. Integrated planning to allow use of information, data and analyses for reporting and monitoring synergies is the key to success.

Conclusions

Agencies like the Secretaries to Conventions, UNDP, UNEP and others have started thinking about bringing synergies to action. Specific and joint work programmes should be developed as a part of JLG (joint liaison group) and

AHTEG (ad hoc technical expert group). A specific inter-agency working group with a mandate to address synergies in action must be established and linkages to on-going ground work be developed. Encouraging parties to submit innovative project ideas under the GEF's operational programme 12 (dealing with the ecosystem approach) should be explored. Countries should also be encouraged to specifically design programmes on synergies as a part of their national strategies and action plans.

At the national level, the agencies coordinating implementation of the UNFCCC must establish a joint working group involving stakeholders and focal points of the convention to discuss options and actions. The CDI must address the issue of synergies specifically and all National Capacity Self-Assessment (NCSA) activities must focus on this at the national level. Agencies mandated to implement the Millennium Development Goals (MDGs) and WSSD outcomes (WEHAB) must design processes on synergies soon, to allow their implementation. Identifying synergies at the local-level, and involving local communities in the implementation of the conventions and synergies is also critical.

Box 1 : Comparison of MEA Objectives

Convention on Biological Diversity (CBD)
"The objectives of this Convention 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…" (Article 1, CBD).

United Nations Framework Convention on Climate Change (UNFCCC)
"The ultimate objective of the Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." (Article 2, UNFCCC)

Convention to Combat Desertification (CCD)
"The objective of this Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective action at all levels with a view to contributing to the achievement of sustainable development in affected areas.

Achieving this objective will involve long-term integrated strategies that focus simultaneously, in affected areas, on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the local level." (Article 2, UNCCD).

Box 2: Possible adaptation strategies and the benefits they bring to each MEA

ISSUE	UNCCD	CBD	UNFCCC
Disaster planning framework: early warning systems, emergency measures to respond to floods, droughts, etc.	Help ensure protection of vulnerable communities (e.g., creating food and water reserves, cattle protection schemes).	Identification of fragile ecosystems and species prior to a crisis, to maximize protection during and following a disaster.	Determine priority measures to minimize loss of life and damage to livelihoods as a result of extreme weather events.
Integrated watershed management: agroforestry (firewood, fodder, annual crops), run-off harvesting for trees and range.	No over-exploitation of local water hence low salinization risk; run-off harvesting, terraces and trees conserve soil.	Conserves much of the watershed's biological diversity, utilizes parts of it thus contributing to overall sustainability.	Increases water retention and hence its availability in times of drought. Slows water movement, reducing the risk of flash floods. Maintains vegetation as carbon sink and reservoir.
Intensive greenhouse agriculture and aquaculture (cash crops, fish, industrial materials from algae).	High income per unit soil and water used, thus economizing on land and water resources.	Reduced pressure on land leaves habitats for in-situ biodiversity conservation, thus promoting its utilization.	Reduced pressure on land allows conservation of biodiversity resistant to climate change and maintains carbon sinks and reservoirs.
In-situ conservation of biological resources, wildlife conservation.	Potential for economic exploitation as an alternative livelihood; promotion of ecotourism.	Global benefits from dryland biodiversity assets.	Conservation of genetic diversity instrumental in restoring climate change damaged ecosystems.

Adapted from: Review of Activities for the Promotion and Strengthening of Relationships with other Relevant Conventions and Relevant International Organizations, institutions and Agencies. ICCD/COP3/9. 1999

Box 3: Common capacity needs across regions and across conventions

1. Low levels of awareness and knowledge limit the ability for discussion, decision-making and action.
2. Lack of information management, monitoring and observations hampers policy and decision-making.
3. Lack of synchronization of national policy, legal and regulatory frame-works leads to confusion between sectors and between national, regional and local levels.
4. Incentive systems and market instruments are inadequately developed.
5. Institutional mandates either overlap or have gaps, key institutions are not involved, and interactions between institutions are not always effective.
6. Science and technology are ineffectively mobilized in support of policy and decision-making.
7. Preparing for, skill in participating in, and reporting back on, international negotiations and agreements is weak.
8. Coordination, and processes for interaction within the country are poorly developed.
9. Cooperation and networking within regions is often lacking.
10. Individuals tend to be ineffectively deployed, mobilized, motivated or given responsibility.
11. Institutional effectiveness is hampered by weak management and resource constraints.
12. Lack of financial resources and technology.

Source: Country Capacity Development Needs and Priorities: A synthesis

Overview of the United Nations Framework Convention on Climate Change: Synergies with other Conventions

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Overview of UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC), a global commitment to address the threats of climate change, took effect in 1994 with over 180 Parties to the Convention. Grounded on the precautionary principle and the principle of common but differentiated responsibilities, the Convention aims "to achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that will prevent anthropogenic interference with the climate system." Under the Convention, developed country Parties should take the lead in combating climate change and assist developing countries shift their economies to become more sustainable through the provision of resources and technology transfer. Developing countries, on the other hand, are encouraged to achieve sustainable social and economic development.

The precautionary principle is one unique feature of the Convention. This is based on the notion that the lack of full scientific certainty should not be used as a reason for postponing measures, particularly if impacts would lead to irreversible damage. This principle has led to the promotion of 'no regrets' measures where social and economic benefits are achieved in addition to environmental ones. A case in point is the widespread dissemination of renewable energy and energy efficiency and the shift towards more fuel-efficient vehicles.

In 1997, Parties to the Convention adopted the Kyoto Protocol to strengthen the commitments to combat climate change through binding and quantifiable emissions reduction targets. Under the Protocol, industrialized countries aim at an aggregated reduction of greenhouse gas emissions of about 5% below 1990 levels during the first commitment period 2008 to 2012. To achieve this target, the Protocol provided market-based mechanisms such as the Clean Development Mechanism (CDM), permitting joint implementation and emissions trading in order for developed country Parties to achieve their

[*] *The ideas expressed in this paper are those of the author and do not necessarily represent the view of the secretariat of the UNFCCC.*

emissions target, while at the same time providing resources to developing countries and countries with economies in transition to promote sustainable development through environmentally-sound technologies and practices.

Status of implementation of UNFCCC at the country level

Developing countries (Non-Annex I Parties)

One of the key activities of the developing country Parties to the Convention is the preparation of their national communications containing information related to the inventory of greenhouse gas emissions, adaptation measures and public education and awareness programmes. To date, more than 130 developing country Parties have received funding assistance from the Global Environment Facility (GEF) to prepare their first national communications. Of these, eighty-five have already completed their first national communications. The 8th Conference of Parties (COP) of the UNFCCC held in New Delhi, India in 2002 adopted the guidelines for the preparation of national communications of non-Annex I Parties. The adoption of the revised guidelines paved the way for those developing countries that have completed their first and second national communications to proceed with the preparation of the succeeding national communications.

Developing countries are also in the process of assessing their technology needs with the assistance of the GEF, in order to identify sources and suppliers of environmentally-sound technologies and determine the modalities for acquisition and integration of these technologies. Twenty-five developing country Parties have completed their technology needs assessments. Least developed countries (LDC) have also received assistance to build human and institutional capacity and improve electronic communications. These countries are in the process of preparing the national adaptation programmes of action (NAPA) which will identify their immediate needs relating to vulnerability and adaptation to the impacts of climate change.

One of the major undertakings of developing country Parties is the implementation of national capacity self-assessment (NCSA) project. NCSA is a multifocal enabling activity involving the UNFCCC, Convention on Biodiversity and UN Convention to Combat Desertification. To date, more than 140 countries have initiated the NCSA process. It is expected that the results of NCSA will, in the case of the UNFCCC, lead to the implementation of the framework for capacity-building in developing countries. Capacity-building for the CDM is also one of the areas that developing countries are

actively pursuing. Agencies that have capacity-building programmes for CDM include the United Nations Industrial Development Organization (UNIDO), World Bank, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP) as well as other bilateral and multilateral institutions.

A host of adaptation and mitigation projects are being carried out in developing countries. From July 2001 to May 2002, the GEF has funded 59 climate change projects with a total of US$137 million. Since 1991, the GEF has provided US$1.5 billion in grants for climate change projects involving renewable energy and energy efficiency, adaptation projects, enabling activities to prepare the national communications, capacity-building, technology transfer, and special support for least developed countries. Other bilateral and multilateral agencies have also launched programmes to assist developing countries address the problem of climate change.

Developed country Parties and countries with economies in transition (Annex I Parties)

While all Parties are required to submit a report on their actions to implement the Convention, Annex I Parties provide more details and have tighter timeframe. Annex II Parties (developed countries) provide additional information on their resource contribution to the activities of the Convention such as technology transfer, capacity-building, support for least developed countries and public education and awareness programmes.

Annex I Parties are also actively engaged in developing policies and measures to address rising greenhouse gas emissions through the development and promotion of renewable energy, energy efficiency, fuel efficiency and carbon sequestration projects. In the case of countries with economies in transition (EIT), they are in the process of developing their institutional and technical capacities to conduct emissions trading and joint implementation projects. The private sector in developed countries is also actively engaged in the promotion of environmentally-sound technologies such as the Business Council for a Sustainable Energy Future.

Synergies between Conventions at the global and country levels

The Climate Convention calls on the Conference of the Parties to “seek and utilize…the services and cooperation of, and information provided by, competent international organizations and intergovernmental and non-

governmental bodies"(Article 7.2). This cooperation involves scientific bodies such as the Intergovernmental Panel on Climate Change (IPCC) and Global Climate Observing System (GCOS) and United Nations bodies such as the World Health Organization and Food and Agriculture Organization. The UNFCCC is also cooperating with the United Nations Convention to Combat Desertification, Convention on Biological Diversity and the Ramsar Convention on wetlands to exchange information and expertise on cross-cutting issues. A Joint Liaison Group (JLG) was formed between the Conventions to enhance the coordination and explore options for further cooperation, such as a joint work plan and workshops. The JLG also agreed to collaborate in the following areas: development and transfer of technologies, education and research, research and systematic observation, capacity-building, impacts and adaptation and reporting of national activities.

The JLG organized a joint exhibit at the World Summit on Sustainable Development in Johannesburg in 2002 to highlight the synergies between the Conventions. A joint calendar of events mandated by the CBD, UNCCD and UNFCCC was also published and posted in the three Conventions' web sites. At the seventh session of the COP, Parties to the Convention requested that the secretariat organize a workshop on synergies and cooperation with the other Conventions. The workshop will focus on addressing possible synergies and joint action with the other multilateral environmental conventions and agreements relating to food security, water resources and ecosystems. The other objectives of the workshop are: to prepare guidance to the national focal point of each convention, to contribute to enhancing coordination and communication among them, and to identify options to increase cooperation and capture synergies among the conventions using existing channels, particularly the exchange of information, in the identified priority areas of the JLG.

Capacity-building and cooperation issues

The framework for capacity-building in developing countries encourages bilateral and multilateral agencies and other international organizations to identify regional and subregional activities that can effectively and efficiently address common capacity-building needs in order to facilitate the exchange of information and cooperation (decision 2/CP.7). Attention given to capacity-building has increased significantly over the years. A review undertaken by the GEF implementing agencies to assess the role of capacity-building in GEF projects found that 96% of UNDP projects, 100% of UNEP projects and 86%

of World Bank projects have capacity development components. The proposed GEF Business Plan for 2004-2006 is expected to include a proposal to allocate at least 25% of its resources to capacity-building activities. While resources are being made available to capacity-building activities, they are not sufficient to address the priority needs of developing countries to build institutional, technical and human capacities.

The limited availability of resources to build and develop capacities necessitates the need for agencies and organizations to cooperate. However, on the ground, a different reality is apparent. Agencies and organizations continue to compete in accessing limited resources for their projects. This has resulted in limited coordination of activities which has led to duplication and overlaps in project implementation. Another challenge in implementing capacity-building activities is the issue of donor- versus country/regional-driven projects. While countries are encouraged to identify their priority capacity-building needs, the question is whether there are available funding opportunities to support the priority needs.

A continued dialogue between donors and the host countries is needed to ensure that capacity-building projects are consistent with national priorities. A one-size-fits-all formula of the donor agencies will not effectively address the needs of host countries. It is in this context that the COP7 decision on capacity-building in Marrakesh encourages bilateral and multilateral agencies and other intergovernmental organizations and institutions to consult with developing countries in formulating programmes and action plans to support capacity-building activities. On the other hand, in 2001 the GEF launched the national capacity self-assessment project to enable developing countries to assess their own capacity-building needs to address global environmental issues, specifically climate change, biodiversity and land degradation.

Issues and approaches for COP-9

The ninth Conference of Parties to be held in Milan, Italy from 1 to 12 December 2003 is expected to address key issues related to the implementation of the Convention and the preparations for the entry into force of the Kyoto Protocol. One of the key issues to be discussed at COP9 is guidance to the GEF on prioritised activities, programmes and measures to be funded under the special climate change fund (SCCF). SCCF was created under the Marrakesh Accords to finance activities, programmes and measures relating to climate change that are complementary to those funded by resources allocated to the climate change focal area of the GEF. This fund will

support activities related to climate change adaptation, transfer of technologies, energy, transport, industry, agriculture and waste management and activities to assist developing country Parties in diversifying their economies. The GEF is also expected to receive additional guidance relating to the implementation of the framework for capacity-building in developing countries and least developed countries and support for national communications of non-Annex I Parties.

It may conclude with COP decisions on additional requirements to complete the review and steps to enhance the implementation of the framework. The Subsidiary Body for Scientific and Technical Advise (SBSTA) will be developing the work programme of its two new agenda on: a) scientific, technical and socio-economic aspects of impacts of and vulnerability and adaptation to climate change and, b) scientific, technical and socio-economic aspects of mitigation. It will also develop definitions and modalities for including afforestation and reforestation activities under the CDM. The agenda item on technology transfer will discuss the results of the technical papers on enabling environments and capacity-building for technology transfer and agree on how to proceed with these issues. The Expert Group on Technology Transfer will also develop its work plan for the next two years relating to the implementation of the technology transfer framework.

Conclusions

Responding to a global problem like climate change requires concerted efforts among various stakeholders and institutions. Close collaboration with other multilateral environmental agreements is also required. The increasing need for synergies between Conventions is felt at the national and regional levels where most often governments, particularly in developing countries, have only one agency dealing with all the Conventions. Issues such as capacity-building, technology transfer and public education cut across not only the different sectors but also between Conventions. Closer coordination of activities between the Conventions will not only improve the effectiveness of implementation of activities but also improve the efficiency in utilization of limited resources.

The current efforts to conduct regular exchange of information through the JLG, as well as the publication of technical papers and use of workshops, strengthen cooperation among the Conventions. The NGOs and other stakeholders have a major role to play to make synergies happen at the ground level. The initiative of IUCN to explore synergies between climate change and

biodiversity through the planning processes of the national adaptation programmes of action, national action plans and the national biodiversity strategy at the regional level is a concrete contribution to this effort. There are other areas such as the preparation of national communications, national capacity self-assessments, and technology transfer where synergies may be promoted and implemented at the national or regional level. While collaboration between the Conventions is happening, donor agencies, NGOs and other stakeholders are also cooperating at the regional and national level to address global environmental problems. The next step is to link initiatives taking place at the global, regional and national levels to achieve the goals of the Conventions.

Vulnerability of Ecosystems and Species to Climate Change

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Introduction

Climate change is the most significant threat to human societies and the natural environment. It affects all areas of the globe, and effects in many regions may be severe (Green et al., 2002). The repercussions of climatic changes on ecosystems are likely to be considerable, particularly given that natural ecosystems are already affected by a multitude of other human-induced stressors. However, climate change rarely receives consideration in plans for the protection of threatened and endangered species or in other conservation plans. Without adequate understanding of the interrelationships between climate and biodiversity, activities to address these issues will be inadequate.

Activities to address climate change include adaptation measures, intended to enhance human and ecosystem capacities to cope with changing climate, and mitigation measures, which by sequestering carbon and reducing emissions aim to reduce the long-term impacts of climate change. Given that there is already evidence suggesting that species and ecosystems have been affected by climate change, the urgency of both adaptation and mitigation measures is incontestable. Likewise, current rates of biodiversity loss are unprecedented. Protection of the earth's biodiversity is critical to allow adaptation to climate change, and to maintain ecosystems and livelihoods that depend upon them.

Ecosystem responses to climate change

Ecosystems reflect their local climates. So as the climate changes, ecosystems too will change. These changes will occur at all scales, from increasing respiration rates driven by changes at the cellular level, to the biome level where boundaries will change over time due to altered precipitation patterns and changes in temperature. The genetic composition of species may be affected, and the composition of communities is likely to change (Malcolm et al., 1998). Given the uncertainties inherent in climate prediction and the tremendous complexity of biological systems, our understanding of how climate will affect ecosystems is quite rudimentary.

However, research suggests that rapid rates of global warming, particularly at high latitudes of the northern hemisphere, will lead to habitat loss. In addition, the rapidity of change may mean that species cannot shift their ranges fast enough, and rates of extinction are likely to rise even further. Rare species throughout the world, as well as species present in isolated patches like those found on islands, mountains or in fragmented habitats, are at a particularly high risk of extinction.

Observed impacts of climate change on ecosystems

The effects of climate change on ecosystems and biodiversity are no longer purely conceptual. Numerous impacts have already been attributed to anthropogenically induced climate change. The IPCC (Gitay et al., 2002) reviewed evidence from 44 studies that showed significant long-term trends in both temperature and a biological or physical parameter, as well as an interrelationship between these trends. The biological trends included changes in migration patterns, species distributions, body size and in the timing of the breeding season. Of these studies that showed an interrelationship between climate and biology, 80% of the studies showed a change consistent with climate change predictions, while 20% showed changes in an opposite direction. The conclusion of the IPCC is that there have been "discernable impacts of regional climate change, particularly increases in temperature, on biological systems in the 20th century" (Gitay et al., 2002).

