Reducing Carbon Emissions

through Community-managed Forests in the Himalaya

Editors

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ICIMOD

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- *Kamal Banskota*

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Foreword

Mountain systems are seen globally as the prime sufferers from climate change. Enhancing resilience and promoting adaptation in mountain areas have thus become among the most important priorities of this decade. The present study describes an example of how mountain areas and mountain people can contribute effectively to mitigation through carbon sequestration, although compensation for their services has yet to be realised.

Climate change has become an overriding issue and its impacts are recognised to be felt globally. The fragile ecosystem of the Himalayas is exceptionally susceptible to even minute variations in climatic conditions and is likely to experience many such impacts over the coming decades. Studies suggest that mountain people in general and poor people in particular are more vulnerable to the impacts of climate change than communities in the plains. The research disscused here looks at emerging issues of climate change and how community forests can help mitigate concentrations of atmospheric carbon dioxide.

The Kyoto Protocol recognises forest management activities in industrialised countries, where CO_2 effects from the management of existing forests can be accounted for in the national green house gas inventories. For non-industrialised countries, forest management as such is not recognised; these countries can only participate in afforestation and reforestation activities, management of existing forests is excluded. In other words the Kyoto Protocol only recognises forests as carbon sinks (afforestation and reforestation) and not as carbon sources (avoiding deforestation), and thus fails to address avoiding further emissions from deforestation in non-industrialised countries. The Protocol provides no incentives to non-industrialised countries to reduce or stop deforestation or maintain healthy forests, for example through community management. Communities that manage forests in a sustainable manner contribute to stabilising atmospheric CO_2 concentrations by maintaining a carbon pool in the terrestrial ecosystem. Deforestation in the tropics accounts for 18-25% of all anthropogenic CO_2 emissions, thus the United Nations Framework Convention on Climate Change (UNFCCC) needs to address this issue urgently in order to make its efforts to reduce global emissions more effective. The present publication highlights the failure of the Kyoto Protocol to address emissions reduction at the grassroots level by excluding avoided deforestation (community forest management) as an effective emissions reduction strategy in non-industrialised countries.

Over the past several decades, the Himalayan region has witnessed a shift in the common property resource management paradigm, from one that excluded local stakeholders from forest management towards one that includes them. This devolution in authority from state to local communities has been successful in reducing deforestation and increasing biomass in common lands through formal institutions established by forest user communities. This has been effective in helping local people meet their needs for firewood, timber, fodder, grass, and other products from the forest.

It is now time to consolidate local actions and raise the concerns of communities about receiving payments for the global benefits they render by sequestering carbon and reducing atmospheric CO_2 concentrations emitted from the industrialised world. The value of sequestered carbon is an incremental benefit for which local communities should receive payments, but so far, global rules under the Protocol exclude recognition of their efforts. Through this project in India and Nepal, described in this publication, communities managing their forests have learned about carbon sequestration and its importance to climate. These communities have realised the benefits they are contributing to mitigating climate change. They have collaborated towards this research and have developed competency in monitoring carbon in their forests using the IPCC guidelines to measure carbon. If payment for carbon from community forests becomes possible, communities will be in a position to retain larger benefits by being able to reduce transaction costs. At the same time, the incremental benefits may persuade more communities to conserve their forests with greater vigour and effectiveness.

As preparatory work is being done for the second commitment period, the UNFCCC has requested countries to submit policies on reducing emissions from deforestation. This research comes at the right time, and reflects the concerns of local communities that conserve forests and reduce global emissions but whose efforts for payment are not recognised. The time is ripe to take up this issue globally because what comes after 2012 is being debated at present.

I would like to thank all the researchers and contributors to this publication. The research project 'Kyoto: Think Global Act Local' was conducted in seven countries and was funded by the Netherlands Development Cooperation (DGIS). I thank DGIS, as well as the Technology and Sustainable Development section of the Centre for Clean Technology and Environmental Policy, University of Twente, Netherlands, who coordinated the research effort. At the field level in the Himalayan region, our two partner institutions have done a commendable job in involving local community forest user groups in implementing the research initiative. The Central Himalayan Environmental Association conducted the research in Uttarakhand, India, and the National Trust for Nature Conservation undertook the research in Nepal. Special thanks and a word of appreciation goes to the local communities in India and Nepal who helped carry out this action research initiative. Finally, I would like to thank Kamal Banskota, Programme Manager, ICIMOD, for coordinating the project and the publication of the results in this book.

Dr. Andreas Schild
Director General
ICIMOD

Abstract

Climate change is real and is occurring at an alarming rate. Currently, worldwide deforestation alone accounts for approximately 18-25% of global greenhouse gas emissions, yet this could be curbed quickly by avoiding deforestation. Forests act both as a carbon source and sink depending on the management regime, and hence can play an important role in stabilising atmospheric concentrations of greenhouse gases (GHGs) such as carbon dioxide (CO_2).

The concern to reduce concentrations of GHGs and CO_2 in order to mitigate global warming has led to the global agreement on the Kyoto Protocol. Under the Protocol, in non-industrialised or developing countries the forest is only permitted as a sink measure in the form of afforestation and reforestation activities; thus the Protocol does not address the huge emissions taking place as a result of deforestation. Forests are not recognised as sources of emissions which can be reduced by avoiding deforestation. One reason for not crediting avoided deforestation under the Kyoto Protocol is uncertainty in quantifying and controlling leakage.

Many communities in non-industrialised countries have been successful in transforming the deteriorating state of their natural forests to sustainable management, thereby avoiding deforestation and the subsequent release of CO_2 emissions into the atmosphere. Some examples of sustainable forest management practices are the Joint Forest Management policy in India, and Nepal's Community Forest Management Programme. These types of community management also result in additional carbon sequestration, but credit for these cannot be claimed under the Clean Development Mechanism (CDM).

This book reports on the work carried out by the research project, '**Kyoto: Think Global Act Local**', which aims to bring local sustainable forest management projects under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The book draws on work carried out since 2003 at three sites in India and Nepal. In India, the project sites were in Uttarakhand State, and in Nepal, in Ilam, Lalitipur, and Manang districts. The project gathered data to show that community-managed forests can play important roles in mitigating the adverse impacts of climate change by sequestering CO_2 from the atmosphere. The levels of CO_2 sequestered annually were quantified from six research sites using the Intergovernmental Panel on Climate Change (IPCC) guidelines. This is probably the first time that the protocol for carbon assessment in the Himalayan region has been carried out. The results show that local people can be trained to assess carbon levels in their community forests.

Community-managed forests in the Himalayan region are becoming an important carbon pool, as previously deforested areas in these forests are showing signs of regeneration. The mean carbon sequestration rate for community forests in India and Nepal is close to 2.79 $tCha^{-1}\ yr^{-1}$, or 10.23 $tCO_2ha^{-1}yr^{-1}$, under normal management conditions and after local people have extracted forest products to meet their sustenance needs. In monetary terms, forested land at existing CDM market prices for CO_2 tonnes could be worth anywhere between US$ 162.84 $ha^{-1}yr^{-1}$, at a rate of US$ 12 per tonne CO_2 and based on biomass data from India, to as little as US$ 34.45 $ha^{-1}yr^{-1}$, at US$ 5 per tonne and based on biomass data from Nepal.

With increasing areas being brought under community management, forests in large parts of the India and Nepal Himalaya are improving and becoming major carbon sinks. The methodology used by this study is important, as it enables quantification of carbon sequestration levels which is required to claim carbon credits. In view of the rise in human and livestock populations in the Himalayan region, carbon trade could be an incentive for forest conservation and management if payment for carbon from avoiding deforestation is recognised. There is little doubt that if carbon payments can be made to communities conserving their forests, this will not only increase community revenues, it will also provide incentives for better forest conservation and management, both of which have beneficial impacts on emissions reduction as well as on the sustainable development of communities and their environments.

Realising that nearly a quarter of the GHG emissions from deforestation is unaccounted by and outside of the UNFCCC, there is growing interest to include deforestation in the second commitment period after 2012. A recent development, the proposed Reduced Emissions from Deforestation (RED), if implemented, could make the UNFCCC more effective in reducing emissions and combating climate change. At the same time, RED would also recognise measures for avoiding deforestation in non-industrialised countries, which could be an incentive to further conserve and manage forest more effectively.

This book is intended to generate awareness on climate change and the role forests in general, and community forestry in particular, play in regulating climate change. The book will be relevant to professionals, researchers, policy makers, and students interested in the topic. In particular, we hope it will be useful to professionals working in community forestry projects in their endeavour to promote payment for CO_2 sequestered by community forests. The book also narrates the IPCC guidelines for measuring carbon.

This research was funded by the Netherlands Development Cooperation (DGIS). The project was carried out in partnership with the Central Himalayan Environment Association (CHEA) and the National Trust for Nature Conservation (NTNC), formerly known as KMTNC. CHEA, based in Nainital, Uttarakhand, was responsible for coordinating field activities in the sites in India, while NTNC coordinated field activities in Nepal.

Acronyms and Abbreviations

AR	afforestation and reforestation
ATHC	Atlantic thermohaline circulation
CDM	Clean Development Mechanism
CER	certified emission reduction
CFC	chlorofluorocarbon
CFM	community forest management
CFUG	community forest user group
COP	Conference of Parties
CO_2	carbon dioxide
C pool	carbon pool
chb	circumference at breast height
dbh	diameter at breast height
FUC	forest user committee
GHG	greenhouse gas
Gt C	gigaton carbon or billion tonnes of carbon
IPCC	Intergovernmental Panel on Climate Change
JFM	Joint Forest Management
KP	Kyoto Protocol
LULUCF	land use, land use change, and forestry
masl	metres above sea level
ppm	parts per million
RED	reduced emission from deforestation
SOC	soil organic carbon
TAR	Third Assessment Report
$tCha^{-1}yr^{-1}$	ton carbon per hectare per year
$tCO_2ha^{-1}yr^{-1}$	ton carbon dioxide per hectare per year
UNFCCC	United Nations Framework Convention on Climate Change
VP	van panchayat
WRI	World Resources Institute

Climate change is occurring at an alarming rate and its adverse impacts are being felt across the globe.