The specific effects of climate change may, in some cases, seem inconsequential. For example, a shift in the northern limit of frog species and earlier spawning may not sound like important biological effects. However, when viewed from an ecosystem perspective, it is quickly apparent that these changes have potentially serious implications, like increased competition for resident species, or mismatches between the timing of hatching and availability of food supplies. Eventual consequences could include the loss of species and fundamentally altered ecosystems.

The frequency and intensity of pest outbreaks have also increased as a result of climate change - changes that are certainly not inconsequential. Increased temperatures led to a 50% increase in egg laying by the spruce budworm, leading to more severe outbreaks. Likewise, human populations have been affected as the distributions of water, food, and vector-borne diseases shift.

Human populations have been further affected by changes in the water cycle. Increased frequencies of droughts and floods in some regions, and timing of

hydrological events in others have changed as a result of climate change. These effects have major implications for agricultural productivity, as well as sustenance of natural ecosystems and dependent communities. Further, water quality and the integrity of aquatic ecosystems have been negatively impacted by these changes in some regions.

The projected impacts on natural ecosystems caused by climate change

Much more widespread effects are predicted as climate change continues. Changes in species' habitat or temperatures exceeding their thermal limits may force species migration. However, effects on individual species will differ. Some species may have broad tolerances, whereas others may tolerate only very specific conditions and will be rapidly extirpated. This means that assemblages of species will change, as intolerant species are rapidly forced out but long-lived and tolerant species persist, and new species begin to move in.

The tolerance of ecosystems to climate change will also differ. Regions where rapid climate change is predicted are quite vulnerable. Ecosystems overlying permafrost are in danger of ecological changes due to permafrost melting and consequent changes in hydrology. And increased frequency of coral bleaching events are expected because sea surface temperatures will exceed the narrow temperature tolerances of coral species. Mangroves, high mountain ecosystems, and remnant native grasslands are also quite vulnerable.

The complexity of ecosystems makes it impossible to predict exact effects of climate change. Ecosystems may be able to compensate for some losses of biodiversity, but the losses of some species may lead to fundamental changes. There may be losses in net productivity as ecosystems shift and adapt, particularly where dominant species or a high proportion of species are lost. Given the rapid rates of biodiversity loss due to habitat loss and habitat fragmentation, protecting habitat and improving ecosystem management is important to ensuring that an adequate capital of biodiversity is maintained to allow adaptation to climate change.

In regions where biodiversity is affected by climate change, local populations may suffer. Rural populations and indigenous populations are often highly dependent on ecosystems for provision of food, fibre and medicines, and the natural environment often plays a central role in cultural and spiritual practices.

Climate change mitigation

Fortunately, there is a suite of activities that can help limit the severity of climate change. Improvements in land use planning, including changes in agricultural and forestry practices, use of renewable energy sources, protecting carbon sinks like wetlands and forests, and creating new forests are all measures that could sequester carbon or reduce emissions rates. In doing so, these activities can significantly affect atmospheric concentrations of greenhouse gases, and consequently affect the rate and extent of climate change.

Many of these activities have strong links to biodiversity. In particular, activities to sequester carbon in vegetation and soils by changing the management of forests, grasslands and agricultural lands have the potential, if implemented wisely, to have significant cross-benefits for the protection of biodiversity. Likewise, the biodiversity and types of species managed are important to the permanence, and rate of carbon uptake.

Adaptation measures

Adaptation measures can encompass a wide range of activities intended to sustain ecosystems and human settlements. The necessary measures will depend upon the specific effects of climate change in a region, and the socioeconomic and environmental conditions of the area. Protection of biodiversity is one crucial aspect of adaptation, and is particularly important for rural and indigenous communities. Some options for adaptation measures that address biodiversity concerns include:

- Establishing interconnected terrestrial and aquatic (freshwater and marine) multiple-use reserves. These reserves should be designed to be resilient to climate change and allow species migrations as habitats shift. These reserves should also be designed to ensure sustenance of local livelihoods.
- Rehabilitating coastal ecosystems that can provide protection from tropical storms.
- Adjusting ecosystem management to address the multiple-stressors (e.g. habitat fragmentation, biodiversity loss and acid deposition in addition to climate change) impacting ecosystems, and managing ecosystems conservatively, to provide insurance against unanticipated consequences of climate change.

Conclusions

Through coordinated efforts to mitigate climate change and to help ensure that ecosystems and human populations can adapt, we can begin to address this most serious threat of climate change. But a holistic view that recognizes the importance of biodiversity to adaptation and mitigation is critical. Ecosystem management must account for all of the multitude of human stressors currently exerted on natural systems. This is critical to ensure that the burden does not become too great for ecosystems to sustain, and that ecosystems can continue to provide the services that we all depend upon.

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Climate Change and Biodiversity: Policy Synergy

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Introduction

Climate change is one of the most important global environmental issues impacting natural ecosystems and socio-economic systems. Climate change is linked to forest ecosystems in three ways: firstly, forest ecosystems through land use change contribute about 20% of the global CO_2 emissions; secondly, climate change is projected to adversely impact forest ecosystems; and thirdly, the forestry sector provides significant mitigation opportunities to address adverse impacts of climate change.

The forestry sector is closely linked to socio-economic systems, particularly to those of forest-dwellers and rural communities in developing countries. Projected climate change due to increased greenhouse gas (GHG) concentrations in the atmosphere will have impacts on forest ecosystems, affecting biodiversity, forest regeneration, growth rates and geographic distribution of plant species. All of these impacts will in turn affect the global environment as well as socio-economic systems. Forest-dependent communities (indigenous as well as agricultural) and their economies are likely to be adversely affected due to climate change. To minimize the adverse impacts of climate change, particularly on biodiversity and socio-economic systems, there is a need to plan and implement adaptation and mitigation strategies. Moreover, mitigation activities within the forestry sector are likely to have positive socio-economic impacts through rural employment generation and increased income generation. Further, climate mitigation activities will have positive environmental impacts such as biodiversity conservation and watershed protection. Policy initiatives incorporating climatic concerns into planning and implementation of forest conservation, afforestation and reforestation are needed, particularly in developing countries.

Similarly, loss of biodiversity is an important global environmental problem with both global and local implications. Global and national policy initiatives are needed to conserve biodiversity. In this paper, the linkages between climate change and biodiversity issues and the need for synergy in addressing both of these environmental concerns is highlighted from a developing country perspective, focusing on India.

Climate change and impacts

The Intergovernmental Panel on Climate Change (IPCC) projects that the global mean temperature is likely to increase between 1.4 to 5.8°C by 2100. Projections show both regional increases and decreases in precipitation over land areas at low latitudes. Considerable year-to-year variation in total precipitation and in summer monsoon precipitation are also predicted. Regional changes in climate, particularly increases in temperature, have already affected hydrological, marine and terrestrial systems in many parts of the world (IPCC, 2001). Observed effects include a lengthening of the growing season, particularly at higher latitudes, changes in flowering patterns, changes in the timing of bird migration and breeding, and increases in the severity and frequency of floods and droughts.

Some of the potential impacts of climate change on forest ecosystems as summarized in the Third Assessment Report of the IPCC include:

- a greater risk to populations of many threatened species due to the synergy between changing climate and land-use change;
- alteration of species composition and dominance, resulting in ecosystem changes;
- extinction of some "critically endangered" species;
- replacement of wetlands by forests or heath lands;
- productivity gains due to changes in climate parameters as well as changes in uses and management of land.

The vulnerability of forest ecosystems and socio-economic systems to climate change can be understood by observing impacts on biodiversity, wood production, terrestrial carbon sinks, water resources and human health.

Impacts of climate change on biodiversity and forest productivity

Increases in temperature and changes in precipitation patterns are primary manifestations of climate change. Resulting impacts on biodiversity remain quite speculative due to the dynamic interactions among species in an ecosystem. Major changes in vegetation types especially at high latitudes are predicted, as are changes in the growth and regeneration capacity of forests. Finally, a decline in the standing biomass of forests is predicted due to increased frequency of fires and outbreaks of pests and pathogens. However,

climate change will not function in isolation. Regional biodiversity will also be affected by habitat degradation, loss and fragmentation and the introduction of exotic species.

As a result of increased ambient temperature and given the availability of sufficient moisture and nutrients, an increase in plant productivity is predicted. However, without an increase in precipitation that will compensate for increased evapo-transpiration at higher temperatures, water stress will result in lower growth rates, tissue damage and mortality (Fitter and Hay, 1987).

In addition, higher atmospheric concentrations of CO_2 may affect productivity, but this relationship is complex and controversial (Krischbaum et al., 1996). According to the Second Assessment Report of the IPCC, ecological productivity and biodiversity will be altered by climate change and sea-level rise. In the tropical rangelands, major alterations in forest productivity and species composition are projected to occur due to altered rainfall, seasonality and increased evapo-transpiration (Watson et al., 1996 and 1998). An increase in forest species turnover is indicated, potentially resulting in large-scale decline of biodiversity and extinction of species (Philips and Gentry, 1994). The Second Assessment Report also projects changes in growing stock, supply of wood and the extent of forest area, by considering the combined effect of climate change and socio-economic pressure.

Impacts of climate change on forest ecosystems in Asia

The forests in Asia, especially in the tropics, are rich in biodiversity. However, biodiversity is being lost or endangered in these areas because of land degradation and overuse of resources. In fact, about 10% of the species in the Himalayas were listed as threatened in 1995. This is of particular concern given that 10% of the world's high altitude plant and animal species occur in this area.

The IPCC has projected the following impacts of climate change on biodiversity and vulnerable ecosystems in Asia:

- shift of species to higher elevations;
- increased erosion and overland flows in highly dissected and steep terrain of the Himalayan mountain ranges;
- large shifts in species ranges within boreal forests over the next 50 years and pole-ward shift of species in temperate Asia;

- increased frequency and intensity of forest fires and pest outbreaks in the boreal forests;
- increased vulnerability of mangroves such as those in the Sunderbans; and
- exacerbated stress on rangelands on which humans and livestock depend, with projected decreases in productivity.

A study on the impact of climate change in the Western Ghats (Uttara Kannada and Nilgiris) based on a simple model, correlating climatic (mean temperature and precipitation) and vegetation types, predicts a change in the area of different forest types under different scenarios (Ravindranath et al., 1997). Under the *most likely climate scenario,* which predicts increased temperature and precipitation, a shift towards moister types of vegetation is projected for the years 2020 and 2050 for Uttara Kannada in the Western Ghats, resulting in loss of area of the drier forest habitats. Similarly, in the Nilgiris, a sequential shift from dry deciduous to moist deciduous then to wet evergreen forests is predicted, with increases in moisture availability as a result of increasing rainfall. Under the worst-case scenario, with increased temperature and decreased precipitation, the drier forest types of Uttara Kannada are expected to increase in area, at the expense of moister forest types by 2050. A similar trend is projected for the Nilgiris also, where drier forest types increase at the expense of dry deciduous forests. A similar study in Himachal Pradesh projects that certain biomes such as the evergreen warm mixed forests and taiga are likely to show marked expansion in areas and some economically and socially important species such as Deodar, Cedar and Oak will decline.

Thus, preliminary studies of climate impacts on forests at the regional level show that the most likely climate change scenarios will have impacts on forests, leading to shifts in forest types. In such a scenario, forests may experience large-scale dieback with serious implications for biodiversity and timber production.

Forest policies, programmes and implications for biodiversity in India

India's Forest Policy of 1952 focused on promotion of timber production for revenue generation. Subsequently, the National Commission on Agriculture (1976) recommended the implementation of a social forestry programme to decrease pressure on forests and increase production, specifically, to increase

the supply of fuelwood, small timber and minor forest produce to rural communities. However, this programme was dominated by exotics with no focus on biodiversity. The most important forestry initiative of the Government of India is the Forest Conservation Act of 1980, which has contributed to biodiversity conservation by reducing the rate at which forests have been converted to other land uses. The Forest Policy of 1988 also indirectly addressed the issue of biodiversity conservation by emphasizing environmental stability and maintenance of ecological balance. The June 1990 Guidelines and the revised 2000 Guidelines on Joint Forest Management (JFM) are progressive measures that have had significant impacts on the regeneration of degraded lands and positive implications for biodiversity. Under the Tenth Five-Year plan, several thrust areas were also identified. Finally, the National Forestry Action Plan is a strategic long-term plan addressing conservation and regeneration.

Numerous other initiatives have also contributed to the protection of biodiversity. These include:

- The establishment of Protected Areas (PA) and Biosphere Reserves which have helped reduce development and commercial pressures and have placed an emphasis on conservation and sustainable use of biodiversity;
- The creation of National Parks and Sanctuaries with the aim of conserving the last remaining pristine habitats and improving existing habitats;
- Eco-development projects;
- Coastal-shelterbelt programmes; and
- Plantation projects (bamboo and medicinal plants).

The relative success in forest conservation and large reforestation programmes in India indicates that the country has the necessary institutions and capacity to plan as well as implement adaptation measures to enhance forest resilience and to minimize the adverse impacts of projected changes in climate on forests. However, new strategies need to be adopted that would not only help mitigate climate change impacts but also promote biodiversity conservation by reducing the pressure on forests. This would in turn enhance forest resilience to climatic stresses (Secrett, 1996).

Climate change mitigation and biodiversity

Climate change mitigation refers to efforts taken for prevention of climate change itself and hence future climate impacts. The forest sector, according to the Third Assessment Report of the IPCC, has the potential to offset 10 - 20% of the CO_2 emissions during the 21st century.

The three broad categories of mitigation in forest or other biological sectors include:

- conserving existing carbon sinks (e.g. by encouraging forest conservation or halting deforestation);
- expanding carbon sinks (e.g. by afforestation and reforestation in degraded lands);
- substituting fossil fuel energy with sustainable energy (e.g. bioenergy).

Globally, efforts are being made in each of these sectors to enhance mitigation.

Environmental and socio-economic benefits of forestry mitigation measures

All potential forestry sector mitigation activities, apart from meeting biomass needs, will contribute to significant socio-economic and environmental benefits. For example, afforestation and reforestation in degraded lands with appropriate guidelines would lead to biodiversity conservation and watershed protection. These mitigation sector activities would also enable communities to meet their needs of fuelwood, industrial wood and sawn wood, if sustainable rates of biomass extraction are adopted. Non-timber forest products including fodder, fruits, oil seeds, leaves, gum, rattan and honey would also be available to local communities. In addition, because forestry sector activities are labour-intensive, they will create rural employment in establishing, protecting and maintaining forests or plantations. Establishing forests in degraded lands will also enhance the carbon sinks in the soil, standing vegetation and stored wood products.

Biodiversity conservation, watershed protection and climate change mitigation can also be achieved by slowing deforestation, and shifting to the use of sustainable logging and reduced impact logging practices. Clearly, effective mitigation activities in the forestry sector can provide socio-economic and environmental benefits, indicating that a conflict need not exist between the

global benefits and the local or national socio-economic and environmental benefits in climate mitigation projects (Ravindranath and Indu, 2002). Therefore, developing countries should incorporate climate change concerns, particularly mitigation benefits, into their forest conservation, reforestation and afforestation programmes.

Climate change adaptation activities and biodiversity

Adaptation is necessary to minimize climate change impacts. Adaptation may enable coping with the impacts, reduce vulnerability to impacts or enhance resilience of ecosystems and communities. Forest conservation and development strategies are necessary to allow adaptation to climate change; however, adaptation activities should be carefully selected to ensure that the goals of sustainable development and biodiversity conservation are adequately addressed. Policy response to climate change could be of four types, based on the approach to adaptation:

i) Maintenance of status quo: Such responses carry the risk of high adaptation costs in the future and could result in irreversible changes to biodiversity.

ii) No regret strategies: Such strategies could minimize the difficulties associated with having to choose between current consumption needs and long-term protection of forests. Promotion of natural regeneration in degraded lands, conservation of forests and adoption of sustainable harvest practices are some of the no regret strategies that could help communities adapt to climate change as well as protect forests. These may not involve additional costs and need to be adopted to address current pressures or threats.

iii) Precautionary measures: Precautionary measures combat predicted adverse impacts on forests. They help promote and enhance forest resilience but incorporate a degree of uncertainty. Precautionary measures should have no adverse ecological or socio-economic impacts and should be feasible and cost-effective. Precautionary measures could involve conservation and anticipatory planting of threatened species.

iv) Pro-active strategies: This set of strategies is wholly aimed at mitigating the adverse impacts of climate change. These measures are implemented with the assumption that climate change impacts will be adverse and measures need to be taken to prevent species extinction or large-scale

forest dieback. Some examples of such measures are the provision of corridors for species migration and shortening the rotation periods of plantations to reduce the risk of exposing mature timber stocks to deteriorating conditions.

Climate change, biodiversity conservation and sustainable development

Mitigation of climate change and conservation of biodiversity cannot be addressed in isolation from development. Sustainable development strategies are known to contribute to mitigation of climate change and conservation of biodiversity. For instance, forest conservation or reforestation with mixed species would not only increase biomass and conserve biodiversity but would also increase carbon sinks. Shifting to renewable energy sources such as bioenergy would help conserve biomass, by reducing pressure on wood resources and thereby reduce CO_2 emissions and pollution. There is therefore a need to realize the linkage between environmental problems and sustainable development needs. Shifting to Environmentally Sustainable Technologies (ESTs), encouraging sustainable use of natural resources, and using a participatory approach to development are some of the strategies available to address adverse impacts of climate change as well as biodiversity and development concerns.