A community-managed forest in Manang, Nepal *(Bhaskar Singh Karky)*

Introduction

1

Kamal Banskota, Bhaskar Singh Karky and Margaret Skutsch

Background

There is a growing body of scientific evidence indicating that the earth's climate is changing rapidly. The summary of the 4th Assessment Report of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC), published in February 2007, reports 11 of the last 12 years from 1995-2006 as among the warmest years recorded since 1850 (IPCC 2007). The rise in temperature is primarily attributed to increase in greenhouse gases caused by human activities. While the 2001 Third Assessment Report (IPCC 2001a) had attributed only 66% probability that human activities are the main causes for the increase in temperature since the mid-20th century, this probability has now been raised to 90%.

Human activity systems lie at the centre of the debate and are thought to be mainly responsible for the changes observed today and those predicted in the future. Some of the activities identified as having led to increased concentrations of carbon dioxide (CO_2) in the atmosphere include those that involve: 1) burning of fossil fuels, which has increased manifold since the start of the Industrial Revolution, and 2) loss of forested areas. Climate change calls urgently for action because concentrations of greenhouse gases (GHGs) including CO_2 have reached levels well above any observed in the last million years. Even if all GHG emitting activities such as burning of fossil fuels, or deforestation were to be stopped tomorrow, the earth's surface temperature would continue to increase for another 50 years because of the time lag between emissions and the earth's response.

Much of the GHG emissions come from industrial processes, production of electricity, and transport in industrialised countries which use large amounts of fossil fuels. In many developing countries, however, there are large emissions of CO_2 from deforestation. This book, which is based on the findings of a research project entitled, 'Kyoto: Think Global Act Local', looks at reducing emissions from deforestation based on field trials in the Himalayan regions of India and Nepal.

The Role of Deforestation in Climate Change

Forests store more carbon dioxide (4500 Gt CO_2) than the atmosphere (3000 Gt CO_2) (Prentice et al. 2001). Conversion of shrub and pasture lands, agricultural fields, or degraded forests into forests leads to sequestration of CO_2 from the atmosphere to the terrestrial ecosystems, where CO_2 is stored in biomass and soil. When forested lands are cleared or converted into other land uses such as agriculture, or urban landscapes, the carbon earlier stored in aboveground and below ground biomass, and in the soil, is released back into the atmosphere. The total amount of CO_2 released from land-use change is estimated to be 1.6 GtC per year over the 1990s (IPCC 2007), although there is a wide range of uncertainty in the estimate. World Resources Institute (2000), for example, estimates that 8 Gt CO_2 is lost annually and released in the atmosphere because of deforestation taking place in Africa, Asia, and South America. While Skutsch, et al. (2007) state that emissions from deforestation account for about a quarter of global emissions. The Stern Review (2007) puts emissions from deforestation in perspective by comparing it with other sectors. Deforestation contributes more than 18% of the global CO_2 emissions, which is more than the total emissions coming from the transport sector. Reforestation on barren lands and avoiding deforestation on lands already with forests are therefore important strategies to check land emission levels.

It is evident that the role of forests in climate change mitigation is significant, and that the carbon dynamics of forests need to be taken into account in mitigation efforts. The central theme of this book is to show that Community Forest Management (CFM) as practiced in the Himalayan regions of India and Nepal contributes to reducing emissions, even though the Kyoto Protocol does not, so far, allow for such activities to enter into the global carbon trading market.

The Kyoto Protocol: A Framework for Collective Action

Global concern to reduce concentrations of GHGs in order to mitigate global warming has led to the Kyoto Protocol (KP) in 1997, which was negotiated in Kyoto, Japan. The KP is an international treaty which builds on the United Nations Framework Convention on Climate Change (UNFCCC), itself adopted at the Earth Summit in 1992. The KP came into force only in February 2005, after Russia's ratification in November 2004. By December 2006, 169 countries responsible for 61.6% of global emissions have ratified the Protocol. Policy details of the KP are discussed in Chapter 3.

The KP is a legally binding international agreement that commits industrialised countries to reducing their emissions of six greenhouse gases (GHGs). Under this framework, a market was developed as well as a number of flexible mechanisms, of which Clean Development Mechanism (CDM) is the one which relates to activities carried out in non-industrialised countries like India and Nepal. Under the CDM, a project to reduce carbon emissions can be set up in a non-industrialised developing country, and the carbon 'saved' can be 'credited' – that is, certificates will be issued on a per tonne carbon base. Developed countries are legally bound to reduce their emissions, but in addition to taking action on this domestically, they may also purchase carbon credits from CDM projects and offset these against their own obligations, thus creating a market for carbon credits.

According to a *Times of India* report (Ranganathan 2007), the emerging global CDM market is worth US$ 50-60 billion annually. At current prices of US$ 12-15 per tonne of CO_2, the report adds, the CDM is worth about US$ 40 billion for CO_2 and another

US$ 10-20 billion for the remaining five other anthropogenic GHGs. In the first half of 2006, according to the report, approximately US$15 billion worth of CO_2 emission credits were traded – five times more than in 2005. However, of the 1000 CDM projects which have been approved or are in the process of being approved, almost all are in the energy sector. Only one forestry project in China has been approved so far (Murdiyarso and Skutsch 2006). This publication tries to address the question of whether a broader approach to forestry for mitigating climate change would stimulate more activity in this sector.

Community-managed Forests: A Dimension Neglected in the Kyoto Protocol

Reducing deforestation is a highly cost-effective way to quickly curtail GHGs emissions (Schlamadinger et al. 2007, Stern 2007, Kauppi and Sedjo 2001) especially in lands with low opportunity costs (van Kooten et al. 2004). The Kyoto Protocol recognises the importance of the forestry sector and allows industrialised countries to take into account GHG effects from human-induced afforestation, reforestation, and deforestation in industrialised countries. Carbon credits generated from these forest management activities can be accounted to fulfill their KP commitment. But for non-industrialised developing countries the scope for carbon trading under the CDM is limited, as reducing emissions from deforestation is not credited. This is because the Protocol recognises only two forest activities: afforestation, and reforestation; afforestation, meaning planting of new tree plantations and not activities geared towards the management of existing natural forests, or towards reducing emissions by avoiding deforestation.

Estimates of emissions from global deforestation range from more than 18% of global GHG emissions (Stern 2007), to about 25% (IPCC 2000), and the vast majority of these emissions are coming from developing countries in the tropics. The Stern Report also suggests that a 50% reduction in these emissions could be achieved at an annual cost of $5-10 billion.

Many communities in developing countries have been successful at transforming natural forests from their deteriorating state to sustainable management under a variety of programmes such as Joint Forest Management (JFM) in India, and the Community Forest Management (CFM) Programme in Nepal. Indeed over the last decade, community forestry has emerged as a new paradigm in natural resources management in non-industrialised countries. Devolution in forest resources management, as witnessed in the Himalayan region of India and Nepal, is a successful example of decentralisation and empowerment of local people. The two case studies presented in Chapters 5 and 6 illustrate this, where local communities are managing forests handed over to them and have shown themselves able to manage these forests better than the government. In addition to resources such as fuelwood, fodder, and timber extracted to meet their subsistence needs, forest cover contributes additional environmental services such as provision of water resources, and wildlife habitat. At the same time, this type of forest management results in additional carbon sequestration. In a real sense, forests provide a win-win situation, with local as well as global benefits by sequestering carbon. Unfortunately, under current CDM arrangements of the Kyoto Protocol polluting industrialised countries cannot pay communities for this service.

The book discusses these shortcomings of the Protocol, focusing on the exclusion of forests types found in the Himalayan region and managed by the communities themselves.

Objective and Justification

The main purpose of this book is to generate awareness among professionals, researchers, and policy makers working in different parts of the greater Himalaya on the role of community-managed forests in reducing carbon emissions. A number of issues are nestled around this topic. First is the question of how to convince the global decision-making community that community forest management (CFM) can help combat global warming. The second issue is, if communities are able to claim credits for the carbon sequestered by their forests, buyers will want sufficient proof that the carbon credit is real. This will require developing a reliable and replicable cost-effective database following the IPCC guidelines. The book discusses how this could be done.

As a starting point, under the Kyoto Protocol forestry is recognised as a means of combating global warming, but in reality this is limited to two forestry activities. Forests can play this role in a number of ways: through afforestation and reforestation to increase carbon sequestration; through improved forest management, both to increase sequestration levels and to reduce emissions through conservation and protection

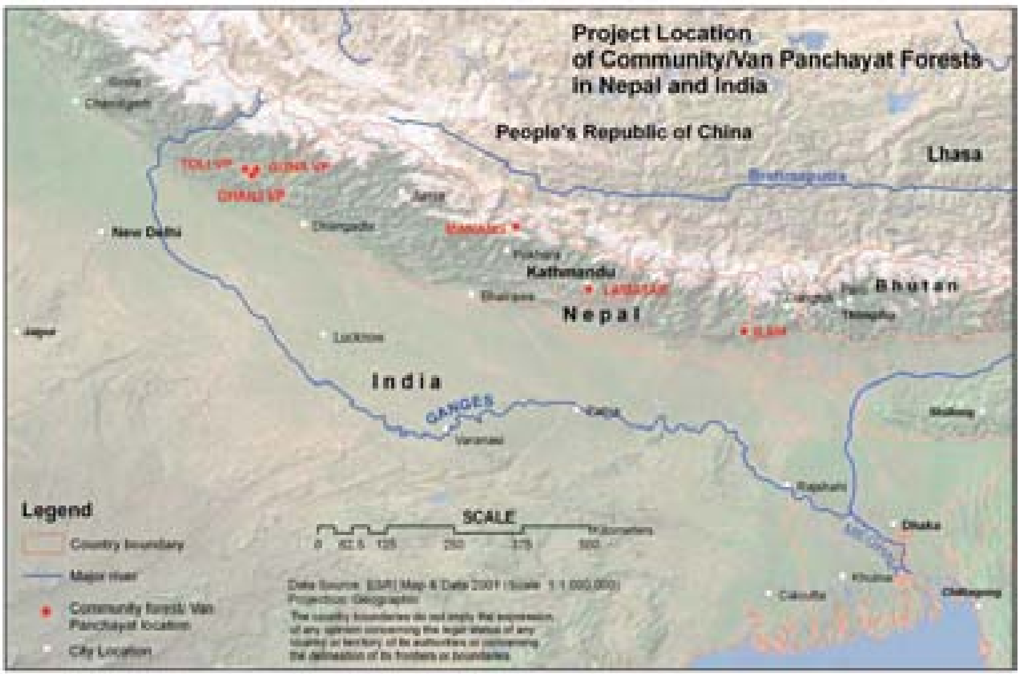

Figure 1.1: **Map of the Himalayan region of western India and Nepal showing the six research sites**

against deforestation; and through substitution of sustainably produced biomass for fossil fuels to cut emissions. The book lobbies for the inclusion and recognition of CFM under climate change regimes in payment for global benefits rendered.

The book reports on the work carried out by the research project, 'Kyoto: Think Global, Act Local', which aims to bring local sustainable forest management projects under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. It draws on work carried out since 2003 in three sites in India, and three in Nepal. In India all the sites are in Uttarakhand state. In Nepal they are in Ilam, Laitipur, and Manang districts. The project gathered data to show that community-managed forests can play an important role in mitigating the adverse impacts of climate change by sequestering CO_2 from the atmosphere. The levels of CO_2 sequestered annually are quantified from six research sites using IPCC guidelines described in Chapter 4. This may also be the first time that the protocol for carbon assessment in the Himalayan region has been carried out.

The Research Project: 'Kyoto: Think Global Act Local'

This project is a research and capacity building programme financed by the Netherlands Development Cooperation (DGIS) and led by the University of Twente. The project is investigating the possibilities and potentials for including community management of natural forests as an eligible carbon mitigation activity under future international climate change agreements (http://www.communitycarbonforestry.org/home.htm).

The programme involves research teams in three regions: East Africa, West Africa, and the Himalaya, coordinating the work of local NGOs conducting experiments in villages already engaged in CFM in each region. The research is recording the extent to which CFM practices increase sequestration in existing forests and reduce emissions of carbon by avoiding deforestation. The programme aims to support developing countries by strengthening their capacity to submit such projects for financing under various climate funds in the future.

Outline of the Book

Following this introductory chapter, Chapter 2 explains the science of climate change and its adverse impacts on global ecology. It highlights some of the ecological issues in the Himalayan region. Chapter 3 deals with Kyoto Protocol policies and issues surrounding it. It details how the Protocol developed, the criteria of the CDM, the significant role forests play in maintaining climatic stability by sequestering carbon even if community-managed forests are presently excluded by the KP. The Chapter attempts to explain why community-managed forests, such as those found in the Himalayan region, remain outside of the Protocol.

Chapter 4 illustrates the IPCC methodology used for measuring forest carbon levels in collaboration with local forest users. It describes the Protocol in detail and also illustrates how CFM is contributing to carbon storage in the form of biomass and in the soil. If these areas were not forested all those would inevitably be released into the atmosphere.

Chapters 5 and 6 present case studies from one community forest each at Dhaili Van Panchayat (VP), India, and Lamatar Community Forest, Nepal. Both these chapters highlight the process of devolution of forest management and how the locals have successfully managed their forests which were previously under government control. They also show how communities have been motivated to conserve the forests for their own benefit.

Chapter 7 concludes by summarising the issues based on findings on all the research sites including issues that need to be addressed further to improve the current Protocol and make it more inclusive. The Chapter leaves the readers with some questions that will need to be answered in time. Clearly, the issue of climate change is not only about safeguarding the environment for future generations but one, more importantly, relating to the ethics of sharing the responsibility for taking up clean measures.

The main cause for rise in global temperatures is the increase in greenhouse gases, mainly carbon dioxide, brought about by human activities.

The Bhojpatra forest in Manang, Nepal in winter *(Bhaskar Singh Karky)*

Carbon Dioxide Rise and Climate Change

2

Surendra P. Singh

Introduction

The world has warmed by about 0.6 °C during the past century and the average global temperature has increased more in the last 100 years than at any other time in the past 10,000 years. According to the Third Assessment Report (IPCC 2001a), by the year 2100, surface temperatures would rise in global average by 1.4-5.8°C relative to 1990 levels.

Most scientists agree upon a 3°C rise (Kerr 2004). Out of the 10 warmest years of the last 125 years, nine were recorded during the last decade. With a mean global temperature of 14.5°C, 2005 was the second warmest year of the last 125 years. While some still question global warming, most people now consider it real. In a survey carried out for the United Nations Environment Programme (UNEP) based on perceptions of environmentalists and research scientists of 50 countries, 51% of respondents consider climate change as the principal environmental crisis. The other problems cited include water scarcity, deforestation and desertification, freshwater pollution, and loss of biodiversity.

The global increase in temperatures will affect global climate, but what changes it will bring remains a topic rife for debate. For example, it may cause an area to be more wet and the other drier. The eastern Himalayan regions are predicted to become more humid, while the north-west regions are likely to turn more arid. Evidences suggest that in the eastern regions precipitation has increased even in some rain shadow areas. This Chapter looks at the science of climate change and its adverse impact on the global ecology.

The Greenhouse Effect

According to the Third Assessment Report (IPCC 2001a), anthropogenic carbon dioxide concentrations have increased by 29%, methane by 150%, and nitrous oxide by 15% since the Industrial Revolution. The greenhouse gases in the atmosphere trap energy from the sun and slow the escape of long wave radiation back to outer space. The phenomenon of trapping and radiating heat by CO_2 and other GHGs in the atmosphere is called 'greenhouse effect'. Since greenhouse gases absorb the radiant heat energy, they are known as radiatively active gases. On a molecule for molecule basis, methane is 21 times more effective, N_2O 310 times more effective, and chlorofluorocarbons

(CFCs) 12,000-15,000 more effective than CO_2 in trapping heat in the atmosphere. It is the heat trapping quality of GHGs that warms the planet and makes the earth habitable. The problem is the extra warming resulting from the rise in concentrations of GHGs during the last century. The extra GHGs come mostly from large-scale burning of fossil fuels from industries and motor vehicles, from intensified agricultural activity and deforestation, and from various other land use changes, mining, and other human activities.

The major sources of methane are enteric fermentation in ruminant livestock, and rice cultivation. Fertiliser application to agriculture is a major source of nitrous oxide. CFCs are entirely human created, used in refrigeration and other such processes. In the year 2000, carbon dioxide accounted for 63%, methane for 24%, nitrous oxide for 10%, and other gases for 3% of carbon equivalent emissions (IPCC, 2001a).

The rates of emission of GHGs vary widely across different parts of the world (Table 2.1). For example, USA, Canada, and European Union countries alone accounted for 44% of global GHG emissions in 1990, compared to 4% emissions from Africa for the same year.

Table 2.1: Greenhouse gas emissions from regions of the world (1990 and 2000)

Region	1990 (%)	2000 (%)
Canada & USA	21	23
Enlarged EU	23	14
Russia & CIS	17	8
Oceania	1	5
Japan	4	4
Latin America	7	7
Africa	4	7
Middle East	4	5
South Asia	3	7
East Asia & South Asia	16	20

Source: Sharma et al. (2006)

While Europe has shown a considerable decrease in GHG emissions between 1990 and 2000, emissions remained high in the USA (Table 2.1). The per capita emission of CO_2 equivalent of the USA is over 15 times that of India, and about 2.6 times the global average (Table 2.2). According to *Earth Trends* (2003), per capita emissions for Nepal in 1998 was 0.1 t yr^{-1}, and the value is likely to be similar in the Indian Himalaya.

Table 2.2: Per capita CO_2 equivalent emission of selected countries in 2000		
Country	**Per capita CO_2 equivalent emission in year 2000 (tonnes/capita)**	**Ratio of per capita emissions with regard to Indian emissions**
USA	23	15.3
Germany	12	8.0
United Kingdom	11	7.3
Japan	10	6.7
India	1.5	1.0
Brazil	1.9	1.3
China	3.3	2.2
Global	3.9	2.6

Source: Sharma et al. (2006)

Carbon Cycle and Carbon Sinks

Since carbon dioxide is the principal greenhouse gas and its emissions keep rising, it is essential to have a closer look at the carbon cycle. Carbon is taken from the atmosphere in two ways, but is released back into the atmosphere in many different ways. The uptake of carbon from the atmosphere occurs (i) as a result of photosynthesis, in which CO_2 is converted into carbohydrates and releases oxygen, and (ii) as CO_2 dissolves in water at the surface of oceans near poles, when water becomes cooler.

The release of carbon back into the atmosphere can occur through: (i) respiration of plants and animals, involving the breakdown of glucose or other organic molecules into CO_2 and water (an exothermic reaction); (ii) decomposition of plant and animal matter, releasing CO_2 if oxygen is present, or methane if oxygen is absent; (iii) combustion of organic material, producing CO_2 and other things like smoke (e.g., burning of fossil fuels such as coal and petrol stored in the geo-sphere for millions of years); (iv) erosion by water of calcium carbonate-rich rocks such as limestone, marble, and chalk (breakdown products include CO_2 and carbonic acid), and production of cement and lime by heating limestone; (v) the release of dissolved CO_2 from ocean surface water as a consequence of warming; and (vi) volcanic eruptions.