The protection, restoration or establishment of biologically diverse ecosystems that provide important goods and services may constitute an important adaptation measure to supplement existing goods and services in anticipation of increased pressures or demand, or to compensate for likely losses (http://www.biodiv.org/programmes/cross-cutting/climate/interlinkages.asp). For example, protection or restoration of mangroves can offer increased protection of coastal areas to sea level rise and extreme weather events while rehabilitation of upland forests and wetlands can help regulate flow in watersheds, thereby moderating floods from heavy rain and ameliorating water quality. Similarly, conservation of natural habitats such as primary forests, with high ecosystem resilience, may decrease losses of biodiversity due to climate change and compensate for losses in other less resilient areas.

Natural processes are often non-linear and the impacts of environmental change often show time lags, leading to surprises and uncertainties. Management must therefore be adaptive in order to be able to respond to such uncertainties and contain elements of “learning-by-doing” or research

feedback. The ecosystem approach, as adopted by the Conference of the Parties to the Convention on Biological Diversity, provides a framework for adaptive management in the face of climate change. This approach involves a focus on the functional relationships and processes within ecosystems, and acknowledgment of the full range of goods and service provided by ecosystems.

Conclusions

Climate change and loss of biodiversity are two of the most important global environmental problems. They have serious local implications as well. Synergy exists in measures to be taken for addressing climate change as well as biodiversity concerns. In addition, both must be considered in the context of sustainable development. Addressing biodiversity, climate change and sustainable development concerns requires long-term policy interventions. However, effective implementation of necessary strategies is possible only if appropriate institutional structures are available and if barriers that impede effective implementation can be overcome.

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An Integrated Climate Risk Management Approach to Disaster Reduction and Adaptation to Climate Change

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Paper based on UNDP Expert Group Meeting on
"Integrating Disaster Reduction with Adaptation to Climate Change"
19-21 June, 2002,
Havana, Cuba

Disaster losses and unsustainable development

Disaster occurrence and losses associated with extreme and not so extreme climate events have increased dramatically in recent years. While many of the emerging patterns of disaster risk associated with natural hazards show no tendency to increases in magnitude and recurrence, human interventions in the natural environment are generating new socio-natural hazards, mainly associated with climate events. In many incidences of flooding, landslides, drought, forest fires and coastal erosion, environmental degradation has transformed natural resources into new hazards. At the same time, the social, economic, territorial, physical and political vulnerability of populations in many developing countries continues to worsen, weakening their capacity to absorb the impact of, and recover from extreme climate events.

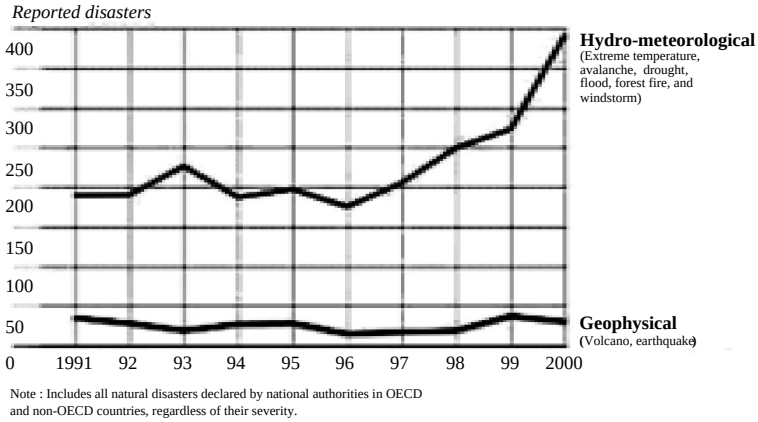

Figure 1: Reported hydro-meteorological and geophysical disasters world-wide from 1991-2000. (From Center for Research on the Epidemiology of Disasters)

Rapidly increasing levels of disaster losses are beginning to outweigh development gains in a number of countries. This is particularly the case in the small island developing states (SIDS). It is now very clear that flawed development and environmental practices are at the root of much of the new disaster risk. The achievement of the UN Millennium Goals in areas such as poverty reduction, health and education will be impossible unless concerted efforts are made to manage and reduce the disaster risks associated with potentially damaging climatic events.

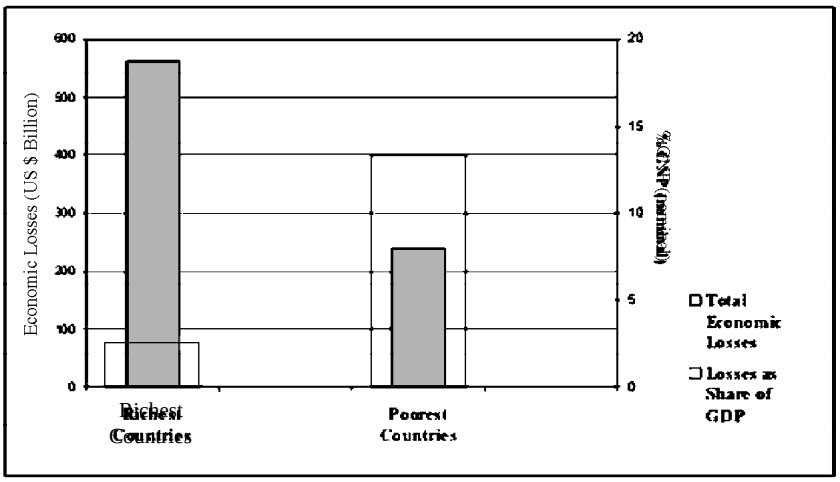

Figure 2: Disaster Losses, Total and as Share of GDP, 1985-99 (from Munich Reinsurance Company, Annual Review of Natural Catastrophes 1999. Munich: 2000). Richest countries are defined as having a per capita annual gross domestic product greater than $9,361, while poorest countries are defined as those with less than $760.

Global change, complexity and uncertainty

Processes of global change are adding new and intractable dimensions to the problems of risk accumulation, disaster occurrence and losses associated with climatic events. Due to global change, rapid and turbulent changes in risk patterns in a given region are rarely autonomously generated, and may in numerous cases be caused by economic decisions made on the other side of the globe. This territorial complexity of causal factors extends down to include the impacts of national, sectoral and territorial development policies on regions and localities.

The scientific evidence that climate is changing due to greenhouse gas emissions is now incontestable. It is equally well accepted that climate change will alter the severity, frequency and spatial distribution of climate-related hazards. However, even while the modelling of the linkages between global climate change and extreme climate events becomes increasingly sophisticated, it is still not possible to predict with any degree of confidence how particular climate events in specific locations will behave in the future. Even with regular and relatively well-understood climate phenomenon like ENSO, considerable regional and temporal variation in impacts are observed from event to event.

Humans have gradually and spontaneously been adapting to variations in climate. However, the rapid accumulation of climate-related risk in recent decades and the resulting patterns of loss point to a loss of effectiveness and even breakdown in spontaneous adaptation. As the range of hazards and vulnerabilities faced by any given community increases, it often becomes possible only to play one kind of risk scenario off against another in search of a "less worse" scenario. The processes of global change have stacked the odds even higher against successful adaptation. As the causal processes of risk become increasingly global, the options available to local communities and other local stakeholders to influence risk generation processes become increasingly restricted, if not entirely non-existent.

Risk management strategies

Different approaches to manage and reduce climate-related risks have been used by the humanitarian, development, environmental and climate change communities.

Since the 1970s, the discourse within the broader disaster risk management community has undergone a gradual paradigm shift from managing responses to improving preparedness, then to hazard mitigation, vulnerability reduction and finally to integrated disaster risk management. The risk-conscious development community has also attempted to promote more integrated schemes where risk considerations are factored into development programs. And, the environmental community has increasingly seen the relevance of environmental management and good resource use for hazard control and reduction.

However, despite the awareness raised by the UN International Decade of Natural Disaster Reduction (IDNDR) in the 1990s, disaster risks have continued to accumulate. Most national and international efforts continue to

be fundamentally focused on preparedness and response. However, a large number of successful projects in Asia, Latin America, the Caribbean and Africa in which different risk management approaches were piloted, have built up a substantial body of knowledge on the theory and practice of risk management. These experiences provide a glimpse into the future of risk management, if they are to be mainstreamed and applied as part of an integrated programme.

In parallel, the scientists and organizations examining the problem of global climate change have gradually expanded their approach from an initial concern with the causes of climate change to addressing its potential effects using modelling. For example, efforts first focussed on quantifying sea level rise and increased risk of desertification have now moved towards addressing how societies and economies can adapt to changing climatic conditions. This has led to international efforts through the UNFCCC to mitigate climate change through reduction of greenhouse gas emissions, the assessment of countries' vulnerabilities to climate change and the design of adaptation strategies. In recent years, there has been an increasing commitment to adaptation rather than just mitigation.

Like the disaster risk management community has failed to substantially move beyond response and preparedness, the climate change community has also not moved beyond fairly theoretical formulations of vulnerability and adaptation towards concrete plans and programmes of action.

In many developing countries there exist totally separate institutional systems for promoting adaptation to climate change and managing disaster risks. As a result, the efforts to design strategies to adapt societies to the effects of climate change remain fundamentally divorced from national and international efforts to manage the disaster risks associated with extreme climate events. At the international level, it is only recently that a search for synergy between objectives and institutional frameworks has been sought with regard to the UN conventions on wetlands, biodiversity, global climatic change and desertification.

The lack of capacity to manage and adapt to climate-related risks is already a central development issue in many developing countries, particularly in SIDS. And the lack of capacity to manage the risks associated with current climate variability is the same lack of capacity that will inhibit countries from addressing the future increases in the complexity and uncertainty of risk due to global climate change. Strengthening national and local capacities to manage current climate-related risks is the best strategy to enable management

of more complex risks in the future. It is also more feasible to mobilise national and international political and financial resources to manage existing risk scenarios than to address hypothetical future scenarios. Medium and long-term adaptation must begin immediately, with efforts to improve current risk management and adaptation practices. Learning from current practices and maintaining a commitment to ongoing learning can help build the necessary capacity to manage future risks.

Integrated climate risk management

Integrated climate risk management addresses both the hazards and vulnerabilities of particular risk scenarios. It can be used to manage the local manifestations of global climate risk through to global measures to reduce hazard (for example, by reducing greenhouse gas emissions) and to reduce vulnerability (for example, by increasing the social and economic resilience of vulnerable countries such as SIDS). Integrated climate risk management would need to include elements of anticipatory risk management (ensuring that future development reduces rather than increases risk), compensatory risk management (actions to mitigate the losses associated with existing risk) and reactive risk management (ensuring that risk is not reconstructed after disaster events). Moreover, it will have to take into account potential impacts on socio-economic and environmental systems.

Integrated climate risk management could provide a framework to allow the disaster community to move beyond its focus on preparedness and response and to allow the adaptation community to move beyond the design of hypothetical future adaptation strategies. In some regions, such as the Caribbean and the South Pacific, synergy such as this is already being achieved. However, urgent actions must be taken at the international, national and local levels if integrated climate risk management is to move from a concept to practice and serve to reduce risks and protect development.

The United Nations should promote an integrated international framework and partnership for risk management, which incorporates elements of existing frameworks for addressing climate change, disaster reduction, desertification and builds upon them. Such a risk management framework needs to start from a clear concept that climate-related risks are among the central development issues of our time and that the achievement of the UN Millennium Goals will not be possible unless climate-related risks are managed and reduced. The current proliferation of parallel international frameworks and programming mechanisms for addressing what is a holistic development issue is

counterproductive to the goals of strengthening national capacities and managing and reducing climate-related risks.

At the national level, integrated climate risk management strategies, plans and programmes need to be built on the dispersed institutional and administrative mechanisms, projects, and human and financial resources that are currently applied to disaster risk management, adaptation to climate change, and other related areas such as desertification. The United Nations should develop new programming mechanisms and tools to promote integrated national climate risk management programmes as well as resource mobilization strategies to ensure that such programmes can be adequately funded.

Ultimately, integrated climate risk management needs to take root at the local level. Most climate-related disasters are small to medium in scale and have spatially delimited local impacts. Risk is manifested and losses occur at the local level and it is at this level that national and international support to integrated climate risk management has to be realised and capacities strengthened. At the same time, cooperation at national and international levels is required given the diverse territorial base of risk causation.

Conclusions

Climate-related risks aggravated by processes of global economic change and climatic change present a central unresolved development issue for many countries. Unless such risks can be managed and reduced, the achievement of the UN Millennium Goals will be impossible.

Current approaches towards managing disaster risks and managing adaptation to climate change fail to address the issue for different reasons. Disaster risk management is still predominantly focused on responses following disaster events and fails to address the configuration of hazards, vulnerabilities and risks. Moreover, mono hazard approaches still prevail and there is still a great deal to do in order to bring risk management and sustainable development concerns and practices together. Adaptation activities focus on the impacts of future climatic changes on risk but fail to make a connection with current climate-related risks and patterns. At the same time, climate adaptation and disaster risk management are not adequately integrated in terms of the institutional arrangements or programme mechanisms at the national and international levels.

To foster continued development in countries affected by climatic risks, an integrated approach to climate risk management needs to be promoted. This

approach should be built upon successful approaches piloted by the disaster risk management community that can be mainstreamed into national strategies and programmes. Addressing and managing climate risk as it is currently manifested is the most appropriate way to strengthen capacities to deal with changing climate in the future.

Vulnerability of Indian Agriculture to Climate Change and Economic Changes

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Introduction

Agriculture and associated activities constitute the single largest component of India's economy, contributing nearly 30% of the total gross domestic product. The tremendous importance of agriculture to the Indian economy can be gauged by the fact that according to the 1991 census, 68% of the workforce was dependent on this sector. The share of agricultural products in export earnings is also substantial, with agriculture accounting for 21% of total national exports (GOI 1997). As such, any adverse effects on agriculture could have serious impacts on the economy, employment and more importantly, poverty.

Agricultural productivity is sensitive to two broad classes of climate-induced effects: direct effects from changes in temperature, precipitation, or carbon dioxide concentrations, and indirect effects due to changes in soils or changes in the incidence of disease or pest infestation. However, the vulnerability of agricultural production to climate change depends not only on the physiological response of affected plants, but also on the ability of the affected socioeconomic systems of production to cope with changes in yield, and changes in the frequency of droughts and floods.

The studies that have been done on agriculture in India can be classified into two categories: physical impact studies and economic impact studies. Most of the studies in the first category analyze the physical impacts of climate change on rice and wheat production in India. However, these studies do not attempt to assess the associated socioeconomic impacts, which would be influenced by the interaction between producer and consumer behaviour as well as the possible adaptations that farmers could undertake in response to climate change. Examples of physical impact studies include:

- Sanghi et al. (1998) attempt to incorporate adaptation options while estimating agricultural impacts. They calculate that a 2^0C rise in mean temperature and a 7% increase in mean precipitation would reduce net revenues by 12.3% for the country as a whole.
- Kumar and Parikh (1998) also show that the economic impacts would be significant even after accounting for farm-level adaptation. The loss in farm level net revenue is estimated to range between 9% and 25% for a temperature rise of 2^0C-3.5^0C.

At the same time, the economic context in which climate change is taking place is constantly evolving. Globalization of the Indian economy has had important effects on the agricultural sector. Some regions and farmers have been able to benefit from market liberalization, as well as from new inflows of investments and technology. Others have had difficulty adjusting to the new open economy, particularly to the pricing effects of increased agricultural imports.

The combined impacts of climate change and economic globalization on agriculture are of great concern to India. Little analysis has been done so far on the combined impacts of these two global processes on India's social, environmental and economic well-being.

It is projected that climate change threatens local environments and agricultural practices in India, and thus the livelihoods of rural communities. More broadly, it will affect national food security and human health. As a result, there is an urgent need to assess the vulnerability of Indian agriculture to climate change and to identify priorities for adaptation. This paper describes an integrated methodology to assess the vulnerability of Indian agriculture to climate change at a district-level, in the context of ongoing economic changes.

Methods

A four-stage approach is described, which includes a macro-level vulnerability profile based on GIS (geographical information systems), village-level case studies, integrated assessment of macro and micro results, and a domestic policy analysis. The macro-level analysis uses GIS to identify areas that are vulnerable to both climate change and economic globalization (defined here as trade liberalization). A district-level base index incorporates indicators of biophysical vulnerability and social vulnerability. This is overlaid with a climate sensitivity index to generate a map of vulnerability to climate change. The base index is also overlaid with a trade sensitivity index to generate a

corresponding map of vulnerability to economic globalization. Finally, to study the micro-level implications of vulnerability, a case study was conducted in Jhalawar district, Rajasthan. This paper draws upon the findings of the case study to highlight how farmers cope with climatic variability, and identifies key economic factors that might enhance or constrain their ability to adapt to climate change.

GIS has been used as a tool to map vulnerability of the agricultural sector to multiple stressors at the district level. The macro-analysis identifies areas that are vulnerable to both climate change and economic globalization. GIS databases for climate, bio-physical, social and technological indices at district level were developed. All of the relevant information was brought into a GIS domain and integrated with non-spatial data for 466 spatial units (i.e. districts).

A district-level base index was developed that incorporates indicators of biophysical vulnerability (soil cover and degradation, groundwater exploitation, and flooding) and social vulnerability (occupational status, literacy, infrastructure development, and gender discrimination). This was overlaid with a climate sensitivity index (based on rainfall variability and dryness) to generate a map of vulnerability to climate change (Figure 1). The base index was also overlaid with a trade sensitivity index (based on port distance and cropping pattern) to generate a corresponding map of vulnerability to economic globalization (Figure 2).