The carbon dioxide concentration was almost stable at 280 ppm over hundreds of years, but increased rapidly following the Industrial Revolution (after 1800 AD), reaching 380 ppm levels in 2005. Carbon emission from the burning of fossil fuels, cement production, and deforestation, on an average, is about 8 Gt yr^{-1} (Figure 2.1). This is more than the average rate at which CO_2 is increasing in the atmosphere, which is 3.2 Gt yr^{-1} (Schimel, 1995). The balance is being taken up from the atmosphere up by lands and oceans. It is agreed that the global carbon sink is equally divided between the ocean and terrestrial ecosystems (Press et al. 2000). Understanding the variations in strength of the carbon sinks and their locations are major challenges and important for managing the carbon cycle in the biosphere. The current average rate at which oceans of the world are absorbing CO_2 is about 2 Gt C yr^{-1}, with strong sinks in north Atlantic and the Pacific. The mid-Pacific, on the other hand, is a source of CO_2 release (Peng et al. 1998). The sink strength of the ocean varies from year to year as a result of variations in current, which affect sea surface temperatures, and thereby influence the amount of CO_2-rich water brought to the surface. For example, the CO_2 efflux from the equatorial region is high during El Niño years, when the surface temperature of the Pacific Ocean rises. The ocean's sink strength depends both on physical and biological processes. In the latter the photosynthesis of short-lived phytoplankton plays an important role. However, the long-term anthropogenic CO_2 uptake by oceans depends upon the mixing of surface waters with water from the deep ocean, not on air-sea gas exchange. Though the ocean can theoretically absorb 70-80% of projected induction of anthropogenic CO_2, the process will take a long time because the mixing of surface water with deep ocean water is a slow process.

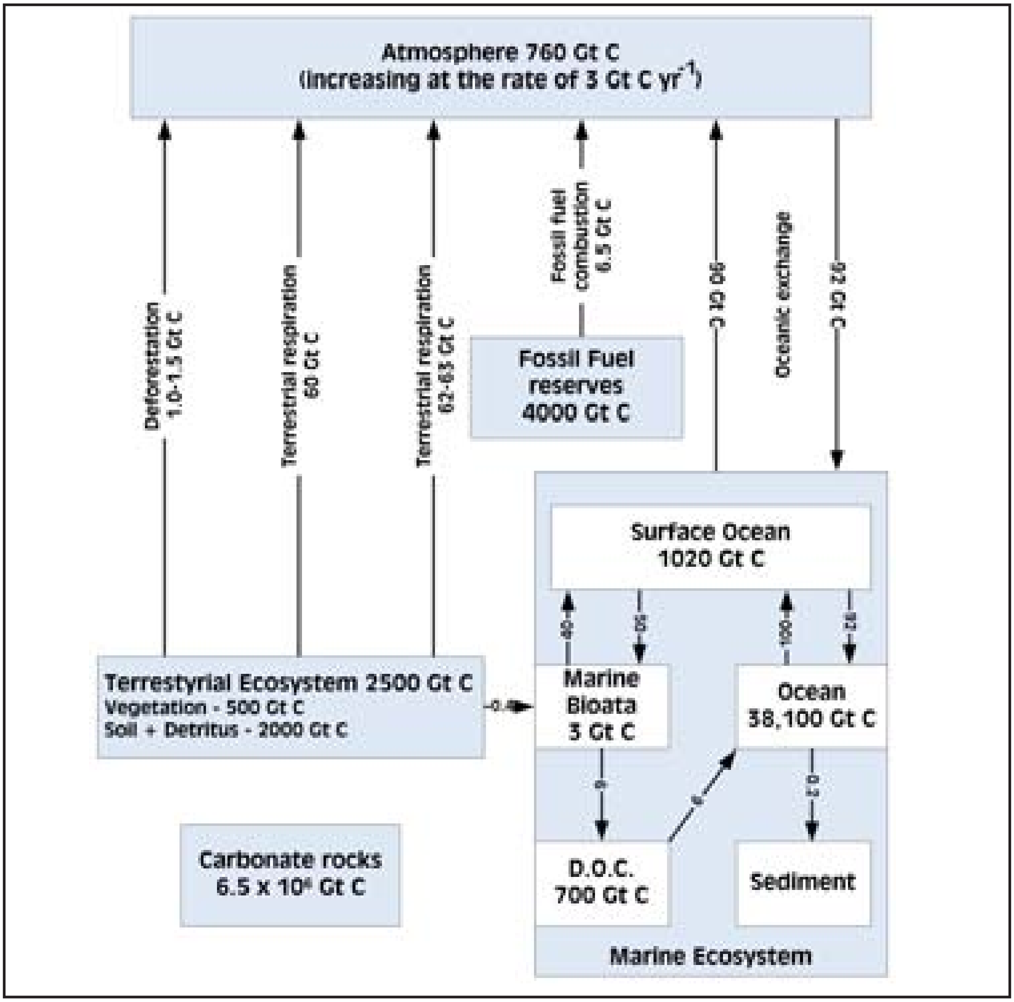

Figure 2.1: A representation of the global carbon cycle during the 1990s

Source: Grace et al. 2000

Note: The carbon stocks are in billion tonnes of C or Gt C. The carbon fluxes, shown with labeled arrows, are in Gt C yr^{-1}. Both terrestrial and marine ecosystems are net absorbers of CO_2, yet atmospheric stock is increasing approximately at the rate of 3.2 Gt yr^{-1} because of fossil fuels combustion (and also cement production) and deforestation (Grace et al. 2000).

Compared to oceans, many terrestrial systems have a much larger biomass and capacity to take up CO_2 per unit area. Many forest ecosystems, are known to have more than 200 t C ha^{-1} in biomass compared to generally less than 10 t C ha^{-1} in oceans (Table 2.3). Soils of forests located in cold climates, such as boreal forests, store unusually large amounts of carbon.

Table 2.3: Carbon stock and increments in the world's major forest types

	Area (10^6 km^2)	Carbon Stock (t ha $^{-1}$)		Annual increment in stock of biomass (t ha^{-} yr $^{-1}$)
		Biomass total	Soil organic matter	
Tropical forests	17.6	285	162	2.30
Temperate forests	10.4	125	56	4.19
Boreal forests	13.7	67	390	1.40
Indian Himalayan forests * (mean)	0.23	148	120	2.59

* Values for the Indian Himalaya are only gross approximations.

Source: Malhi et al. (1998)

Some of the conclusions of the measurements of net uptake of carbon, using sensors mounted above vegetation on towers distributed in different parts of world, are as follows:

- Most boreal and temperate forests are reasonably good C-sinks, sequestering between 0.5 - 8 t C ha^{-1} yr^{-1} (Press et al. 2000).
- Old growth Amazonian forests are also strong carbon sinks, with carbon store values in the range of 0.5 - 6 t C ha^{-1} yr^{-1} (Malhi et al 1998). This is contrary to the general perception that old growth forests are ineffective carbon sequesters.
- Of the respiratory fluxes of carbon, fluxes from the soil far exceed the fluxes from the aboveground parts of plants.
- Potential for soils to sequester carbon is considerable. For example, forests in Finland show that soil carbon content stabilises only after 2000 years (Liski et al. 1998). Even agricultural soil has considerable ability to store carbon.

The Impact of Climate Change

The warming of the earth is expected to affect other parameters of climate such as spatial distribution and amount of precipitation and its seasonal pattern. For example, in much of the Indian subcontinent global warming is likely to enhance the hydrological cycle and intensify severity of floods.

The possible impact of climatic change are listed in Table 2.4. Attempts have been made to include examples from the Indian subcontinent and the Himalayan region. The majority of the people in India and Nepal, for example, depend heavily on climate-sensitive sectors such as agriculture and forests, and on other natural resources such as water and biodiversity. Sizeable portions of the population in these countries are dryland farmers, nomadic shepherds, and forest dwellers, or forest dependents with limited adaptive capacity to deal with the problems likely to arise as a consequence of global climate change.

According to a projection, depending upon the rise of CO_2 concentrations in the atmosphere India's average temperature during 2071-2100 will rise by 2.9-4.2°C, and annual precipitation by 220-300m (Ravindranath et al. 2006).

Table 2.4: A broad outline of possible impacts of global warming

Temperature rise	Wider fluctuations in weather	Ecosystem disruption	Human health
Ice melting in polar and high mountain areas	More incidents of heavy rainfall	Stress and death of vegetation	Heat stress
Sea land rise and flooding of coastal cities	More incidents of severe drought	Species migration	Migration of disease vectors
Increased methane release from permafrost			Increase in incidents of diseases like malaria

Weather and climate

According to the IPCC (2001), average precipitation, particularly during winters, will increase in the Northern Hemisphere. There would be more incidents of floods and droughts. Warming is likely to cause severe floods in the Gangetic Plains adjacent to the Himalaya because of enhanced monsoon rainfall and glacial melting. In the Ganges, the peak time run-off at present is six times greater than the normal time. This is predicted to increase further by 27-116% (Beniston 2003). According to a report of UNEP and ICIMOD based on data from 49 monitoring stations, a number of melting glaciers are retreating by 30-100m in Nepal and Bhutan, leading to the formation of unstable lakes threatening to burst their banks.

Glaciers are found in every continent except Australia, and reports indicate that most of the glaciers are shrinking in size. The smaller they become, the faster they disappear. The Himalayan rivers would become seasonal once their glaciers are gone. The Arctic Greenland ice sheet is said to have shrunk by 6% between 1978 and 1996. The loss of ice cover is likely to increase warming because of reduced reflectance of solar energy.

Changes in distribution of species and ecosystems

With increasing global warming, species and ecosystems are likely to shift from lower to higher latitudes and altitudes. Temperatures decrease by altitude at the rate of 5-10°C/km across various mountains of the world. Species would need to migrate upward in order to survive. However, the upward movement of alpine species occurring near mountain peaks is likely to be restricted by the lack of space and soil. Since mountain tops are smaller than their bases, the species near the tops would occupy smaller and smaller areas with global warming. They may be severely affected by the smallness of the populations. Some of the important alpine species of the Himalaya that may face immediate extinction include the oak *Quercus semecarpifolia* (Singh et al. 1997), birch *(Betula utilis)*, some rhododendrons, several herbs of medicinal value, and mammals like pikas, brown bears, and snow leopards. Many highly preferred fodder species, like *Grewia optiva* (bheemal), *Celtis australis* (Kharhak), and Ficus spp, which local communities in Western and Central Himalayan regions cultivate around crop fields below 1600m altitude, would shift to higher ranges. Oaks which are the foundation tree species of much of the agricultural zone in these Himalayan regions would also shift to higher ranges provided they get favourable soil and moisture conditions. One of the major consequences of this would be the occupation of new areas in higher mountains above 2000m altitude by humans. The upward movement of local communities may lead to new people-protected area conflicts; as many of the large protected areas in the Himalaya are located in higher ranges above 2500m altitude, and more people are likely to occupy those areas with the rise in temperature.

Local communities would be forced to select new species and varieties of crops and fodder trees. They may also need to change the species they use for leaf litter and the practices they employ to prepare manure for crop fields. For example, the conversion of pine forests into Sal forests in the subtropical belt of the Himalaya is likely to improve manure quality but deprive local people of grasses that they collect from pine forests and store for the winters.

These altitudinal shifts may bring about major changes in the fire regime of an area. Enhancement in the hydrological cycle may restrict fire intensity, but severe droughts are likely to desiccate dry habitats like south-facing slopes and ridge tops more, and thus lead to more forest fires.

According to a projection for the year 2085, depending upon the rise in CO_2 in the atmosphere, 68-77% of forested grids in India are likely to experience a change in forest types. The shift generally would be towards wetter types of vegetation in the north-eastern parts and drier types in the north-western parts (Ravindranath et al. 2006). The tropical evergreen forest type is predicted to expand extraordinarily, from 3% of the grids at present, to 21.5% and 35%, respectively, under low and high increases in the atmospheric CO_2 concentration. The impact on tropical dry deciduous forests is likely to be negligible, in contrast.

The changes in mountains are expected to be much sharper. It is estimated that snowline will rise by about 150m for each degree Celsius increase in temperature. The warming would also affect vegetation by reducing snow pack duration, its amount, and water availability from snowmelt. Plant growth in alpine meadows, where many medicinal plants occur, can be severely affected by early snowmelt. Many species may be exposed to severe frosts with the thinning of the snow cover. Species requiring winter cooling for regeneration are likely to be most vulnerable to warming. In the Himalaya, junipers for which winter chilling is not necessary may survive warming.

At the species level there are three likely adaptational responses (Huntley 1991): (i) replacement of dominant species by more heat-loving species, (ii) replacement of climax species by pioneer species having adaptation capacity for wider ranges of environments, and (iii) better expression of the less important species of the same community. During the transitional stage many exotic weeds may invade new areas and expand their ranges.

Changes in phenology

A number of studies carried out in different parts of world indicates that global warming during the last three decades has advanced by a few days several springtime activities such as leaf production and flowering in plants, breeding in birds, and arrival time of migrant birds. There are also indications of delayed colouration of leaves during autumn. In the Himalaya, there are many dominant forest tree species (e.g., *Shorea robusta*, *Quercus floribunda*, and *Q. semecarpifolia*) in which seed maturation is synchronised with commencement of the monsoon and their seed viability is unusually short, one to two weeks. Early maturation of seeds due to warming or drought stress may break this synchronisation, and thereby impair regeneration of such species.

Failure of oak regeneration will adversely affect subsistence living of local communities, as people depend on these trees for nutrient replenishment of their crop fields, for hydrological services, and for firewood and fodder. Communities in the Himalaya will need to prepare themselves for these situations long before they begin to affect them. The growth in the national economy may help people to go beyond a biodiversity-dependent lifestyle.

Melting of ice sheet and rise in sea levels

Sea level rise can occur both because of ice melting and volume expansion of water at warmer temperatures. World over sea level rise of 1-2 mm yr^{-1} during the last century has been reported. Estimates of mean sea level rise at selected stations along the Indian coast indicate a rise of fairly close to 1mm yr^{-1}. Furthermore, intensity of tropical cyclones in Bengal is predicted to increase. Many coastal cities of the world would have problems.

Mention may be made of the melt of the ice sheets of Antarctica, the fifth largest continent. Its ice sheet is vast (covering 99.7% of the continent) and about 2 km thick, with a total volume of about 25 Mkm^3. If this were to melt completely, global sea levels would be about 57m higher. Fortunately, the net contribution of the Antarctic ice sheet to the global sea level change would be small during the 21st century. There is a need to investigate the matter more deeply (Repley 2006).

Oceanic pH and the marine ecosystem

Oceans, by absorbing atmospheric CO_2, have played a great role in slowing the process of global warming. But they tend to decrease the pH levels of seawater, and the consequent acidification has the potential to affect several marine geobiological and ecological processes (Turley et al. 2006). By 2100, atmospheric CO_2 concentrations is likely to be 700 ppm the pH of the ocean's surface water and is predicted to decline by 0.3-0.5 units from the levels in 1800 AD. Reduced pH levels is predicted to inhibit calcifying organisms such as cocolithophores, pteropods, gastropods, aminifers, and corals. This may lead to increase in non-calcifying organisms, affecting structure and process in marine ecosystems. Decrease in pH can also disrupt metal ions uptake, causing symptoms of toxicity and intra-cellular enzymatic reactions in marine life.

Malarial infection

The occurrence of many vector-borne diseases until now has not been seen in cold latitudes and altitudes. At elevations above 1500m in the Himalaya and other subtropical and tropical mountains, the Anopheles mosquito can neither breed nor survive (Craig et al. 1999). The warming is likely to lead to new distributions of vector-borne diseases. Malarial transmission is predicted to increase in warmer and wetter climates. Predictions are that even Himalayan states like Himachal Pradesh, Arunachal Pradesh, Nagaland, Manipur, and Mizoram are likely to be prone to malaria (Battacharya et al. 2006). Conditions in Nepal are not going to be any different.

Tourism

The skiing industry may be adversely affected, as it requires a continuous snow cover of over 30 cm depth for at least 100 days. However, tourist activity in general may expand because of longer summers in the mountains and more heat stress in the plains, particularly in the Indian subcontinent. Tourist centres are likely to move upward into remote areas, threatening some of the last remaining forest-rich areas in the Himalaya.

Atlantic thermohaline circulation

The Atlantic thermohaline circulation (ATHC) is a phenomenon which transports a huge amount of heat (currently about 1 petawatt or 10^{15}w or a million billion watts) toward poles. This amount of energy in equal to 100 times the current human use of energy, i.e., 10^{13} w. This northward circulation is driven by temperature (thermo) and salt (saline), and makes Europe up to 8°C warmer than other longitudes at its latitude. There is a risk of collapse of the ATHC as a consequence of the addition of freshwater from snowmelt. There are evidences to suggest that ATHC was shut down or slowed in the past, resulting in the cooling of Europe. The fear is that ATHC may collapse again because of global warming (Schlesinger et al. 2006).

Coral reef bleaching

Coral reefs are complex systems involving anthozoan corals and their symbiotic endozoan dinoflagellate and coralline algae. Though occurring in nutrient-poor tropical oceans, they support a high diversity of colourful organisms. There are indications that coral bleaching (reduction in the density of dinoflagellate algae and their pigments) and warmest years coincide.

Ecosystem level responses

Biotic communities are not merely slaves of climatic factors. They have the capacity to respond to climatic changes and determine the course of changes in them. For example, in response to warm temperatures, forests may enhance evapotranspiration and thus, affect precipitation at a regional level. In response to warming, boreal ecosystems are likely to increase CO_2 emissions from the soil and thus, escalate global warming.

The above description only gives an outline of the possible impacts of global climatic change. Since ecosystems function in a complex way and have the capacity to modify the course of warming, many changes under the influence of global warming could be different from what are being predicted. Carbon dioxide enrichment is likely to have many direct influences on biota and soil component, and may thus modify the path of global climate change.

The Global Community's Response

Achieving reductions in the emission of GHGs without affecting global economic growth is a challenging task in a world sharply divided between industrialised and non-industrialised countries. There are two broad ways of reducing the rate of increase of the atmospheric pool of carbon dioxide: (i) reduce CO_2 emissions by using energy sources which do not add to atmospheric concentrations of CO_2 (e.g., solar energy, wind energy, hydroelectricity, and biofuels), and by increasing energy use efficiency (high GDP-energy use ratio); and (ii) sequester CO_2 in vegetation and soil pools of the biosphere. There is a strong need to have an understanding among countries of the world to make any progress in this direction.

Irrespective of the success the global community achieves in controlling GHGs emissions, global temperature is going to rise. Therefore, it is important to develop strategies to adapt to the climatic change. These may pertain to dealing with problems of the rise of sea levels in coastal areas, shift in cultivation zones of agricultural crops, early snowmelt, species extinction, and others in terrestrial ecosystems. Needless to say, considerable efforts would be required to develop cooperation among countries of the world to tackle the global crisis. The Kyoto Protocol, an amendment to the UNFCCC, is an international treaty to address the problems of global warming. The KP entering into force in February 2005 in the global community is a matter to celebrate, but it is only a small step at best (Najam et al. 2004). Even if completely implemented, the KP is expected to reduce the average global temperature only between 0.02 and 0.28 °C by year 2050. Unfortunately, the greatest emitter of GHGs, USA, is still out of the orbit, and much of the post-KP period was consumed to make Annex I countries commit to what they had agreed to at Kyoto (Najam et al. 2004).