By overlaying these two maps, vulnerability hot spots within the Indian land mass were identified (Figure 3). This method has been used to assess differential vulnerability for any particular sector in a region and serves as a basis for targeting policy interventions.

Detailed case studies were completed in the identified hot spots using a participatory approach. The approach involved a detailed questionnaire survey, group discussions and interviews with villagers, and individualized meetings with village heads and district officials.

Results and discussion

India is particularly vulnerable to climate change due to its dependence on agriculture and due to its seasonal weather patterns and extreme weather events. This vulnerability is further redefined due to its interactions on trade at the global level. Based on the methods defined above, climate sensitivity was mapped (Figure 1). India's vulnerability to climate change was mapped based on a derived index, the Climate Sensitivity Index (CSI) of Dryness and

Monsoon Dependency. The increasing number of districts in higher CSI categories in Uttar Pradesh and Uttaranchal is a cause for concern. It covers the Indo-gangetic plain that is currently a highly fertile region. A combination of other indicators were used to define socioeconomic conditions, technological development and biophysical status and develop the globalization vulnerability index.

Case study findings from the Rajasthan survey indicate that the district's population is highly vulnerable due to their heavy reliance on agriculture, the region's high climatic variability, as well as limited infrastructure development and because access to resources like irrigation are available only within limited areas.

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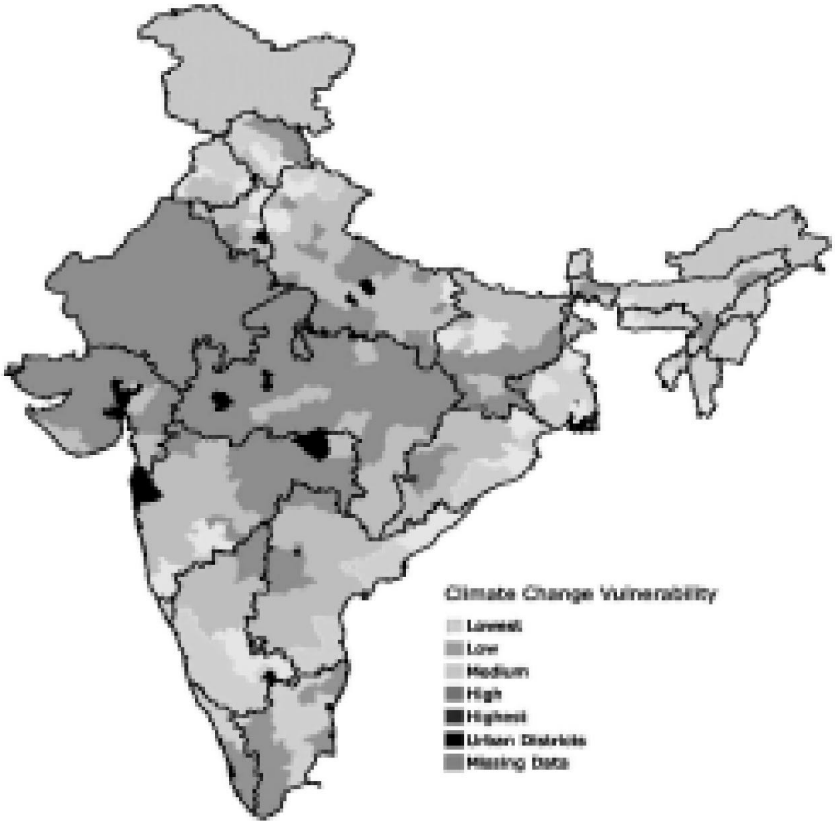

Figure 1: Climate change vulnerability map

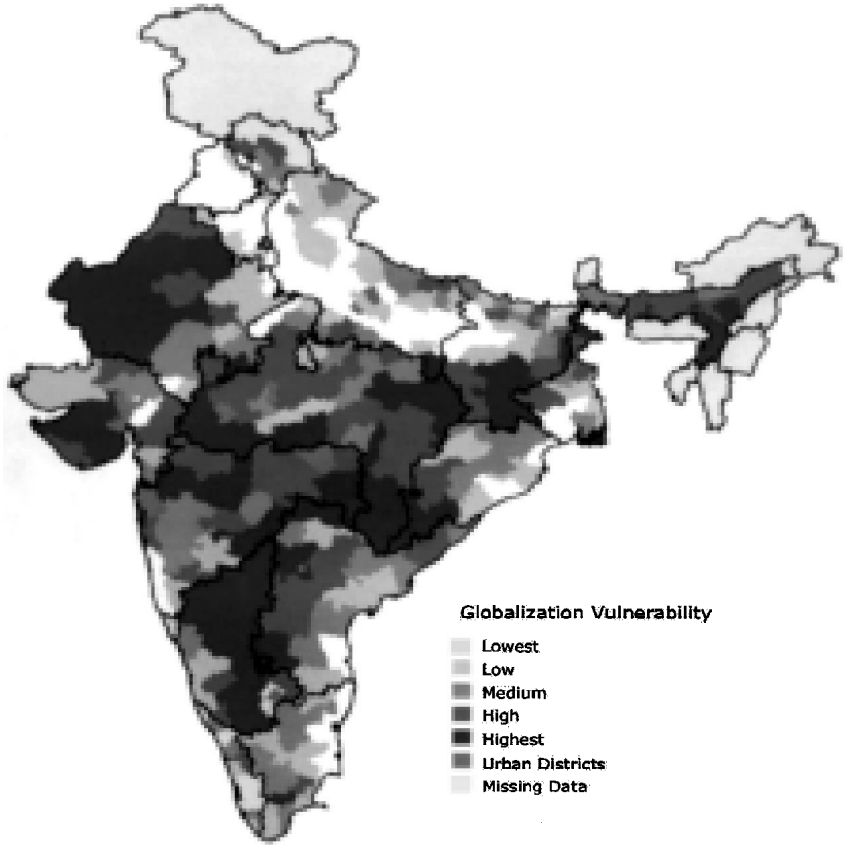

Figure 2: Globalisation vulnerability map

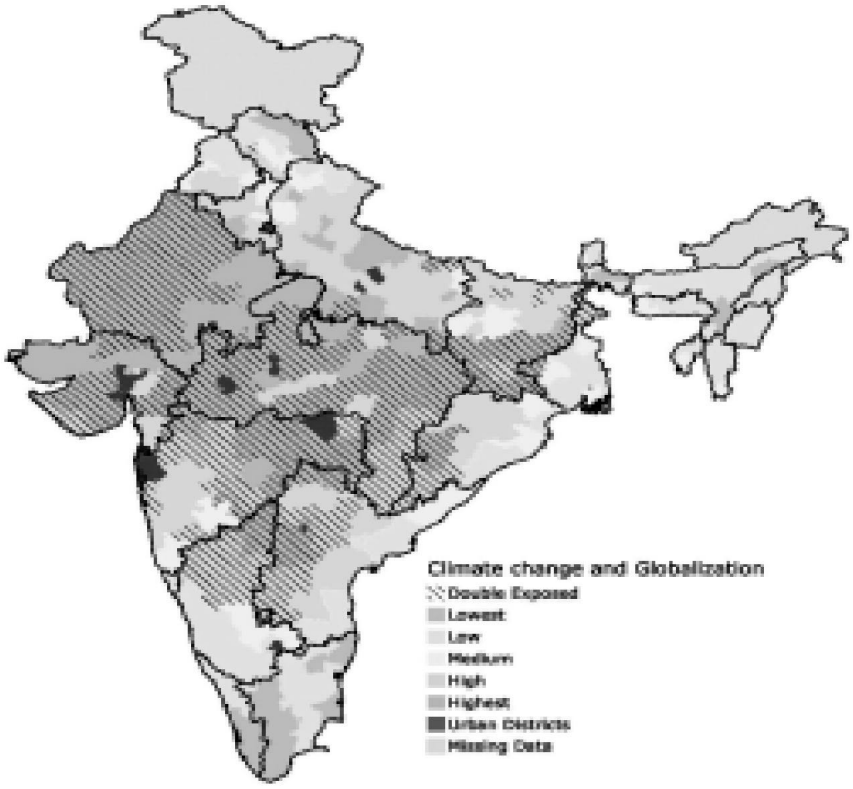

Figure 3: Map highlighting regions of "double exposure"

Impacts of Climate Change on Biodiversity: Techniques and Tools for Mitigation

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Introduction

Human activities have led to changes in ecosystems and attendant loss of biodiversity in many regions (IPCC 2002). Available observational evidence indicates that regional changes in climate, particularly increases in temperature, have affected a diverse set of physical and biological systems in many parts of the world. Examples of observed changes include shrinking glaciers, earlier break up of ice on rivers and lakes, lengthening of mid to high latitude growing seasons, poleward and altitudinal shifts in the ranges of some plant and animal species, declines in some plant and animal populations and earlier flowering of trees and emergence of insects and egg-laying of birds. In fact, from the collective evidence there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems.

As a result of changing climate, ecosystem services that are crucial to human survival may be affected, or may have already been affected. Of particular concern is the critical role of ecosystems in global biogeochemical processes that underline the functioning of the earth's systems. Of further concern is the potential that indigenous and rural communities may lose access to services like food, fibre, fuel, energy, fodder and medicines, and the consequences of biodiversity loss to cultural, spiritual, aesthetic and recreational values.

The effects of climate change and biodiversity loss will not operate in isolation, but rather must be understood in the context of global change, incorporating pressures such as increased demand for natural resources (including water), exploitation or destruction of biodiversity through human activities, land use change, pollution, and the destruction of the ozone layer.

Climate change impacts on water resources and biodiversity

Approximately 1.7 billion people, one third of the world's population, presently live in countries that are water stressed (defined as using more than 20% of their renewable water supply). Demand for water is generally increasing due to population growth and economic development. In addition,

climate change may substantially affect irrigation withdrawals. Higher temperatures will lead to higher crop evaporative demands, but overall effects on withdrawal will depend on how increases in evaporation are offset by changes in precipitation. However, the general tendency will be towards an increase in irrigation demands.

As a result of increased temperature and reduced flow, water quality within streams and rivers will generally be degraded. In addition, changes in hydrological processes will affect many wetland habitats. For example, about 20% of coastal wetlands could be lost by 2030 as a result of sea level rise. And, increased temperatures are expected to lead to widespread coral bleaching. Associated with these changes are likely to be major losses of biodiversity.

Tools and techniques for addressing climate change

Broadly, the two tools to address to climate change are mitigation and adaptation. Mitigation is defined as a human intervention to reduce net greenhouse gas emissions, or to increase sequestration of CO_2 through sinks such as forests. Adaptation to climate change, particularly at the community level, can supplement mitigation measures, and reduce the adverse impacts of climate change on human systems and biodiversity.

The Clean Development Mechanism (CDM) as a tool for mitigation

The Clean Development Mechanism (CDM) of the Kyoto Protocol is one of three flexibility mechanisms for cost-effective mitigation of climate change. CDM can use either technologies such as carbon neutral technologies or sequestration of CO_2 through afforestation and reforestation project activities.

Purpose of CDM

The Article 12 of the Kyoto Protocol defines the objectives of CDM as:

- to assist developing countries in achieving sustainable development;
- to contribute to the ultimate objective of the Convention i.e. stabilisation of greenhouse gas concentrations in the atmosphere at levels that would prevent dangerous anthropogenic interference with the climate system;
- to assist developed countries in achieving compliance with their

quantified emission limitation and reduction commitments (QERCs).

The opportunities of the industrialised countries to reduce emissions through CDM project activities in developing countries are enormous and have fairly low associated costs, particularly in the sectors of energy, transport, building materials (brick, cement and steel etc.), municipal wastes, and animal husbandry.

Benefits India expects from CDM project activities

It is expected that CDM project activities will contribute to progress in achieving sustainable development in India, particularly under the four pillars of sustainable development: social, economic, environmental and technological well-being. In doing so, this will help to address India's main agenda of development - poverty eradication and improving the quality of life of people. In addition, CDM projects will attract additional foreign investment and India may be entitled to a share of the certified emission reductions (CERs) that accrue from CDM project activities. Finally, the development and implementation of CDM projects will contribute to capacity building within the country.

Participation requirements of a developing country party

To participate in a CDM activity:

- participation must be voluntary;
- the country participating in the CDM activities shall designate a national authority (DNA);
- a country not included in the Annex I of the Convention may participate in a CDM project activity if the country has ratified the Kyoto Protocol.

Readiness of India to join the CDM process

The readiness of India to join the CDM process is demonstrated by India's recent ratification of the Kyoto Protocol, as well as by hosting the Eighth Conference of the Parties to the United Nations Framework Convention (COP 8) at New Delhi, and by the Prime Minister's address at COP 8. The Government of India has already set up an enabling environment to speed up

the process of endorsement and approval of CDM project proposals. It is also in the process of establishing a designated national authority (DNA) as required under the Marrakesh Accord. Further evidence of India's readiness to join the CDM process is clear in the Government of India's endorsement of two CDM projects in response to the Certified Emission Reduction Unit Procurement Tender (CERUPT) of the Netherlands.

In addition, industrial associations and NGOs such as CII, Development Alternatives and other institutions like IIM-Ahmedabad, TERI, Winrock are taking keen interests, and during the last couple of years a number of CDM projects have been developed in close collaboration with the Indian business sector.

Mitigation options in India

India conducted a study to produce a least-cost greenhouse gas abatement strategy (ALGAS-India) and identified potential sectors for greenhouse gas abatement. The focal points of the abatement strategy are the reduction of CO_2 emissions in the energy and forestry sectors and the reduction of methane (CH_4) emissions in the agriculture sector.

The mitigation options for the energy sector are improvements in energy efficiency through upgrading the currently employed technologies, the introduction of advanced technologies that are more efficient, and the use of renewable energy sources wherever feasible. The recently declared 'Energy Policy' of the Government of India aims to increase the contribution of energy from renewable sources to at least 10% of the total supply (at least 10,000 Megawatt) by 2012. India has considerable renewable energy potential and much has yet to be exploited (Table 1).

Adaptation as a tool to supplement mitigation measures

The IPCC Third Assessment Report (IPCC 2002) on Climate Change has clearly stated that adaptation at all scales is a necessary strategy to complement climate change mitigation efforts. Achieving sustainable development, particularly through CDM processes, will enhance country's capacity to adapt to climate change. To strengthen the framework of adaptation, the world community has to work as one to eradicate poverty, as articulated in the United Nations Millennium Development Goals. These goals are fundamental in developing the coping capacity and resilience of vulnerable communities in developing countries.

Table 1: Renewable Energy Potential in India

Source/Technology	Potential	Potential Exploited (MW)
Biogas Plants	12 million MW	2.7 million
Biomass Based Power	17,000 MW	769.5
Efficient Woodstoves	120 million MW	20 million
Solar Energy	5×10^{15} W hr/yr	25
Small Hydro	10,000 MW	250
Wind Energy	20,000 MW	1,000
Ocean Thermal	50,000 MW	
Sea Wave Power	20,000 MW	
Tidal Power	9,000 MW	

Different tools for adaptation to climate change

Tools for adaptation to climate change that are considered suitable for the developing countries such as India are:

- empowering communities to reduce their vulnerability;
- education, training and public awareness;
- sustainable livelihood practices (e.g. providing electricity through renewable energy technologies using local resources);
- cooperative / participatory activities such as cooperative banks;
- insurance against natural disasters such as floods, drought, cyclones and crop damage;
- operational research on adaptation to increase resilience and coping capacity of vulnerable communities.

Measuring the success of adaptation tools

The success of adaptation tools can be measured using indicators such as:

- percentage of poverty reduction;
- percentage improvement in public awareness (could be achieved by introducing curriculum on climate change in middle and high schools);
- changes in per capita emission of CO_2 per year;
- GDP per unit of energy use;
- yearly incidences of malaria / dengue fever;
- percentage of people having access to clean water and sanitation.

Conclusions

Biodiversity is an important component of the earth's systems. Because ecosystems and species are sensitive to changes in precipitation, temperature and sea level, climatic change is introducing additional stresses to plant and animal life, as well as to humans. As a result, there is an urgent need to clearly understand linkages between the function of earth's systems and climate change.

Governments, academia, NGOs and other civil societies, and the various multilateral organisations should come forward to take up this challenge for conserving biodiversity and the planet earth. The industrialised countries have a special role to come forward to work together on these programs that are vital for all nations - rich and poor. In addition, there is a need to further develop tools through field research to develop applications on the ground, and to develop quantified indicators to monitor the efficacy of adaptation and mitigation activities, as well as the success of CDM projects. The aim in developing and implementing CDM projects should be to 'learn by doing' and use the lessons learned to improve the operational aspects of CDM and to build capacity for CDM in India and elsewhere.

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National Adaptation Programme of Action and Conservation of Biodiversity in the LDCs

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Introduction

Effects of human-induced climate change have been recognized both by the global scientific and policy communities. In response, various measures both for mitigating climate change and adapting to its negative impacts are being initiated. However, the impacts and the consequent vulnerabilities will not be the same across different countries and regions. The 49 least developed countries (LDCs) will be the most affected groups because of the overwhelming dependence of their economies on nature, as well as their low adaptive capacity. Mindful of this, the international community through the COP process has initiated some responses targeted specifically at these countries. One such response is the preparation of the National Adaptation Programme of Action (NAPA) by the LDCs with funding from the LDC Fund, established by COP7 at Marrakech in November 2001. COP7 also adopted the Guidelines for preparation of NAPAs which contain the guiding elements, the structure and a set of criteria for selection of 'urgent and immediate measures' for enhancing adaptive capacity in these countries. In this paper, the background of NAPA and support for adaptation are reviewed, and linkages between climate change and biodiversity policy are discussed.

Regime support for adaptation

The UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol have already established many provisions that support adaptation to climate change impacts in the developing countries. These are the following:

- Article 4.1: Parties are committed to formulate, implement … national and where appropriate, regional programs … to facilitate adequate adaptation.
- Article 4.4: Developed countries shall assist the developing countries in meeting the costs of adaptation.

- Article 4.8: Parties to give full consideration to the needs of countries with special characteristics (specifies 8 disadvantaged areas and countries including low-lying coastal areas and fossil fuel-dependent economies).
- Article 4.9: Parties shall take full account of the LDC needs in their actions with regard to funding and transfer of technology.
- Article 12.8 of the Protocol: The COP shall ensure that a share of CDM [Clean Development Mechanism] proceeds is used to … assist developing countries that are particularly vulnerable … to meet the costs of adaptation.

Background of NAPA and the LDC Expert Group (LEG)

Emergence of LDCs as a separate negotiating group within climate change negotiations began in Lyon, France at the 12th session of the subsidiary bodies held in September 2000. Since then, the group representatives have met seven times in different places to develop their main agenda. Finally, the group consolidated their clout at COP7 held in Marrakech in November 2001. This and the subsequent COP8 adopted some major decisions:

- Adoption of the LDC Work Programme which includes elements of capacity building.
- Adoption of the NAPA Guidelines: NAPA is expected to be a structured communication of urgent and immediate adaptation needs of the LDCs. The LEG has prepared an annotated version of the Guidelines, explaining the concepts, categories and connotations.
- COP8 established the 12-member LDC Expert Group (LEG) as an advisory body to the LDC Parties for preparation and implementation of NAPAs.
- GEF developed the Operational Guideline for expedited access to the LDC fund for preparation of NAPAs.
- An LDC-wide Workshop on Capacity Building for preparation of NAPAs was held in Dhaka, Bangladesh in September 2002. Forty-five LDCs and donor representatives participated.
- COP9 decided that LEG would organize 4 regional workshops on

Capacity Building for preparation of NAPAs: for Anglophone African LDCs, for Francophone African LDCs, for Asian LDCs and for the LDCs of the small island developing states.

Sequential steps in preparing the NAPA

1. Build NAPA and multidisciplinary teams (national and expert-level).
2. Synthesize available impact assessments, coping strategies, past consultations, development trends and existing development frameworks.
3. If existing information and assessments are inadequate for NAPA preparation, further information is to be collected through participatory rapid assessment.
4. Conduct public consultations for articulation of potential ideas for adaptation activities.
5. Undertake criteria prioritization (ranking of guideline criteria, while considering country specifics).
6. Rank activities/projects and demonstrate integration into national policy frameworks and plans/programs.
7. Develop project profiles and submit NAPA.

Conceptualizing the NAPA-Biodiversity nexus

The impact of climate change on biodiversity is likely to figure prominently in vulnerability assessments, but these vulnerabilities will differ across communities and sectors. The poor, the landless, and women and children will be the most affected segments of the LDC population. These segments of the population depend to a large extent on biological resources for their survival and livelihood support. However, the inequitable distribution of resources and lack of access to them by the poor stand in the way of sustainable development.

Poor people in LDCs are interested in conservation of biodiversity through sustainable use of its components. Poverty-induced biotic pressure has made biodiversity conservation a challenge; however, community-based management of biological resources may be one solution. There are already examples in the developing countries of sustainable management of natural

resources by individual communities, an approach that is in line with Article 1 of the Convention on Biological Diversity (CBD).

Figure 1 shows the impacts of climate change on the poor, and consequent impacts on achieving the Millennium Development Goals (MDGs) set out at the Johannesburg Summit. It is evident that climate change impacts may reduce agricultural productivity and availability of natural resources, and may create greater water stress, damage infrastructure and increase the prevalence of disease. These sectoral impacts are more evident when one looks at the livelihood options available for the poor. Climate change is expected to make livelihoods more insecure, increase health risks for the poor (who are often not covered by any health services) and constrain economic opportunities because of economy-wide effects. These impacts in turn affect the achievement of the MDGs, both directly (goals 1 and 4 to 8), and indirectly (goals 2 and 3; UNEP et al. 2002).

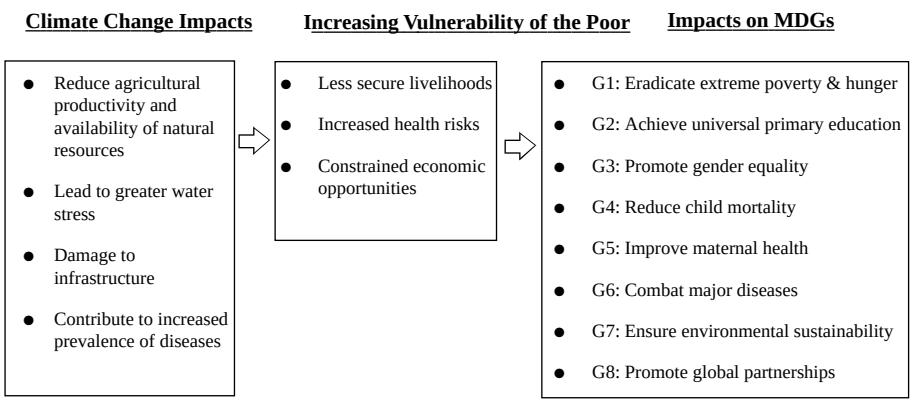

Figure 1: Links between Climate Change and Millennium Development Goals

Although biodiversity has been mentioned as one specific area in the NAPA guiding elements, it actually covers most of the other areas, including loss of livelihoods of the poor, human health, food security and agriculture, water resources, land management and forestry, coastal zones and other environmental amenities. With this clear importance of biodiversity, the achievement of the MDGs and the success of initiatives to foster climate change adaptation will depend to a great extent on how natural resources are managed.

Therefore, a more appropriate approach for assessment and analysis of biodiversity issues in the NAPA preparation process would be to use a livelihood approach, rather than a sectoral, vulnerability-based approach. This will present a more realistic picture from the human security point of view.

Biodiversity, livelihoods and the NAPA process

The LDCs are now at the beginning stage of preparing their NAPAs which will identify high priority adaptation activities and projects. Although these activities and projects will address 'urgent and immediate' needs, they should be a well-considered first step in developing long-term plans.

There is a need for development and poverty reduction strategies to work in concert with climate change policies and for climate change to be seen not merely as an environmental issue, but very much as a development issue. The NAPA guidelines clearly specify poverty reduction as criteria for selection of adaptation measures. As mentioned, one major key to reduction of poverty in the LDCs is the provision of access to and management of biological resources by the communities. Historically, these communities enjoyed access to these common property resources. But, with privatization and nationalization of natural resources and encroachment by the rural elites, the poor have lost customary rights to them. Ensuring access to biological resources and flow of benefits on a sustainable basis to the poor will contribute towards enhancing adaptive capacity both in the immediate and longer terms and will contribute to poverty reduction.

The second step in NAPA preparation is the review of national plans and policies including the National Conservation Strategy documents or National Biodiversity Strategy and Action Plans. In this process, it should become clear whether these documents have adequately addressed the importance of biodiversity conservation to climate change adaptation, and addressed other interlinkages between climate change and biodiversity. If these issues have not been addressed at the policy level, we must consider how this policy level debate may be raised, given that the NAPA process is intended to be participatory, and relevant stakeholders should be able to raise issues of concern. The communities need to look into the issues, such as: how does this participatory process take place? What was the basis of rapid assessment – research studies, historical records, or people's age-old experiences and knowledge of adaptation to climate events? Have indigenous knowledge and practices of coping mechanisms been analyzed?

In the third step of the NAPA process (public consultation for articulation of ideas for NAPA activities) the issues that need to be considered and raised are: What kind of public participation takes place? Who participates? What were the modalities of public consultation? Does the country have any tradition of community consultation? If not, how was the methodology for public consultation designed? By whom? Was it a combined group across all strata of the society? If so, could the poor and marginalized voice their concerns before the powerful elites? Is their thinking incorporated into the list of potential ideas for NAPA activities?

It is important that procedural justice is ensured in NAPA preparation, and the process used to arrive at a decision is fair. Procedures will be perceived as fairer if they provide some control of the process as well as a voice to those affected by climatic change. Other characteristics of procedural justice are that the process is unbiased and has a level-playing field, that there is representativeness and a concern with needs and well-being, and finally that the process is flexible and ethical. In addition distributive justice, or the fair distribution of outcomes from a decision, is critical.

Conclusions

Ensuring synergies in implementing the measures under the UNFCCC, CBD and Convention to Combat Desertification (CCD) is important to achieving biodiversity conservation and sustainable use of resources. In addition, the linkage between livelihood security of the poor and sustainable use of the components of biodiversity should be reflected in NAPA projects, and in implementation of other multilateral environmental agreements.

Climate change policies, plans and programs should be the result of articulation of the interests of a broad range of groups. However, most of the LDCs are nascent democracies and articulation of group's interests is not yet a balanced exercise. The rich and the powerful dominate the policy process. It is therefore crucial that procedural justice is ensured in the preparation phase and that distributive justice follows during the implementation phase. To ensure that this happens, non-governmental organizations (NGOs), community-based organizations and the professional associations of the most impacted livelihood groups need to be proactive in the NAPA formulation phase. As well, civil society and NGOs involved in biodiversity and natural resource issues should remain active in the NAPA teams as well as in its preparation process.

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Livelihoods and Climate Change: An Integrated Approach to the Reduction of Vulnerability and Poverty

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Introduction: Climate change impacts and vulnerability

In its Third Assessment Report (TAR), the Intergovernmental Panel on Climate Change (IPCC) concluded that the globally averaged surface temperatures increased 0.6 ± 0.2°C in the 20th century, and this warming trend is expected to persist for the next century and beyond. Projected changes in climate include additional warming, increases and decreases in precipitation, sea level rise and changes in the frequency and intensity of some extreme events. These changes will impact natural and human systems directly or in synergy with other factors to alter the productivity, diversity and functions of many ecosystems and livelihoods around the world. With regional changes and impacts already being observed, the need for adaptive response measures is imperative, and for the poor and most vulnerable people, an urgent imperative.

The poor are already vulnerable to climate risks. Settlement on marginal or unstable lands such as steep slopes or floodplains heightens their exposure to the impacts of climate hazards. Heavy dependence on ecosystem services can place their welfare and survival at the mercy of environmental conditions. As the availability and quality of natural resources decline due to natural and human-induced pressures, so does the viability and security of their livelihoods. With limited capacities and resources at their disposal to respond to stresses such as droughts and floods, their ability to meet basic needs and move out of poverty is constrained. Climate change threatens to exacerbate these existing vulnerabilities and further entrench development disparities, as those with the least stand to suffer the most.

Reducing vulnerability and adapting to climate change through sustainable livelihoods

Increasing the capacity of poor communities to adapt to climate change must therefore start with actions that target and reduce the vulnerabilities they currently face, allowing them to build more resilient and secure livelihoods.

This places the goal of poverty reduction at the centre of adaptation, as the capabilities and assets that comprise people's livelihoods often shape poverty and the ability to move out of poverty. A livelihoods-based adaptation approach requires an understanding of how livelihoods are conducted and sustained – that is, how resources are mobilized to earn an income and meet basic needs. Five forms of assets are usually identified when discussing peoples' livelihoods:

a) Human capital: the skills, knowledge, ability to labour and good health that enable people to pursue livelihood activities;

b) Social-political capital: the range of social relationships upon which people draw in pursuit of their livelihoods;

c) Natural capital: the natural resource base from which resource flows and services useful to livelihoods are derived;

d) Physical capital: the basic infrastructure and productive capital (such as tools and machines, etc.) that support livelihoods; and

e) Financial capital: the financial resources – both stocks and flows – allowing people to pursue different livelihood options.

Taken together, these assets determine much about how livelihoods work and how people will respond to shocks and stresses, such as climate-related disasters and climate change. As such, these assets should form the basis of adaptation strategies.

While all of these livelihood assets are important, given the reliance of the poor on natural resources for their livelihoods, natural resources are particularly important for the most vulnerable communities in the world. While climate change is not the only threat to natural resources and livelihoods, climate-induced changes to resource flows will affect the viability of livelihoods unless effective measures are taken to protect and diversify them through adaptation and other strategies. As a result, ecosystem management and restoration activities should be a central element of adaptation activities. Examples of such activities include watershed rehabilitation, agroecology, and forest landscape restoration. In fact, protecting and enhancing the natural services that support the livelihoods of vulnerable communities can represent 'win-win' approaches to climate change adaptation, as they serve immediate needs and bring immediate benefits to local communities while also contributing to longer-term capacity development that will create a basis for reducing future vulnerabilities.

Disciplinary and institutional synergies: the IUCN, IISD, SEI and Intercooperation project on Climate Change, Vulnerable Communities and Adaptation

Promoting this integrated approach to adaptation calls for the convergence of four distinct communities who have long been tackling the issue of vulnerability reduction through their respective activities: disaster risk reduction, climate and climate change, environmental management, and poverty reduction. Drawing from each of their portfolios of projects and lessons-learned, these communities now have the opportunity to jointly explore and strengthen those synergies that promote climate change adaptation.

IUCN-The World Conservation Union, the International Institute for Sustainable Development (IISD), Stockholm Environment Institute-Boston Center (SEI-B), and the Swiss Organisation for Development and Cooperation (Intercooperation) are working together to identify and operationalize these synergies, particularly those where ecosystem management and restoration activities reduce the vulnerability of communities to climate-related disasters and climate change. The project partners have developed a three-year research and policy project with the following objectives:

1. Identify successful ecosystem management and restoration actions that reduce the vulnerability of communities to climate-related hazards and climate change;
2. Enhance the role of these activities by identifying barriers to action, conditions for success and policy options;
3. Mobilize and expand constituencies and operational capacities for adopting this approach; and
4. Promote the integration of this approach into emerging policy frameworks and strategies on disaster reduction, climate change action, biodiversity conservation and poverty alleviation.

These objectives will be met through a work programme involving information papers, project assessments, case studies, consultations and advocacy efforts.

The following section provides a concrete example of the types of activities that will be supported and expanded through the IUCN-IISD-SEI-IC project – i.e. a community-based natural resource management programme that

simultaneously reduces vulnerability to climate risks, diversifies and enhances local livelihoods, and protects biodiversity. Apart from seeking to articulate the rationale and objectives of the project through an actual case, it is hoped that the example below will also help policymakers realize that synergies are already taking place in many communities and should therefore be supported and scaled-up through effective policy frameworks.

Adapting to climate change through sustainable watershed management: an example of operationalized synergies in India

In the semi-arid region of Maharashtra State, India the Watershed Organisation Trust (WOTR) is assisting poor, rural communities to increase their livelihood security by supporting watershed restoration projects (For more information see http://www.wotr.org). With rain-dependent livelihood systems, these communities survive on limited water supplies to meet their needs for crops, livestock and cottage industries. The combination of recurring droughts and human pressures on the surrounding land has degraded watersheds. Barren and eroded lands are unable to absorb and retain water, thereby accelerating surface runoff and soil erosion and inhibiting ground water recharge. The resulting decrease in soil fertility and water availability has created extremely water-stressed communities vulnerable to the impacts of climate change. WOTR's work seeks to assist these communities alleviate their poverty and regenerate the watershed environments upon which they depend.

Conducted on a micro-catchment basis, WOTR's work is community-driven and characterized by participatory planning, implementation, and management and a self-assessment process for monitoring and evaluation. Upon approaching WOTR with a proposal for action, communities agree to undertake a series of rigorous watershed restoration measures designed to regenerate and conserve micro-catchments. These include:

1. Soil, land and water management, e.g. trench building to control erosion, improve soil fertility and enhance groundwater recharge;
2. Crop management;
3. Afforestation;
4. Rural energy management, e.g. ban on tree-felling; planting shrubs and grasses to meet household fuel needs;
5. Livestock management; pasture/fodder development, e.g grazing restrictions leading to the natural regeneration of grasses and shrubs.

To simultaneously lessen human pressures on the micro-catchment, a set of community development measures are undertaken to enhance, diversify and secure livelihoods. Such measures include:

1. Community organization through the formation of "Village Self-Help Groups", which work with WOTR to build 'social capital' and guide the restoration process;
2. Micro-lending, supporting cottage industries for supplemental income;
3. Human resource development, e.g. training on project management, new fruit crops or animal husbandry techniques.

These measures represent a blending of new or external techniques with traditional knowledge in order to ensure both effective management and local ownership.

The results of this approach have been laudable. Reduced barren soil cover, improved soil moisture regimes, increased well water levels, biomass regeneration, and dramatic increases in fodder availability, milk production, and vegetable farming are some of the results reported by participating villages. Coupled with micro-enterprise development and an increase in savings groups, these results have translated into more secure livelihoods, diversified asset bases and reduced exposure to climate-related shocks. In short, drought-prone communities have been able to make themselves less vulnerable to drought. In the face of projected increases in extreme events, this reduced vulnerability will improve their capacity to adapt to climate change.