The impacts of global climatic change are already being felt and are likely to intensify in the coming decades. The most vulnerable to the ravages of climate change are people of poor countries who have contributed the least to the atmospheric accumulation of GHGs, and have a low capacity for climate change adaptation. The post-Kyoto phase is going to witness a dramatic improvement in the economy of several developing countries, including two Asian giants, China and India, each with more than a billion population. As economic growth picks up, total emissions from developing countries is going to be equal that of developed countries, even if per capita emissions remain much lower. In fact, the country level emissions of China may match that of the USA in next couple of decades. New coalitions of nations (Figure 2.2) are likely to develop to avoid the risks of climate change. Factors like exposure to risk, and ability to pay, apart from levels of emission, may play significant roles in determining the country groupings in the near future (Morlet et al. 2005). Vulnerability to climate change would also vary across different parts within a country. In the Himalayan region, people depending on alpine range resources, such as nomadic races, are likely to be worst affected. Glacier melts and flash floods will affect people living in both mountains and the adjoining plains. The problem of seasonal water scarcity may worsen.

It is important to have a better understanding of the problems of different countries, their limitations and strengths, and to be considerate of the problems of those who are less capable to deal with the ravages of climate change, to effectively deal with the crisis of global change.

High exposure	**Countries likely to be affected**		
Coastal and high mountain zones	Most Andean countries, Bangladesh, Indonesia, Nepal, many small island countries	Brazil, China, India, Malaysia, Thailand, S. Africa, etc.	Germany, Switzerland, UK, etc.
Arctic nations		Russia	US, Canada, Norway, Finland, Sweden, Iceland
Mediterranean nations	Albania, Egypt, Morocco, others	Croatia, Turkey, Tunisia, etc.	France, Greece, Norway, Sweden, Iceland
Low exposure	Low GHGs emitters Low ability to pay →	→	High emitters High ability to pay

Figure 2.2: Likely coalition of countries to develop in view of the risks of climate change, their GHGs emissions, and ability to pay

Climate Change and Other Ecosystem Services

Carbon sequestration is one of the principal ecosystem services, but several other services flow from the ecosystems that play major roles in supporting all forms of life. The Kyoto Protocol has led to the establishment of carbon trade, and thus given economic value to standing forests. However, to promote conservation, payment mechanisms are required to be developed for other ecosystem services such as regulation of watershed hydrology, soil formation and climatic regulation by forests, and nutrient storage and recreational value of wetlands. Many payment schemes for ecosystem services from forests are being experimented in Mexico, Costa Rica, and Brazil (see Pagiola et al. 2002). Efforts are required to learn from these experiences and put payment mechanisms in place in other parts of the world. That may require identification of providers and receivers of services.

Services like carbon sequestration and biodiversity conservation are global in nature; those flowing through river connections, such as deposition of fertile soil, are regional level, and many, such as water and air purification and pollination of crops, are local in nature. Evidently, any payment system involving ecosystem services needs to consider educating people and developing understanding and agreements among the concerned parties. Climate change will affect the flow of many ecosystem services, particularly as a result of mid-continent drying and increased frequency and intensity of climate extremes, including rainfall. Mass-scale species extinction is likely to adversely affect ecosystem functioning and the services that ecosystems generate.

Conclusion

At this stage, as we do not understand the full extent of the damage climate change is inflicting on the earth and its diverse ecology, we need to focus on identifying measures that should be taken up collectively to slow this process. Strategies will also be required to develop adaptive measures specific to regional conditions. Some of the efforts that may be useful from the adaptation standpoint are identification and prioritisation of climate risks, compilation of existing knowledge on climate risks and their dissemination, analysis of critical knowledge gaps that impede effective adaptation decisions, and generation of new relevant knowledge. Developing the science of ecosystem services will be important for achieving sustainable development in a world faced with the threats of climate change.

Community-managed forests generate environmental and social benefits that should be cost out, and services paid for to communities managing them.

Forest recovery in the Tibet Autonomous Region, Southwest China, China's contribution to world carbon sequestration through tree plantation
(Xu Jianchu)

The Kyoto Protocol and Community-managed Forests

3

Bhaskar Singh Karky and Kamal Banskota

Introduction

Global climate has always been changing naturally. But the changes witnessed in the last 50 years have been dramatic, and scientists attribute the change to human-induced factors linked directly to increased levels of CO_2 and other greenhouse gases, emitted mostly after the Industrial Revolution from burning of fossil fuels, deforestation, and other human activities as a result of economic and population growth. According to Janzen (2004), the concentration of atmospheric CO_2 has increased by over 30% since pre-industrial levels and has crossed 380 ppmv (parts per million by volume) in 2005; it is expected to exceed 500 ppmv by 2100. Global temperatures increased by 0.6°C in the last century, and this increase could be far greater in the future (Figure 3.1). The Intergovernmental Panel on Climate Change (IPCC) states in its Third Assessment Report (IPCC 2001b) that most of the global warming observed over the last half century is attributed to human activities, and the IPCC predicts that anthropogenic emission of GHGs will raise the global mean surface temperature between 1.4 and 5.8°C over the next the century (UNFCCC 2003).

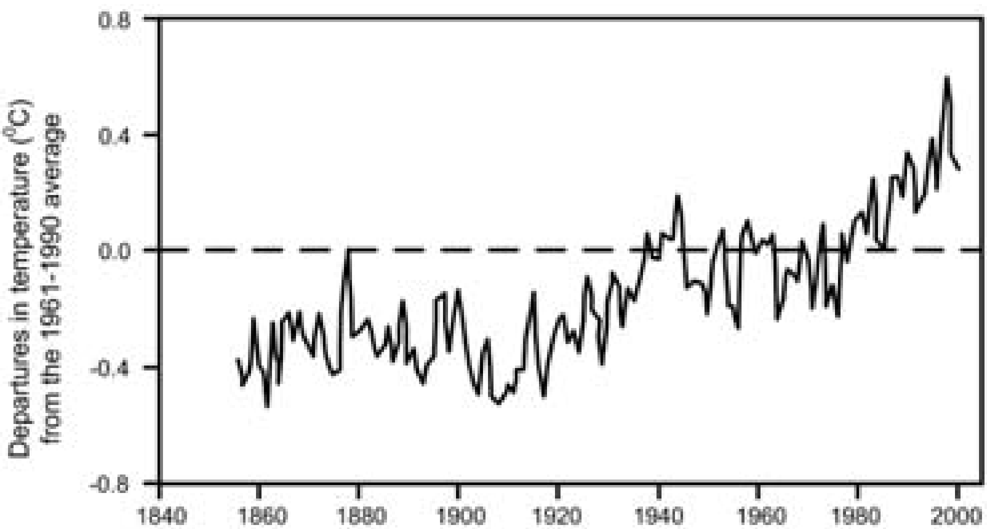

Figure 3.1: Estimates of global temperature over 144 years
Source: Janzen (2004)

GHGs are necessary to regulate the earth's temperature, but their excess concentrations in the atmosphere trap heat and raise the earth's temperature. Signs of global warming are evident from receding mountain snowlines and glaciers, melting polar sea-ice, shrinking ice cover on lakes and rivers in winter, changes in agriculture seasons and in migration patterns of birds and animals, and in the migration of lowland ecosystems to higher altitudes, as explained in the previous chapter. This Chapter will explain community-managed forests from a climatic perspective in the context of the Kyoto Protocol.

Genesis of the Kyoto Protocol

Concerns over climate change due to anthropogenic interference first emerged in 1979 at the First World Climate Conference. Following this in 1988, IPCC, was established as a global body to assess climate change scientifically. The IPCC in its First Assessment Report published in 1990, confirmed that the threat from climate change is real, and in its Second World Climate Conference held later that year concluded that a global treaty was necessary to mitigate the dangers resulting from it . This conclusion paved the way for the establishment of the United Nations Framework Convention on Climate Change (UNFCCC).

The text of the UNFCCC was adopted at the United Nations Conference on Environment and Development (or the Earth Summit) in Rio de Janeiro in 1992. The objective of the Framework Convention was to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system through the adoption of a global protocol called the Kyoto Protocol. The KP is a binding commitment that would assist in implementing the UNFCCC goals. The text of the KP to the UNFCCC was adopted at the Third Session of the Conference of the Parties (CoP) to the UNFCCC in Kyoto, Japan in 1997. With Russia having ratified the KP in November 2004, this global protocol has come into force in February 2005. For this, it was necessary that at least 55 countries that encompass at least 55% of global emissions from Annex 1 countries (industrialised countries) ratify it. By December 2006, 169 countries responsible for 61.6% of global emissions have ratified the Protocol. India and Nepal are both signatories of the UNFCCC and have also ratified the KP.

The UNFCCC and the KP have become globally high profile policies of political importance, as GHGs are embedded in every economic and development activity of any country. The enforcement of the KP from 2005 has paved the way for the following:

- Industrialised nations (Annex 1) that ratified the KP have to comply meeting emission reduction targets for six GHGs during the first commitment period, 2008-2012.
- A global carbon trading market, which earlier was a voluntary market, must be established.
- Non-industrialised nations (non-Annex 1) will participate in emissions reduction by hosting Clean Development Mechanism (CDM) projects.
- The establishment of an Adaptation Fund in 2001 under the KP to start assisting developing countries to cope with the adverse effects of climate change.

According to the Protocol, all industrialised countries or Annex 1 countries party to the UNFCCC are legally committed to reduce their emissions of GHGs by an average of 5.2% from the 1990 levels by 2008-2012. This can be achieved by domestic and by international action. The Protocol has devised three flexible mechanisms to enable compliance with the commitment: Joint Implementation (JI), Clean Development Mechanism (CDM), and Emissions Trading (ET). CDM is the only activity in which developing countries like India and Nepal can participate in collective action for emissions reduction. Hosting of CDM projects is limited to non-Annex I countries, and Certified Emission Reduction (CER) credits are purchased by Annex 1 countries. Non-Annex 1 members cannot participate in JI and ET mechanisms.

The KP's rules focus on:
- Commitments to legally binding emissions targets,
- Implementing the three mechanisms,
- Reducing adverse impacts in non-industrialised countries, including use of the Adaptation Fund to do so, and
- Complying with the commitments.

These rules are confined to six anthropogenic GHGs namely, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). As CO_2 is the major GHG, the term 'carbon trading' is used as an umbrella, and all emissions are conventionally expressed as carbon dioxide equivalents (CO_2e). Hence, the certified emissions reduction (CER) credits in CDM are calculated in tonnes of CO_2e and, for the remaining GHGs, are converted to equivalent carbon in terms of their global warming potential (GWP) based on their ability to retain heat in the atmosphere.

CDM is set out in Article 12 of the KP and has the twin objectives of:
- Assisting non-Annex I (non-industrialised) countries in achieving sustainable development, and
- Assisting Annex I (industrialised) countries in achieving compliance with their quantified emissions limitation and reduction commitments (UN 1997; Aukland et al. 2002).

Institutional capacity building and technology transfer are the means of encouraging sustainable development in non-Annex I countries. Abatement projects in non-Annex I countries are the means of enabling these countries to meet part of their commitment for fulfilling the second objective in a cost-effective way. Because developing countries have no commitments under the KP to reduce their GHG emissions, they may implement activities for reducing GHGs by hosting CDM-compatible projects in two main sectors: 1) energy, and 2) land use and land use change and forestry (LULUCF). Activities related to agriculture and forestry fall under the LULUCF sector. There are different guidelines for quantifying and certifying credits between the energy and LULUCF sectors.

Potential Benefits of the Clean Development Mechanism

CDM has several benefits owing to its innovativeness and the inclusion of developing countries in collectively mitigating GHG emissions. By creating markets for CER credits, CDM can generate private sector investments from Annex I parties towards climate-friendly projects that would not otherwise take place, or that are accorded a low priority in the development agenda of developing or non-Annex I countries. Market-based CDM can be used to accrue economic incentives for conservation-related activities in non-industrialised countries. Given that public sector spending on conservation is experiencing global cutbacks, CDM could be viewed as a promotional agent for conservation activities, especially in the resource-scarce developing world. This unique market linkage has given the KP added weight and higher profile globally than the Convention on Biological Diversity (CBD), which has not garnered the same level of interest in the political and private sectors (Koziell and Swingland 2003). CDM can also be regarded as a catalyst in bridging the gap between industrialised and developing countries. In addition to deriving payments from CER credits, developing countries gain from the technology transferred, including knowledge and experience transferred from the industrialised to non-industrialised countries.

Another innovative aspect of the CDM is that it sets aside a portion (2%) of the proceeds from CER trading, which is deposited in the CDM registry. This fund is to be utilised to assist adaptation projects in non-industrialised countries vulnerable to adverse climate change effects and to cover CDM-associated administrative expenses.

Conditions for CDM

Just as the CDM has numerous potential benefits, there are also strict criteria for CER credits, to ensure that they are real and additional. If CER credits are exaggerated there will be a transfer of exaggerated CER credits to Annex 1 countries, which would increase the global GHG emission levels to above the KP threshold, rendering the whole mechanism counter-productive. Projects are scrutinised very closely and stringent criteria are set for projects to qualify, including a timeframe for emission reduction activities within the budget period of 2008-2012 – known as the first commitment period – so that emission reduction credits are authentic and credible. The GHG emission reduction achieved can also be banked from the beginning of 2000 until the budgeted period for CDM activities. Box 3.1 highlights the conditions to be fulfilled for a qualifying CDM.

The Role of Forests in Altering Atmospheric Concentrations of Carbon Dioxide

Forests as sinks

Depending upon the succession stage, specific disturbance, or management intervention, the forest can act as a source and as a sink (Masera et al 2003). Forests act as sinks by increasing aboveground biomass through increased forest cover and by increased levels of soil organic carbon (SOC) content. By converting shrub/pasture lands and agricultural fields, or degraded forests into forests, the rate of respiration from plants, soil, and dead

Box 3.1 Conditions for CDM Afforestation and Reforestation

1. Only areas that were not forests on 31st December 1989 will meet the CDM definitions of afforestation or reforestation.
2. Projects must result in real, measurable, and long-term emissions reduction, as certified by a third-party agency ('operational entities' in the language of the Convention). The carbon stocks generated by the project need to be secured over the long term (a point referred to as 'permanence'), and any future emissions that might arise from these stocks need to be accounted for.
3. Emissions reduction or sequestration must be additional to any that would occur without the project. They must result in a net storage of carbon and, therefore, a net removal of carbon dioxide from the atmosphere. This is called 'additionality' and is assessed by comparing the carbon stocks and flows of project activities with those that would have occurred without the project (its 'baseline'). For example, the project may be proposing to afforest farmland with native tree species, increasing its stocks of carbon. By comparing the carbon stored in the 'project' plantations (high carbon) with the carbon that would have been stored in the 'baseline' abandoned farmland (low carbon) it is possible to calculate the net carbon benefit. There are ongoing technical discussions regarding the interpretation of the 'additionality' requirement for specific contexts.
4. Projects must be in line with sustainable development objectives, as defined by the government that is hosting them.
5. Projects must contribute to biodiversity conservation and sustainable use of natural resources.
6. Only projects starting from the year 2000 onwards will be eligible.
7. Two percent of the carbon credits awarded to a CDM project will be allocated to a fund to help cover the costs of adaptation in countries severely affected by climate change (the 'adaptation levy'). This adaptation fund may provide support for land use activities that are not presently eligible under the CDM, for example, conservation of existing forest resources.
8. Some of the proceeds from carbon credit sales from all CDM projects will be used to cover administrative expenses of the CDM, a proportion still to be decided.
9. Projects need to select a crediting period for activities, either a maximum of seven years that can be renewed at most two times, or a maximum of ten years with no renewal option.
10. The funding for CDM projects must not come from a diversion of official development assistance (ODA) funds.
11. Each CDM project's management plan must address and account for potential leakage. Leakage is the unplanned, indirect emissions of CO_2 resulting from the project activities. For example, if the project involves the establishment of plantations on agricultural land, leakage could occur if people who were farming on this land migrated to a clear forest elsewhere.

Source: Bass et al (2000)

organic matter is exceeded by Net Primary Production (NPP). This leads to sequestration of CO_2 from the atmosphere to the terrestrial ecosystem. On average, 50% of the biomass is estimated as the carbon content for all species of trees (MacDicken 1997).

According to Upadhyay et al. (2005), revitalising degraded forest land and their soils in the global terrestrial ecosystem can sequester 50-70% of the historic losses. Degraded forests have emitted their carbon pool and now have the potential capacity to sequester greater volumes. Managed forests sequester more carbon than unmanaged forests nearing their climax stage as decay, burning, and die-back are balanced by the growth of plants (Upadhyay et al 2005).

Forests play a profound role in reducing ambient CO_2 levels as they sequester 20 to 100 times more carbon per unit area than croplands (Brown and Pearce 1994). Trees absorb atmospheric CO_2 for the growth of woody biomass and increase the SOC content in the soil as well. Of the different land uses globally, forest vegetation including tropical, temperate, boreal, and savanna forests accounts for over 90% of carbon in plants and about 52% in the soil, from only 43% of the land as depicted in Table 3.1. The CDM recognises forests as sinks by permitting afforestation and reforestation projects to be developed in non-industrialised countries.

Table 3.1: Summary of global carbon stock in plants, soil, and atmosphere

Biome	**Area** (10^9 ha)	**Global carbon stock** (Pg C)			**NPP** (Pg C per year)
		Plants	**Soil**	**Total**	
Tropical forests	1.76	212	216	428	13.7
Temperate forests	1.04	59	100	159	6.5
Boreal forests	1.37	88	471	559	3.2
Tropical savannas and grasslands	2.25	66	264	330	17.7
Temperate grasslands and shrub lands	1.25	9	295	304	5.3
Deserts and semi-deserts	4.55	8	191	199	1.4
Tundra	0.95	6	121	127	1.0
Croplands	1.60	3	128	131	6.8
Wetlands	0.35	15	225	240	4.3
Total	**15.12**	**466**	**2011**	**2477**	**59.9**

Source: Janzen (2004)

Of the total global terrestrial carbon, about two-thirds, excluding those sequestered from rocks and sediments, are stored in forested areas in the form of standing biomass, under-storey biomass, leaf and forest debris, and soil (Sedjo et al. 1998, cited in Upadhyay et al. 2005). The Forest Resources Assessment estimates the total carbon content in forest ecosystems to be 638 Gt for 2005, half of which are coming from biomass and deadwood, and half from soil and litter, which together amounts to more carbon than is in the atmosphere (FRA 2005).

Forests as sources

The global forestry data shown in the Table 3.2 (FAO 2001) reveals that deforestation occurred in the tropical region of non-industrialised countries at the rate of 12.3 million ha of forest per year between 1990 and 2000. Forests in Asia are sources or net emitters of CO_2 (Dixon et al. 1994, cited in Upadhyay et al. 2005). But in the non-tropical region there is a net increase of 2.9 million ha of forest area per year. The increment mainly comes from boreal forests in temperate regions of North America and Europe (Kauppi and Sedjo 2001). These regions are becoming moderate sinks through plantation of forests, avoidance of deforestation, and natural expansion of forests and plantations on abandoned agricultural lands.