Conclusions

The WOTR project is but one of many examples of how ecosystem management and restoration activities can effectively reduce community vulnerability to climate-related disasters and climate change. Other examples from around the world include mangrove reforestation in Vietnam, rangeland rehabilitation in Sudan, forest landscape restoration in Central America, aquifer recharge in Iran, and coastal zone management in the Caribbean. These types of activities have been yielding decades worth of lessons-learned and are now poised to help vulnerable communities adapt to some of the biggest changes in the global environment. As local communities, researchers, NGOs, governments and industries seek sustainable approaches to adaptation,

they must harness this existing wisdom and encourage trans-disciplinary cooperation to design, support and expand successful resilience-building activities such as those exemplified by the WOTR project in India. IUCN, IISD, SEI and Intercooperation look forward to working with all stakeholders in the endeavor and invite others to engage in the joint effort.

Assessment of Growing Stock, Biomass and Carbon in Forests of India

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Introduction

The increasing levels of green house gases (GHG) in the atmosphere have generated global concern about adverse effects on climate, and have led to the search for mitigation options. Forests have been recognized as having important mitigation potential because of their critical role in the global carbon cycle and significant potential to capture and hold carbon. Deforestation currently contributes to about 1.6 Gt C per year to the atmosphere; however, by preventing deforestation and expanding reforestation and afforestation projects, forests constitute a large mitigation opportunity to stabilize GHG concentrations (2 to 4 Gt C annually) in the atmosphere (Scholes and Noble, 2001). Preventing deforestation helps preserve current carbon reservoirs and limit new emissions, while afforestation and reforestation can sequester carbon. In addition, preserving and increasing forest coverage can have numerous benefits for biodiversity.

India is a vast country with a geographical area of 3,287,263 km^2. The variety in its climate and its rich biodiversity have made India one of the 12 mega-biodiversity regions of the world. It has 20.55% of its geographical area under forest cover (FSI, 2001) and the forests have been classified into 16 forest type groups and 221 forest types (Champion and Seth, 1968). It is not an easy task to estimate the volume or carbon contents of such a vast variety of forests using traditional field inventory methods. During the last few decades, remote sensing data have found immense applications in the forestry sector particularly in estimating forest cover. In recent years, the Forest Survey of India (FSI), an organization of Ministry of Environment and Forests, Government of India, has developed a methodology for integrating remote sensing data (information based on satellite data as well as aerial photographs) with the field inventory data to assess above-ground growing stock of forests at a national level.

The FSI has been assessing the forest cover of the country using satellite data on a 2-year cycle since the early 1980s. In 1995 it developed a methodology for estimating the growing stock of the forests of the country. The

methodology involved interpretation of satellite data and aerial photographs, and the processing of forest inventory data collected from about 170,000 grids spread all over the country. Recently, this methodology has been used by the FSI in collaboration with the Forest Research Institute (FRI), Dehradun to assess growing stock, biomass and carbon stock in the forested areas of India for the year 1994. The work has been done as a part of the 'Land Use and Land Use Change and Forestry' (LULUCF) component of India's Initial National Communication (NATCOM) to United Nations Framework Convention on Climate Change (UNFCCC).

Methodology

The growing stock for the entire country (according to major forest strata) was assessed using information available from the vegetation maps, thematic maps and the ground forest inventory done by the FSI. For this purpose, all the states and Union Territories (UT) were divided into grids of 2.5' x 2.5' (latitude x longitude). Data were collected for parameters related to the growing stock from these 170,000 grids. This exercise yielded information on the extent of forest cover, composition (21 species strata), density (3 classes) and inventory data on growing stock. The following information was collected for each grid:

Density

The land cover category occupying more than 50% area of the grid was assessed. If more than 50% area is forested, the grid was marked as forested otherwise it was marked as non-forested. A single density class was assigned to each forested grid. This information was mostly collected from satellite data for the year 1994 (range: 1993-95). Each grid was assigned one of the following three density classes using the satellite data:

Class	Crown density
1. Very dense forest	70% and above
2. Dense forest	40 to 70%
3. Open forest	10 to 40%

Areas which showed less than 10% forest density were treated as non-forest and were not used further. Any grid which spread over more than one state was included in the state in which it showed maximum area.

Forest composition

The major forest type/strata in each grid was marked using information from the following resources:

1. Thematic maps prepared by the FSI on 1:50,000 scale using aerial photographs were used for marking the major species composition of each grid.

2. In areas for which thematic maps were not available in FSI, the information on species composition was collected from the stock maps of the State Forest Department, irrespective of the year and scale of preparation of stock map.

3. In areas for which neither thematic maps nor the stock maps were available, information was collected from the inventory field forms.

4. In areas for which none of the above sources of information on species composition were available, the information on the adjoining area falling in the same agro-ecological zones was taken into consideration.

5. In all, twenty-one forest strata for major species compositions were identified (FSI, 1995). These include fir, spruce, blue-pine, deodar, chir pine, mixed conifers, hardwood mixed with conifers, upland hardwoods, teak, sal, bamboo, Dipterocarpus, khasi pine, khair, salai, alpine pasture, western ghat evergreen, western ghat semi-evergreen, western ghat deciduous and miscellaneous.

Forest inventory data

Determination of growing stock was done using forest inventory surveys performed by the FSI. Forest inventory design was based on the methodology developed by FSI (FSI, 1982). The growing stock of any state was estimated by calculating the number of grids for each combination of density and forest composition. The volume per hectare (termed as wood volume factor) for a particular combination of density and forest composition was generated by processing the data of forest inventory surveys that were carried out in various states/UTs. Three wood volume factors were calculated for each stratum and density class for each map sheet in each state. Wherever the inventory data were not available for a grid, wood volume factors from neighboring areas with the same agro-ecological zones were used. Trees with less than 10 cm

diameter and branches less than 5 cm in diameter were not taken into account. The growing stock was first estimated for each map sheet and then aggregated to obtain the total growing stock of each state.

Biomass and carbon estimation

Based on the information on forest cover estimation was made for the above-ground biomass and carbon. The estimated volume or growing stock was converted into biomass by using specific gravity (Rajput et al., 1996, Limaye and Sen, 1956) of dominant tree species in each grid employing the following standard formula:

$$\text{Biomass (ton)} = \text{Volume } (m^3) \times \text{Specific Gravity}$$

Oven dried plant components were burned in an electric furnace at 400^0C to determine the percent carbon in the tissue. The carbon stock in the above-ground biomass was computed using the following formula:

$$\text{Carbon (ton)} = \text{Biomass (ton)} \times \text{Carbon \%}$$

Results and discussion

The forest carbon stock estimates for India were completed using satellite data from 1993-1995 and should therefore provide estimates of 1994 carbon stocks.

Forest cover of the country based on interpretation of satellite data was assessed to be 63.34 million hectares (FSI, 1997) which constitutes 19.27% of country's geographic area. The total growing stock in the country for the year 1994 is estimated using this methodology, to be 4340 million m^3. Growing stock per hectare of India's forest cover comes out to be 68.5 m^3. The estimate is for forests having more than 10% crown density (Table 1).

Table 1: Growing stock, biomass and carbon in India's Forests

		Unit	Total	Per ha Forest Cover
	Growing Stock	Million m^3	4,340.0	68.5
	Biomass	Million ton	2,395.4	37.8
	Carbon	Million ton	1,083.8	17.1

Several other researchers have also provided estimates of forest biomass. Haripriya (2000) used FSI data on growing stock (FSI, 1995) and inventory data of various FSI inventory reports and estimated the above-ground stem biomass in India's forests as 2782.88 million tons. He also used a biomass expansion factor (BEF) ranging from 1.51 to 1.59 for different forest compositions (1.06 for bamboo) and estimated total above-ground biomass as 4312.74 million tons. Chabra et al. (2002) also used FSI data of 1995 (FSI, 1995) and estimated above-ground biomass to be 6865.1 million tons. In their estimates, they used BEF of four forest types and related wood volume to biomass as a function of growing stock volume density. In the present study only the above-ground woody biomass was calculated. The national estimates of carbon stock computed in the current study, although significantly less than those given in other studies, are based on more detailed data and therefore this study is likely to give a more realistic picture. However, it can be further improved by using a BEF for all 21 forest types and by including underground biomass.

Information on growing stock, biomass and carbon in each of the 21 forest strata for the year 1994 is given in Table 2. This table shows that more than 60% of forests in the country have mixed composition with miscellaneous species. Consequently contribution of growing stock, biomass and carbon stock of miscellaneous species is about 56% of total growing stock, biomass and carbon of the forests in India.

Since FSI is assessing the forest cover of the country on a two year cycle, it is possible to assess changes in growing stock and carbon contents due to changes in forest cover and forest species composition. This information can be treated as a baseline information and used for making an estimate of changes in GHG fluxes resulting from changes in forest cover and species composition. Such exercises will not only help in preparing GHG inventory in LULUCF but also in delineating areas of rich biodiversity and areas which are more vulnerable to climatic change. The methodology will also help in assessing impacts of anthropogenic pressures in large areas and contribute to biodiversity planning and management.

The results in Table 2 are based on forest cover as assessed by visual interpretation of satellite data on 1:250,000 scale. Due to cartographic limitations, it was not possible to delineate areas of forest cover less than 25 hectares in extent. There is considerable forest cover in such isolated patches. Using digital technology for forest cover assessment at 1:50,000 scale, FSI has been able to assess forest cover down to 1 hectare (SFR 2001). Better

Table 2: Forest strata-wise forest cover, growing stock, biomass and carbon for 1994

Strata	Code	Forest Cover (Km^2)	Growing Stock (000, m^3)	Biomass (000, tons)	Carbon (000, tons)
Fir	1	3881	152039.21	55131.81	25360.63
Spruce	2	465	13677.27	5478.34	2520.04
Fir-Spruce	3	1197	32049.83	12295.02	5655.71
Blue-Pine	4	4082	73681.00	25447.67	11705.93
Deodar	5	1412	30364.06	14183.08	6524.22
Chir-Pine	6	13022	95603.13	44089.24	20281.05
Mixed conifers	7	16295	398378.50	165794.55	76265.49
Hardwood & conifers	8	5006	43548.71	22681.42	10433.45
Up-lands hardwoods	9	14440	145431.65	67800.16	31188.07
Teak	10	61250	286128.13	156787.26	68986.39
Sal	11	75372	514117.61	371477.31	170876.38
Bamboo	12	10210	31760.97	21185.57	9109.79
Mangrove	13	4598	39442.29	28022.72	12610.22
Depterocarpus	14	68	908.94	540.82	243.37
Khasi pine	16	1486	6317.64	2722.90	1252.54
Khair forest	17	2012	2649.56	2039.11	917.60
Salai	18	2245	3814.73	1899.97	870.45
Alpine pastures	19	67	481.24	262.76	118.24
Miscellaneous forest	20	407316	2427416.29	1370097.81	616544.02
W.G (evergreen forest)	22	3767	25753.65	16709.20	7519.14
W.G (semi-evergreen)	23	2808	11017.91	7496.85	3373.58
Deciduous	24	2361	5445.66	3229.88	1453.45
Total		**633359**	**4340027.98**	**2395373.44**	**1083809.76**

resolution will definitely help in providing refined estimates of growing stock, biomass and carbon in forested areas. In addition, it has also assessed tree cover in areas less than one hectare using ground inventory. A new methodology is being used to assess growing stock in forest and non-forest areas of the country. All the information generated is being put into GIS (Geographic Information System) mode and the resulting information will help with developing a decision support system for biodiversity planning and management.

Conclusions

The significance of forests in global carbon cycle and their potential to capture and hold carbon are well recognized, and as a result forest protection and expansion initiatives are now considered important climate change mitigation options. The Forest Survey of India (FSI) developed a methodology in 1995 which allowed the integration of remote sensing data with field inventory data to assess the above-ground growing stock of forested areas of the country. This methodology has recently been used by FSI in collaboration with the Forest Research Institute, Dehradun to assess the growing stock, above-ground woody biomass and the carbon contents of India's forests using data from 1994. The growing stock for the year 1994 was estimated to be 4340.0 million m^3, while the above ground woody biomass and carbon were estimated to be 2395.4 million tons and 1083.8 million tons respectively. The work has been done as a part of the LULUCF component of India's Initial NATCOM to the UNFCCC.

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Tools and Techniques for Assessment and Monitoring of Biodiversity

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Introduction

Biodiversity represents the very foundation of human existence. Yet by our heedless actions we are eroding this biological capital at an alarming rate. Even today, despite the destruction that we have inflicted on the environment and its natural bounty, its resilience is taken for granted. But the more we learn of the workings of the natural world, the clearer it becomes that there is a limit to the disruption that the environment can endure. Besides these implications, it is clear that the loss of biodiversity has serious economic and social costs (UNEP, 1995). The genes, species, ecosystems and human knowledge that are being lost represent a living library of options available for adapting to local and global change. The experiences of the past few decades have shown that as industrialization and economic development take place, the patterns of consumption, production and needs change, strain, and even destroy ecosystems.

A recent study projecting future trends in biodiversity predicted that the main cause of biodiversity loss in the coming decades would be land-use change, mainly loss of habitat and landscape fragmentation. Changes in atmospheric composition and climate are regarded as longer-term factors, increasing in relative importance over time. Research on the consequences of these changes to biological diversity and to the functioning of terrestrial ecosystems is in its infancy. However, a landscape approach using geospatial tools will help improve understanding of how land use change and climate change have affected terrestrial ecosystems and will help predict changes in landscapes of the future.

Landscape ecology

Landscape ecology provides a new, higher level for understanding biological complexity and ecological processes. The spatial arrangement of patches, their different qualities, their juxtaposition, and the proportion of different habitat types are elements that influence and modify the behavior of species

populations and communities (Lidicker, 1995). New ideas about heterogeneity and the role of disturbance regimes in ecological processes represent a further stage on which new paradigms such as ecotones and connectivity have been implanted. To humans, landscape is a broad-scale area composed of a mosaic of patches or ecotopes, in to which we introduce physical, biological and cultural elements.

Recent concern regarding loss of biodiversity results from extremely high rates of species and habitat loss. Tools to assess biological diversity have only been able to provide a partial understanding, as taxonomic inventories are time-consuming and current high rates of species extinctions have overtaken the inventory process (Figure 1, approach 1). An alternative, 'top-down' approach (Figure 1, approach 2) uses a stratified approach in which biodiversity can first be characterised at landscape level and a subsequently detailed inventory can be performed for the prioritised areas. This 'top-down' approach allows extrapolation to large landscapes and involves the development of a spatial environmental database and systematic monitoring. Biodiversity assessments should use both the traditional 'bottom-up' approach and a 'top-down' approach.

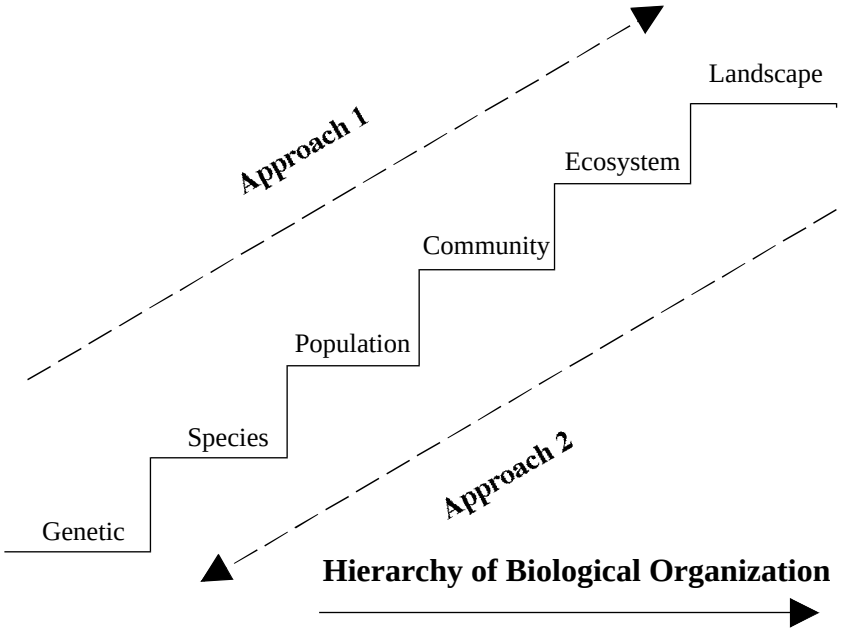

Figure 1: Approaches to study biodiversity at different level of biological organization

The complexity of the environment is so great that landscape ecology cannot explain all processes or patterns. However, the strength of landscape ecology lies in its ability to use geoinformatics to understand processes at different spatial and temporal scales. For example, landscape ecology is important in understanding relationships between disturbance regimes and biodiversity.

Geoinformatics

Satellite remote sensing is an important tool in landscape ecology. It has helped in the development of various forest assessment methodologies, providing the following advantages when compared to conventional ground-based methods:

- Synoptic view: Remote sensing facilitates the study of various features of earth's surface and the spatial relationship between features.
- Accessibility: Remote sensing makes it possible to gather information about areas that are not accessible for ground surveys, like mountainous areas or foreign lands.
- Time: Since information about a large area can be gathered quickly, these techniques save time and effort.

Some of the uses of remote sensing technology for characterizing biodiversity are to:

- Map and classify vegetation;
- Assess the spatial arrangement of land cover and vegetation types;
- Create sampling frames and sample units;
- Provide information for extrapolating field observations;
- Allow analysis of time-series images to analyze a landscape's history;
- Report and analyze results of inventories including inputs to Geographical Information System (GIS);
- Provide a basis for model building.

Physiography, topography, climate and human interventions largely control the distribution of vegetation and biodiversity. Developments in computer-based GIS enable the integration of spatial and non-spatial information for defining the habitats and improving vegetation type descriptions in space and time. It is also possible to evolve geospatial models using multiple criteria to model disturbance regimes and assess effects on landscape diversity.

Specific capabilities of GIS in characterizing biodiversity include:

- Providing a database structure for efficiently storing and managing ecosystems data over large regions;
- Enabling aggregation and disaggregation of data between regional, landscape and plot scales;
- Assisting in location of study plots and ecologically sensitive areas;
- Supporting spatial analyses of ecological distributions using statistics;
- Improving remote sensing information extraction capabilities;
- Providing input data/parameters for ecosystem/landscape modeling.

Global Vegetation Mapping

The Forest Resource Assessment (FRA) of the Food and Agriculture Organization (FAO) presented a global analysis of the distribution of forest ecosystems in 1990, as well as changes during the period from 1980-90. The FRA 1990 assessment of the tropical zone was conducted using two complementary approaches. The first was based on statistical analysis of existing, reliable forest inventory data from different countries. The second approach made use of multi-date observations of forest cover using high-resolution satellite images for 1980 and 1990. Different international projects and missions are now using remote sensing techniques to map forest or land cover digitally at global and/or regional levels. This acquisition of images of earth from space has opened new frontiers in mapping.

Global Land Cover 2000 (GLC 2000)

Efforts have been started to map the distribution and extent of the major land cover classes at a global level. A monitoring system that encompasses all of the geographic and ecosystem dimensions of the changes resulting from

industrialization and urbanization was developed as GLC 2000. This effort provides a baseline map which can be used in conjunction with other data sets available to define the extent of deforestation. As a part of the GLC 2000 initiative, SPOT vegetation data has been used to prepare a land use/land cover map of South Asia at a 1 km spatial resolution (Agarwal et al., 2003).

Biome Level Classification

The repetitive cycle of Indian Remote Sensing (IRS) Wide Field sensor (WiFS) gives a unique edge on phenology process modeling. WiFS provides regional coverage at very high temporal resolution. It is the first of its kind to efficiently overcome the shortcomings of NOAA-AVHRR (Advanced Very High Resolution Radiometer). The ISRO-GBP project entitled 'Biome level characterisation (BLC) of Indian vegetation using IRS WiFS data' undertakes the nationwide land cover/use mapping and subsequently uses it for biome classification. The robust BLC model explains the criteria to delimit the distribution of sub-biomes attributed to climatic data (rainfall and temperature) and topographic configuration. The temporal resolution along with the recommended spatial and spectral resolution allows assessment of the phenological growth of vegetation in terrestrial ecosystems. Using climatic data along with a biogeographic map, the biomes in India have been delineated. This tool has demonstrated its ability in classifying forest type, land use/land cover, and agriculture production on the Indian subcontinent with an accuracy of 80% by using combination of multi-date data. WiFS data has been successfully used to characterize vegetation of different bio-climatic situations (e.g Singh et al. 1999).

Landscape dynamics and predictive modeling

Forest landscapes are subject to severe impacts as a result of land-use changes and unsustainable exploitation. The forests of Meghalava are no exception. Shifting cultivation and continued disturbance have affected most forests within the region. Increased cultivation has driven land-cover conversion, land degradation and intensification of land use. The destruction of forests has altered the natural landscape of Meghalaya which has resulted in fragmented landscape with poor species composition (Talukdar et al., 2001). A study was initiated to assess disturbance regimes based on land-use dynamics and landscape analysis in Meghalaya. The study was designed to allow prediction of future impacts on forests of the region. In order to characterize landscape dynamics, information was collected about its current

and prior states. Results of the study indicate that Meghalaya lost about 275.60 km^2 per year from 1980 to 2000. The predicted rate of loss of forest cover for the next decade is 259.88 km^2 per year. In the four decades following 2010 rates of loss would be reduced to 20.23 km^2 per year; however, the irony is that according to the model there will be little remaining forest cover to lose by 2050.

Biodiversity characterisation at the landscape level in India

A project is presently being undertaken by the Department of Space and Department of Biotechnology to prioritize national conservation activities in the biologically rich areas in the three mega-diversity sites of India. The study has analyzed large and diverse landscapes and found that habitat fragmentation has led to biodiversity loss. Highly fragmented forests were shown to have fewer plant species, reduced anthropogenic usefulness and newer community types than less fragmented forests.

The information generated in this study will be of immense use if it is linked to other planning and policymaking efforts that direct resource allocation, land use planning and sustainable consumption of natural resources.

Biodiversity Information System (BIS)

The varied regions of the country, with their unique floristic and faunal richness, vastness, endemism, heterogeneity and also inaccessibility of large areas have necessitated collection of authentic baseline data on biodiversity. The BIS is essential to monitor, analyze and plan action-oriented programs for conserving and preserving India's biological wealth. The spatial characterization of landscape structures and their linkage to information on the floristic composition, economic valuation, and endemism has been developed in the BIS (Roy et al., 2002).

The BIS is an integrated system of large databases that uses Internet GIS. The information within the BIS was generated as a part of a project entitled "Biodiversity Characterization at Landscape Level using Remote Sensing and Geographic Information System" completed by the Department of Biotechnology and the Department of Space, Government of India. The project provided information on vegetation type, land use, disturbance regimes, and biological richness, as well as non-spatial data on plant species and ancillary information from different sources. The database and the wealth of information stored within the database are intended to facilitate development of legislative measures related to conservation.

Conclusions

Satellite images are a very convenient tool to measure landscape patterns since they provide a digital mosaic of the spatial arrangement of land covers. The technology helps in extracting information that describes vegetation diversity i.e. extent, structure, composition, biomass/production and condition. Although each of these can be measured on the ground, they may be interpreted more effectively from satellite imagery. With careful ground truthing, it is possible to draw limits around vegetation types and thus remote sensing can be used successfully to identify the frequency, boundaries, sizes and shapes of different landscape components.

Patterns of disturbance and habitat fragmentation can be identified and combined with studies to assess their effects on biodiversity. It is clear that geoinformatics and GIS are important to the monitoring of the key attributes of biodiversity, including both flora and fauna. Integrating these data and tools into models makes the biological data more accessible, and will enable the development of more effective conservation policies and practices.

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Intersectoral Linkages for Conservation and Management of Forest Resources – A Case Study on Mangroves of India

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Introduction

Importance of mangroves

Mangrove forests are found in tropical and subtropical estuaries, where there is constant exchange of seawater and river water. Mangroves contain a rich diversity of intertidal fauna and flora, including specialized plants with stilt roots and pneumatophores that adapt them to wetland conditions. Mangrove wetlands serve as spawning and nursery grounds for many economically important freshwater and marine fishes and play an important ecological role as nesting grounds for many resident and migratory birds. Although these ecosystems are highly productive, the full importance of mangroves is still relatively poorly understood.

Mangrove forests form a thick coastline near estuarine areas that protect mainland areas from cyclones and the full force of storm water. They also prevent soil erosion along the river coast, preventing sedimentation near the river mouth, and allowing normal nutrient flow into the sea.

Mangroves of Andhra Pradesh

The state of Andhra Pradesh has a geographical area of 276,000 km^2. Out of this, 23% is forested – an area of 63,770 km^2. However, of the forested area, only 582 km^2 is mangroves, just 0.9% of the total forest area of the state.

About 40 major, medium and minor rivers flow through the state. Out of these, the most important rivers are the Godavari, the Krishna, the Pennar and the Vamsadhara (respectively). The majority of mangroves are present in the estuaries of these rivers, with the Godavari mangroves in the Godavari estuary in the East Godavari district, the Krishna mangroves in the Krishna estuary of Krishna and Guntur districts as well as small patches of mangroves on the coasts of the Visakhapatnam, West Godavari, Guntur, and Prakasam districts.

Management of ecosystems with intersectoral approaches

Mangroves and other forested ecosystems can be effectively managed through village level institutions. In India, elected democratic institutions called Panchayat Raj Institutions (PRI – Panchayat is a local administration body) are available at the grass roots level. The decade-old Joint Forest Management (JFM) movement has been in operation in more than 62,000 villages. This has improved the biophysical condition of around 11.2 million hectares of degraded forest and the socio-economic conditions of about 35,000 villages. Apart from this, there is a better understanding between foresters and community members that has also resulted in community playing an effective role in forest management.

The JFM has been implemented with funding from external agencies like the World Bank. At present there are many international development agencies involved in implementing projects on poverty alleviation, watershed development, rural development and fisheries development. These programs are implemented independently from one another which results in overlapping in some areas and certain key areas getting neglected. As forest resources and biodiversity are very much interlinked to poverty and socio-economic conditions of local communities, there is a greater need for intersectoral linkages, primarily for biodiversity conservation and sustainable management, starting with forest resources, and by addressing value addition to the non-timber forest products (NTFP).

Climate change and sea level rise jointly threaten coastal ecosystems. Restoration and conservation of mangrove habitats through the work of local communities helps sequester carbon in peat, provides livelihood benefits to the local communities, and provides protection from storms.

Linkages

Linkages between forest and tribal development agencies are being developed for the management of terrestrial forests. Linkages between forest and fisheries development agencies will assist in the management of coastal mangrove forests. These linkages will enable tribal and fishermen communities, who have been custodians of these ecosystems, to participate in the sustainable management of biodiversity in conjunction with rural development agencies, banking institutions and non-governmental organizations (NGOs). More detailed information on the proposed linkages is shown in Figure 1.

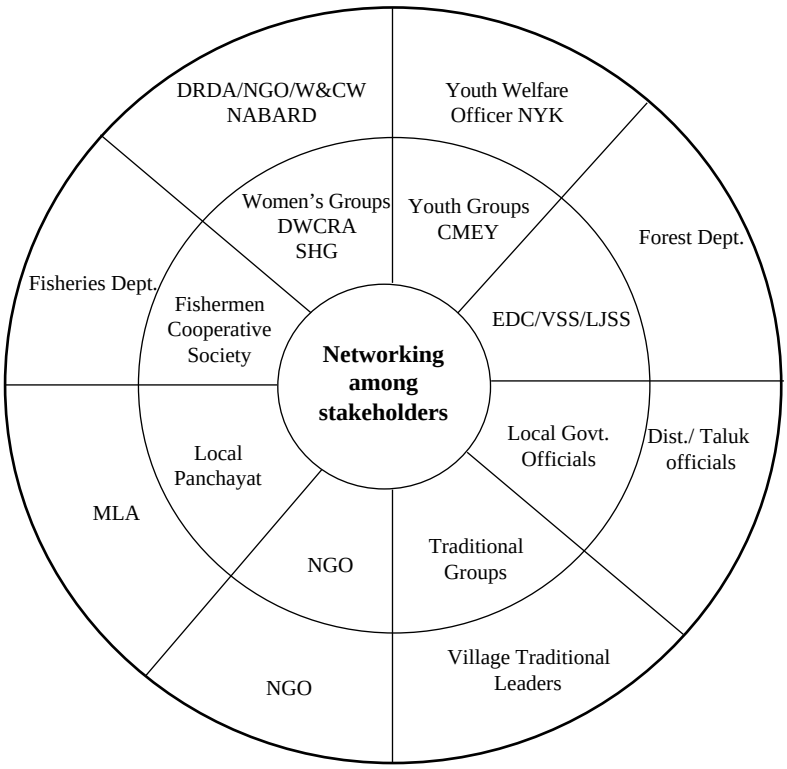

Figure 1: Proposed linkages required to enable sustainable management of mangrove wetlands

Acronyms: MLA – member of legislative assembly, NYK – Nehru Yuva Kendra, CMEY – Chief Minister's Employment for Youth, SHG – Self Help Groups (Women), NABARD – National Bank for Agriculture and Rural Development, W & CW – Women and Child Welfare, DRDA – District Rural Development Authority. Dept. – Department, Dist. – District, Govt. – Government. Other acronyms are defined in the text.

How the mechanism of Joint Forest Management (JFM) / Joint Mangrove Management (JMM) works

The JMM model consists of two aspects. The first involves mobilization of institutional organizations and mobilization of the community towards mangrove management. It also involves village development through training and capacity building and awareness generation. Village-level institutions like

the Eco Development Committee (EDC) and Vana Samrakshana Samithi (Forest Conservation Council - VSS) in Andhra, the Luna Jungla Samrakshan Samithi (Mangrove Conservation Council - LJSS) in Orissa and VDMC in Tamil Nadu (as per JFM terminology) are established as a result of these activities.

The second aspect of the JMM model is the technical part. This includes identification of site-specific causes for degradation, and planning for restoration. These planning activities include taking geomorphological and hydrological factors in to consideration when constructing canals to facilitate tidal influx. Specifically, these activities must consider tidal amplitude and river water inflow and outflow to arrest further degradation, and reduce hyper–salinity. Maintaining appropriate conditions allows the easy establishment of mangrove plantations and facilitates natural regeneration.

These two aspects form the package of JMM that has been tested in Andhra Pradesh. JMM in this region has resulted in the restoration of 515 hectares of degraded mangroves and brought over 9,442 hectares of verdant mangroves under the management of the village level JMM institutions. At present the Forest Department has accepted the technical part and is testing the social mobilization part of the JMM. The sustainable management of mangrove wetlands will be possible only when the Government of India adopts the whole JMM package and begins large-scale restoration of mangrove wetlands using this framework.

In many of the JFM/JMM rehabilitated areas, the key stakeholders (local communities) have seen greenery shooting up and previously barren areas have shown an strong increase in biodiversity, with the return of animal, insect, bird and plant species. In some areas where the water table has been problematically low, water levels have increased so much that the change has to be seen to be believed.

The self-help thrift groups and the micro enterprises linked micro credit have helped people increase their incomes and have also helped to develop a better rapport with the administration. This has assisted in leveraging the much needed community participation in the rehabilitation exercise.

Conclusions

The Joint Mangrove Forest Restoration and Management undertaken in protected areas is different from the existing Joint Forest Management in reserve forests. In JFM areas, members of the Vana Samrakshana Samithi

(VSS) institution are entitled to the usufructs of forests, in the form of Minor Forest Producer (MFP) from the areas being protected under the respective management units of the VSS. As far as mangrove ecosystems are concerned, local people can only derive indirect benefits in the form of fisheries. Hence, developing a mangrove management system requires the improved understanding of stakeholder interests, particularly the interests of local fishermen and the forest and fisheries departments, and of the ecological roles played by the mangroves in fishery resources. The cyclones (particularly in 1996), which devastated the Andhra Pradesh coast were an eye opener to local fishermen and managers of the mangrove forests, showing them the important defensive role that is played by the mangroves in protecting the life and property of the coastal people.

The JMM model developed by the M. S. Swaminathan Research Foundation (MSSRF)- Indo-Canada Environment Facility (ICEF) project, incorporates training and capacity-building for leveraging financial support from other agencies. In total, 1,400 hectares of degraded mangroves have been restored and 15,000 hectares of verdant mangroves have been brought under the joint management by implementing the JMM model along the east coast of India. It incorporates self-propelling mechanisms like daily loan schemes, and empowerment-oriented training on topics like coir rope making, tailoring, raising of homestead kitchen gardens, and the use of community woodlots to reduce mangrove dependency. Training conducted for the EDC/VSS members in canal construction work made the people recognize their potential, and the value of hard work. The wages for undertaking restoration work also generated income within the village. Training and human resource development using a welfare-oriented approach also helped people realize their potential and helped them recognize the need to conserve the mangrove ecosystems on which their livelihoods depend. The JMM guidelines need policy support to help implement this model in other areas within southern India and in areas with similar conditions like parts of Asia and Southeast Asia.

Acknowledgements

The authors wish to thank Prof. M. S. Swaminathan, Chairman, for his constant guidance and encouragement and to Prof. P. C. Kesavan and Dr. V. Selvam, M. S. Swaminathan Research Foundation for their encouragement. The authors acknowledge the help and support of their colleagues. The help and cooperation rendered by the Forest Departments of Andhra Pradesh, Tamil Nadu and Orissa states is deeply acknowledged. India-Canada Environment Facility (ICEF), New Delhi is thanked for the financial support. The present

study is done in collaboration with the fishermen living abutting the mangrove wetlands.

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Outputs and Activities

Results of Group Work on Mainstreaming Biodiversity and Climate Change

The Working Group identified four essential principles related to mainstreaming biodiversity and climate change:

- All interventions should be based on effective participation of all stakeholders as far as possible with due consideration to gender and equity;
- Collective political will is essential for achieving long-term vision of the conventions, the Millennium Development Goals (MDGs) and WEHAB (Water, energy, health, agriculture and biodiversity);
- Respect for cultural traditions, values, and ensuring rights of local communities is crucial;
- Elimination of current and potential conflicts at national, regional and global levels must be supported to ensure that sustainable development is achieved.

Activities common to the UN Framework Convention on Climate Change (UNFCCC), Convention on Biological Diversity (CBD) and Convention to Combat Desertification (CCD) were identified by workshop participants to identify opportunities for cooperation and synergies. The activities listed in this section are classified under the following cross-cutting thematic areas of the UNCBD, UNFCCC and UNCCD (as identified by the Joint Liaison Group of these conventions): impacts and adaptation; research and systematic observation; policies, legislations and regulations; capacity building; financing; education and awareness; technology transfer and development; reporting; and institutional mechanisms.

Impacts and Adaptation

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Support afforestation and reforestation processes that address carbon sinks, land degradation and biodiversity conservation
✔	✔	✔	Develop early warning systems for natural disasters and land degradation processes and effectively disseminate these warnings to stakeholders in local communities
✔	✔	✔	Encourage integrated watershed management using a basin-wide approach
✔	✔		Strengthen the effectiveness of buffer zones and ensure representativeness of protected areas
	✔	✔	Develop appropriate cropping systems with drought-, saline- and flood-tolerant species and varieties. Use an ecosystem approach in agriculture
✔	✔	✔	Sustain stable human settlements in mountain areas
✔	✔		Establish marine biodiversity conservation areas with particular attention to coral reefs
✔	✔	✔	Promote means of sustainable landscape management
✔	✔		Use an integrated approach to management of coastal wetlands with a focus on the protection of mangrove and coastal ecosystems
✔	✔		Promote waste management systems that use the 3-R principles (reduce, re-use, recycle)

Research and Systematic Observations

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Establish ecological benchmarks, standards and baselines for monitoring vegetation changes, land degradation, and impacts of climate change on biodiversity and carbon stocks through appropriate research and development efforts, monitoring and evaluation
✔	✔	✔	Compile a database including scientific parameters, tools, techniques, experiences and lessons learned and disseminate this knowledge and information
✔	✔	✔	Develop biological indicators for pollution monitoring and assessment of ecosystem health
✔	✔	✔	Assess adverse impacts of climate change and desertification on biodiversity and effectively disseminate the findings
✔		✔	Support the use of modern methods of water harvesting and management that incorporate traditional knowledge and practices
✔	✔	✔	Develop pollution treatment and abatement methods that ensure environmental sustainability, conservation and sustainable use
✔	✔	✔	Develop and compile tools and techniques for sustainable mountain area development, including addressing issues of environmental impact assessment (EIA), soil conservation and watershed management
✔	✔	✔	Support bioprospecting aimed at the development of new drugs and medicines
✔	✔	✔	Develop carbon trading systems
✔	✔	✔	Develop tools, techniques and management systems that address issues of forest fires (through appropriate actions and policies including through community participation)
✔	✔	✔	Ensure that National Communications (NatComs - UNFCCC), National Adaptation Programmes of Action (NAPAs - UNFCCC), National Action Programs (NAPs - CCD) and National Biodiversity Strategy and Action Plans (NBSAPs - CBD) are complimentary to each other as well with poverty reduction strategy papers (PRSP)
✔	✔	✔	Initiate green accounting and valuation of ecosystem functions

Policies, Legislation and Regulations

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Develop policies that support integrated watershed management, sustainable agricultural practices and reduce environmental degradation
✔	✔	✔	Integrate EIAs, social impact assessments (SIAs) and Strategic Environmental Assessments (SEAs) into structural adaptation measures
✔	✔	✔	Establish systems of appropriate land-use practices including policy monitoring and zoning through proper characterization of land types
✔	✔	✔	Develop policy interventions to provide access to resources for bona fide users and to address users' needs
✔	✔	✔	Develop joint policy for implementation of the Rio conventions
✔	✔	✔	Support policies in mountain areas that aim to achieve sustainable development
✔		✔	Develop and review disaster management strategies, also suggesting remedial actions
✔	✔		Develop and review policies that address issues of water supply and air quality to enhance human and animal health
✔	✔		Develop management strategies, including use of appropriate biological interventions, to deal with pathogens, vectors and diseases affecting human health that have linkages to environmental hazards
✔	✔		Identify and develop soft and hard options to deal with sea level rise and associated adaptation needs
	✔	✔	Develop and review policies that support reducing the use of chemicals and avoiding the introduction of invasive alien species

Capacity Building

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Use integrated programmes to enhance or build the capacities of national focal points and other stakeholders for the implementation of UNFCCC, CBD and CCD
✔	✔		Enhance the capacities of local communities to deal with sustainable ecosystem management including coastal zone management
✔	✔		Enhance the capacities of governments and communities of small-island developing states (SIDS) and low-lying coastal areas to sea level rise.

Financing

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Develop community-based funds to support local action dealing with issues of climate change and biodiversity
✔	✔	✔	Prioritise projects that address synergies
✔	✔	✔	Modify and simplify existing financial mechanisms to ensure and expedite flow of funds

Education and Awareness

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Ensure regular consultations between policy-makers and other stakeholders for decision-making purposes and to share knowledge and skills
✔	✔	✔	Promote the use of indigenous knowledge and skills to deal with issues of sustainable development and environmental management using the ecosystem approach. Using indigenous knowledge and skills for policy making.
✔	✔	✔	Launch an intensive awareness-raising programme using popular media
✔	✔	✔	Influence policy-makers to support actions on synergies at national, regional and global levels
✔	✔	✔	Integrate multilateral environmental agreement (MEA) issues into the formal and non-formal educational curriculum through appropriate programmes
✔	✔	✔	Assess adverse impacts of climate change and desertification on biodiversity by developing and disseminating tools, tool kits and findings

Technology Development and Transfer

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Support and facilitate transfer of clean environmental technologies (North-South, South-South, South-North)
✔	✔		Develop financial and technical mechanisms through the clean development mechanism (CDM) and bio-prospecting for biodiversity conservation
✔	✔	✔	Develop appropriate agro-silvi-pastoral technologies to deal with adaptation issues
✔	✔	✔	Develop early warning and decision support systems for natural disasters and land degradation processes
✔	✔	✔	Promote appropriate water management practices to prevent wastage of water and support sustainable use
✔	✔		Promote use of alternate and clean energy technologies
✔	✔		Develop, modify and transfer technologies for treatment of effluents that pollute coastal belts as well as coral reefs

Reporting

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Ensure that NAPA, NAP, NBSAP and PRSP are complimentary
✔	✔	✔	Encourage development of synergistic reporting (formats and contents) for CBD, UNFCCC, CCD
✔	✔	✔	Develop and disseminate information related to Capacity Development Initiative (CDI) processes, progress, and activities to encourage synergies. This information should incorporate National Capacity Self Assessment (NCSA)-related activities.
✔	✔	✔	Ensure synergies are reflected in the national MDG report preparation processes

Institutional Mechanisms

Climate Change	Biodiversity	Desertification	
✔	✔	✔	Resolve inter-sectoral conflicts through appropriate institutional mechanisms
✔	✔	✔	Ensure regular consultations are held between policy-makers and other stakeholders on participatory decision-making processes

Issues for further discussion

Several further areas were identified for further discussion (areas for potential synergies are indicated in brackets):

- Intellectual Property Rights (IPRs) and Traditional Knowledge (TK) (climate change and biodiversity)
- Biodiversity registration; documentation (climate change, biodiversity and CITES)
- Risk management options, coping strategies of the poor (climate change and desertification)
- Linkages with other conventions, agreements, and processes (WTO, RAMSAR, CMS, POPs, GEF, CITES)
- Compliance and enforcement (climate change, biodiversity and desertification)

Outputs and Activities

Country priorities: Actions at national and regional levels

One of the most important sessions of the workshop dealt with prioritizing urgent actions necessary to foster climate change mitigation and adaptation and in doing so limit the adverse effects on biodiversity and livelihoods in individual countries. The participants, using their first-hand knowledge, reported on priorities for their own countries. The prioritized actions were categorized into the cross-cutting areas of UNCCD, UNFCCC and CBD as identified by the Joint Liaison Group (JLG) of the conventions.

Bangladesh

Impacts and Adaptation

Develop appropriate cropping systems with drought-, saline- and flood-tolerant species and varieties. Use an ecosystem approach in agriculture.

Approach

- Undertake research on developing suitable varieties of rice using indigenous varieties as the basis. The types of seeds needed may include varieties of early maturing Boro rice to combat early flooding, deep water varieties of High Yielding Varieties (HYV), Kharif rice, and varieties suited for late planting and for semi-saline environments;
- Develop an incentive structure for scientists;
- Develop a larger stock of seeds;
- Use field tests to establish the suitability of different varieties;
- Train extension workers;
- Organize approvals of the seed board;
- Encourage continuous monitoring and feedback.

Research and Systematic Observations

Develop a mechanism that ensures optimum downstream flow (mainly for fish production).

Approach

- Identify the locations where water flows are obstructed and the impacts of the obstructions;
- Carry out studies on fish spawning characteristics and locate fish migratory routes;
- Identify obstructions to the migration of aquatic species and establish mechanisms to address the obstructions;
- Quantify minimum flows necessary to support aquatic species.

Policies, Legislations & Regulations

Establish systems of appropriate land-use practices including policy monitoring and zoning through proper characterization of land types.

Approach

- Review existing land-use policies and alternative, more appropriate land-use practices;
- Identify the changes necessary to adopt more appropriate practices and ways to make these changes;
- Advocate policy reform and implementation of changes in land-use policy and practices.

Capacity Building

Build and enhance capacities for national focal points and other stakeholders on UNFCCC, CBD and CCD through an integrated programme.

Approach

- Reform the organizational structure of the Ministry of Environment and Forests and the Department of Environment to properly reflect the responsibilities for implementing MEAs;
- Develop appropriate human resources;
- Develop a system for the officials to continue this office for a minimum required period;
- Develop appropriate systems to maintain and strengthen institutional memory.

Funding

Prioritise projects that address synergies.

Approach

- Review all of the relevant MEAs;
- Find synergies between MEAs;
- Develop projects to implement the synergies.

Education and Awareness

Develop and disseminate tools, tool kits and findings on issues of assessment of adverse impacts of climate change and desertification on biodiversity.

Approach

- Identify methodologies for assessing adverse impacts of climate change and desertification on biodiversity;
- Develop appropriate tools and tool kits based on the methodologies;
- Test the application of the tools;
- Involve communities and other stakeholders at each stage;
- Disseminate information nationwide using workshops, distribution of materials, etc.

Bhutan

Research and Systematic Observations

Establish ecological benchmarks, standards and baselines for monitoring vegetation changes, land degradation, and impacts of climate change on biodiversity and carbon stocks through appropriate research and development efforts, monitoring and evaluation.

Approach

- Collect and analyze baseline data using a consultative process;
- Implement the standards.

Capacity Building

Build or enhance capacity for national focal points as well as other stakeholders on UNFCCC, CBD and CCD and their implementation through an integrated programme.

Approach

- Establish a committee consisting of the various focal points;
- Report on the integration of synergies (NAPA, NAPs and NBSAPs).

Education and Awareness

Develop awareness-raising programmes at the community level, bringing in the recent decentralisation policy (dissemination of power to the block level-GYT and district level - DYT).

Approach

- Enhance the existing Micro-Environmental Action Plan implementation.

India

Impacts and Adaptation

- Establish systems of appropriate land-use practices and zoning, adopting a landscape/ecosystem approach with a focus on afforestation, reforestation, carbon sequestration and integrated watershed management.
- Develop early warning systems for natural disasters and land degradation processes and effectively disseminate these warnings to stakeholders at the grass-roots level.

Research and Systematic Observations

- Set up ecological benchmarks, standards and baselines for monitoring vegetation changes, land degradation and impacts of climate change on biodiversity and carbon stocks through appropriate research and development efforts, monitoring and evaluations.

Funding

- Prioritize projects that address synergies;
- Develop community-based funds to support local action dealing with issues of climate change and biodiversity.

Education and Awareness

- Promote the use of indigenous knowledge and skills to deal with issues of sustainable development and environmental management, using an ecosystem approach. Uses these skills and knowledge in policy-making.

Lao PDR

Impacts and Adaptation

Support stable human settlements in mountain areas.

Approach

- Improve the quality of human resources;
- Improve agriculture practices;
- Build the capacities of farmers and encourage the use of better cultivation practices;
- Control landslides.

Policies, Legislations and Regulations

Integrate EIA, SIA and SEA concerns into structural adaptation measures.

Approach

- Incorporate EIA as an essential element of project development;
- Encourage better irrigation systems as a means of poverty reduction;
- Support income generating activities (e.g. ecotourism);
- Develop community-based environment funds.

Capacity Building

Enhance capacities of local communities to deal with sustainable ecosystem management.

Approach

- Train the trainers;
- Initiate pilot projects in at least 2-3 areas;
- Exchange experiences with communities on sustainable ecosystem management through workshops and study tours.

Funding

Develop community-based funds to support local action dealing with issues of climate change and biodiversity.

Approach

- Integrate the concept of climate change into national planning;
- Allocate finances.

Education and Awareness

Influence policy-makers to support actions on synergies at national, regional and global levels.

Approach

- Enhance information dissemination;
- Organise a workshop to address synergies at a policy-makers level;
- Encourage the exchange of professionals from country-to-country;
- Enhance exchange of knowledge about synergies through study tours.

Nepal

Research and Systematic Observations

Develop and compile tools and techniques for sustainable mountain area development including addressing issues of EIA, soil conservation and watershed management.

Approach

- Hire consultants or formulate an inter-agency task force;
- Prepare a draft report for expert review;
- Create a database on tools and techniques and disseminate this information using a website;
- Use legal tools in EIA report preparation and review through existing regulatory framework (i.e. Environment Protection Act, 1996 and Environment Protection Rules, 1997);
- Integrate soil conservation and watershed management into development programmes, particularly the infrastructure programmes, through existing policies and strategies.

Capacity Building

Build and enhance capacities of the national focal points and other stakeholders, including local communities, on UNCCD, UNFCCC and CBD through extensive awareness-raising programmes.

Approach

- Collect and collate information;
- Organise workshops and training sessions;
- Identify concerned specialists and focal points;
- Prepare material for the press and local communities;
- Develop a media communications campaign and use the media to disseminate materials.

Technology Development and Transfer

Promote use of alternative and clean energy technologies (hydropower, solar and wind energy).

Approach

- Perform research on alternative and clean energy technologies and disseminate findings through the Alternative Energy Promotion Centre and the Rural Energy Development Programme;

- Assist in developing pilot projects;
- Encourage the continued use of subsidies, particularly for the promotion of the use of biomass fuels;
- Develop a mechanism for subsidies in other areas such as micro-hydropower and solar energy.

Reporting and Research

Ensure that NAPAs, NAP and NBSIP (Implementation Plan) are complementary to each other as well as PRSP.

Approach

- Encourage the use of processes that facilitate inter-sectoral coordination;
- Create a task force to identify strengths, and areas where improvements are required;
- Organise cross-sectoral workshops and share information;
- Support consultation amongst the focal points;
- Facilitate achievement of synergies among the programmes.

Technology Development and Transfer

Develop financial and technical mechanisms through the CDM and bioprospecting for biodiversity conservation.

Approach

- Organise a consultation programme or workshop on CDM and bioprospecting;
- Establish a taskforce to implement cleaner technologies;
- Develop mechanisms to reduce fossil fuel burning;
- Conduct a workshop and other activities to finalize mechanisms to reduce reliance on fossil fuels and encourage use of cleaner technologies.

Sri Lanka

Impacts and Adaptation

Develop conservation financing mechanisms through bioprospecting and carbon trading.

Approach

- Develop community-based funds;
- Support afforestation and reforestation programs that address biodiversity and carbon stocks;
- Establish bioprospecting mechanisms aiming at providing inputs from new drugs and medicine;
- Develop CDM projects that address land degradation and CBD issues;
- Establish joint steering committees.

Technology Development and Transfer

Develop appropriate agro/silvi-pastoral technologies to deal with adaptation issues.

Approach

- Develop drought-resistant agri/silvi/pastoral varieties;
- Encourage cropping systems that are resilient to natural hazards;
- Augment warning systems to the grassroots level to adapt appropriate agro/silvi/pastoral systems;
- Adopt an ecosystem approach to agri/silvi/pastoral systems;
- Establish joint programmes to develop ecological benchmarks, baselines and indicators for monitoring biodiversity, land degradation and climate change variables for synergistic reporting and information dissemination.

Research and Systematic Observations

Approach

- Identify ecological benchmarks, baselines and indicators;

- Improve combined databases on the Rio Conventions;
- Encourage use of a synergistic reporting format and procedures for submitting reports to UNFCCC, CBD and UNCCD;
- Develop a joint monitoring system;
- Establish a joint system to prepare NAP, NBSAP, NatCom and related documents;
- Adapt a joint dissemination programme.

Policies, Legislations and Regulations

Develop joint policy for implementation on Rio conventions.

Approach

- Ensure regular consultation between sectors, policy-makers, stakeholders;
- Promote participatory decision making;
- Develop regulatory framework to provide strong foundations for synergistic implementation.

Education and Awareness

Integrate MEA issues on educational curriculum (formal as well as non-formal) through appropriate programmes.

Approach

- Introduce MEA issues in curricula at all levels of university education;
- Encourage a non-formal education system;
- Develop joint public awareness programme;
- Raise awareness for key stakeholders (e.g. politicians).

Vietnam

Impacts and Adaptation

Support afforestation and reforestation processes that address carbon sinks, land degradation and biodiversity conservation.

Approach

- Develop guidelines and manuals on selection of suitable species and forest planning;
- Build capacities of people to apply these techniques;
- Encourage integrated watershed management using a basin-wide approach;
- Develop mechanisms to disseminate lessons learned;
- Encourage public-private partnerships in watershed management;
- Develop and expand the Marine Protected Area (MPA) network.

Policy, Legislations and Regulations

Establish systems of appropriate land-use practices including monitoring and zoning through proper characterisation of land types.

Approach

- Review and strengthen land allocation policy and regulations.

Capacity Building

Build and enhance the capacities of national focal points and other stakeholders on UNFCCD, CBD, CCD and their implementation through an integrated programme.

Approach

- Encourage information sharing;
- Organize workshops, seminars, training;
- Publish guidelines, booklets, resource kits etc. for dissemination;
- Support the participation of the focal points at the convention events (e.g. Conference of the Parties, Subsidiary Body for Scientific and Technological Advice etc.);
- Enhance the capacities of local communities to practice sustainable ecosystem management, including coastal zone management;
- Support the development of eco-villages;
- Develop community-based MPAs.