Deforestation occurring in tropical areas ultimately translates to CO_2 emissions. Globally, CO_2 emissions from land use change have increased greatly over the last century, approaching 2 Pg C (Peta gram of carbon) per year, as reflected in Figure 3.2, and is mainly attributed to tropical deforestation (Janzen 2004).

Table 3.2: Annual change in global forest cover from 1990 - 2000 (million ha)

Domain	Natural forests					Forest plantation			Total Forest Net Change
	Loss due to		Total Loss	Gain	Net Change	Gain		Net Change	
	Deforest-ation	Convers-ion to forest plantation				Convers-ion from natural forest	Afforest-ation		
Tropical areas	-14.2	-1.0	-15.2	1.0	-14.2	1.0	0.9	1.9	-12.3
Non-tropical areas	-0.4	-0.5	-0.9	2.6	1.7	0.5	0.7	1.2	2.9
World	-14.6	-1.5	-16.1	3.6	-12.6	1.5	1.6	3.1	-9.4

Source: FAO, 2001

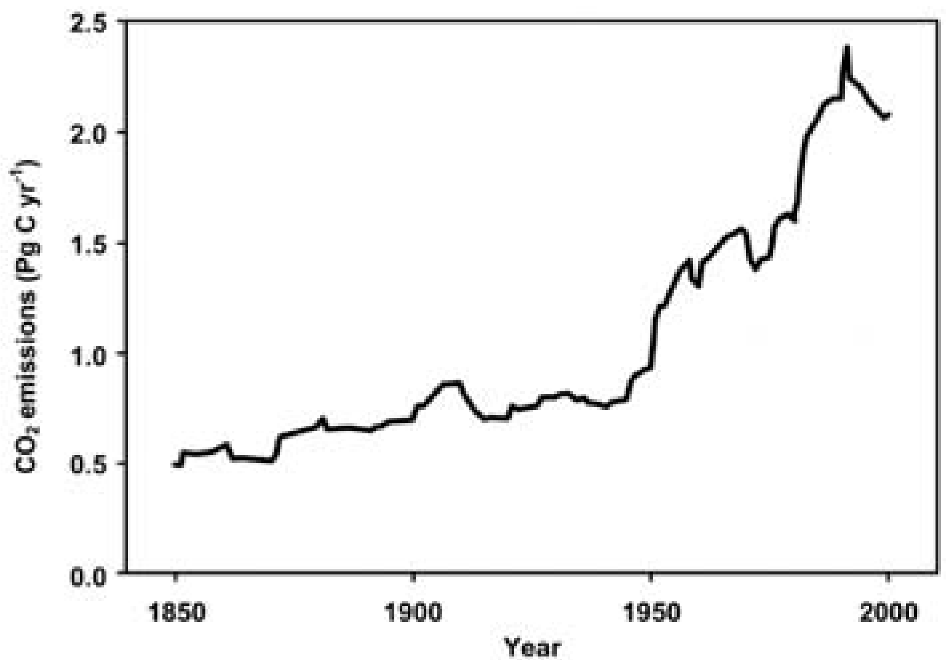

Figure 3.2: CO_2 emissions from land use changes (1850-2000)

Deforestation in tropical countries is the main concern with regards to CO_2 emissions from the terrestrial ecosystem. Estimates show a quarter of global CO_2 emissions (IPCC 2000) to 18% (Stern 2007) being emitted from deforested in tropical regions. This needs to be addressed urgently by the UNFCCC as, currently, the KP is ineffective in controlling these emissions. CDM does not recognise avoiding deforestation as a strategy for reducing CO_2 emissions from non-industrialised countries.

Recent Findings on the Carbon Pool

The latest forest inventory data comes from the Global Forest Resource Assessment (FRA 2005), where countries were asked to provide forestry-related data for the period 1990, 2000, and 2005. Based on the FRA 2005 estimate, carbon in forest biomass decreased in Africa, Asia, and South America between 1990-2005 from deforestation and forest degradation, as reflected in the Figure 3.3. These regions are responsible for unabated emissions from the terrestrial ecosystem, and these are the areas that the concerted effort to combat climate change must start to address.

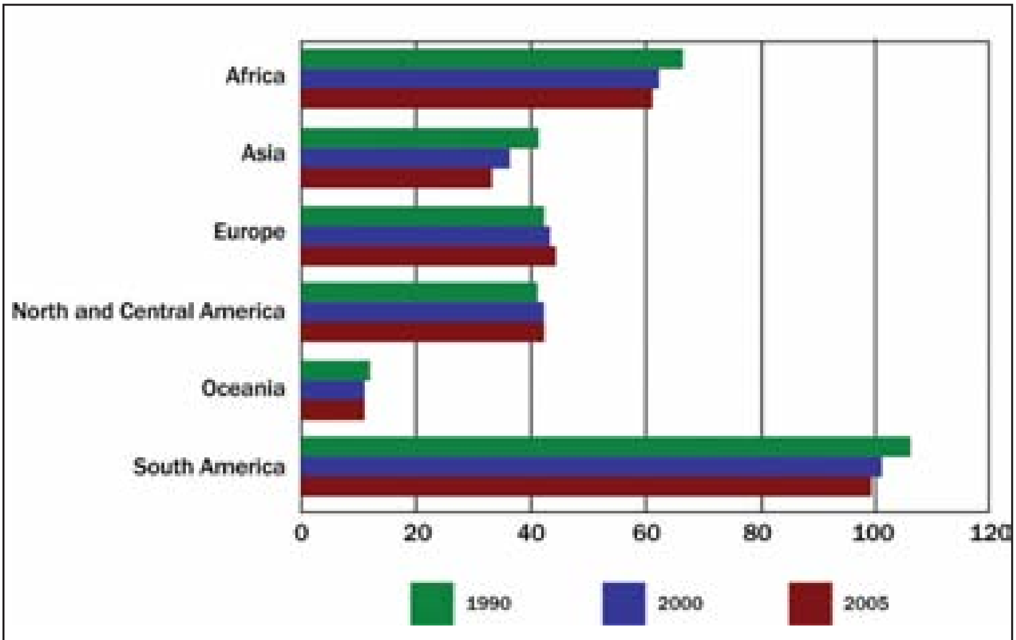

Figure 3.3: Changes in global carbon stock in forest biomass from (1990-2005) (in Gt)

The FRA shows that carbon stock in forest biomass between 1990-2005 declined from 32.3 to 21.8 Gt in South and Southeast Asia, making these regions one of the most severe cases globally, not only because their figures are huge but also that the figures are even suppressed as large-scale reforestation is offsetting real biomass loss. China witnessed a forest area growth of 2.2% annually between 2000 and 2005, making the country one with the largest annual gain in forest area of about 4.1 million ha per annum. China also ranks 5th, and India 10th in the world with the largest forest areas in 2005, and both countries report significant total carbon stock increases between this period, mainly from afforestation programmes. This shows that though the forested areas in these countries are increasing through afforestation, huge biomass loss is occurring at the regional levels through deforestation and devegetation in old forests. The figures in FRA 2005 are reported by the countries themselves but their reliability could vary.

One element missing from the statistics on deforestation is density of forests. Deforestation is measured in terms of loss of canopy cover (i.e., when canopy cover drops below 30%, as defined by UNFCCC). In many cases there are human processes going on which result in the thinning out of the forests, but these processes may not result in complete deforestation. This is considered to be forest degradation. Most countries do not collect statistics on degradation, nevertheless it is a major source of CO_2 emissions.

The Role of the Forestry Sector in the Kyoto Protocol

Initially, emissions trading was only for the energy sector; it was only later that the forestry sector was included. The carbon dynamics of forests have now become an integral part of the KP. There are important reasons for the inclusion of forests in the Kyoto Protocol. Biological sequestration of CO_2 by the forest is considered to:

- Be more cost-effective than other carbon sequestration methods (Schlamadinger et al. 2007, Stern 2007, Kauppi and Sedjo 2001, and van Kooten et al. 2004);
- Reduce carbon emissions as it is estimated that global deforestation accounts for more than 18% of the global GHGs emissions (Stern 2007) to about 25% (IPCC 2000);
- Bear the potential to store large volumes of carbon as huge historic losses have occurred from terrestrial ecosystems (Upadhya et al. 2005, Kauppi and Sedjo 2001);
- Open up of a 'virtual market' for carbon as a non-timber forest product (NTFP), where previously, forest products had no linkages with markets (Skutsch, 2005), thereby assisting in the development of a Payment System for Environmental Services (PES);
- Replenish carbon in the terrestrial ecosystem with a multitude of benefits in improving soil fertility, ecosystem and biodiversity, which in turn has a series of other benefits attached (Janzen 2004);
- Enhance livelihood options for poor communities dependent on forest resources; and
- Be an adaptive strategy to cope with the adverse effects of climate change.

In spite of the importance of the forestry sector, the Kyoto Protocol views activities permitted under this sector differently for industrialised and non-industrialised countries. Article 3.3 of the KP requires industrialised countries to take into account in their national inventory of GHGs human-induced afforestation, reforestation, and deforestation activities and, under Article 3.4, puts additional measures in the land-use sector that contribute to the national accounts. These include management of forests that were there before 1990. This allows industrialised countries to generate carbon credits and meet part of their KP commitments. Consequently for many industrialised countries where forest biomass is increasing, (for example, the boreal forests), inclusion of forest management in national GHG accounting enables these countries to gain carbon credits in a relatively low-cost manner. This is the reason countries like Switzerland have expressed interest in including forest management in their national GHG inventory.

But permitted forestry activities for non-industrialised countries are limited to afforestation and reforestation and do not include avoiding deforestation and other forest management activities under the CDM. Forest management through avoiding deforestation is not credited under this mechanism for non-industrialised developing countries.

Forestry activities for carbon management

As mentioned in the previous section, only two categories of forestry activity qualify forests as sink projects under CDM: afforestation, and reforestation. According to the CDM definition, afforestation is the direct human-induced conversion of land that has not been forested for a period of at least 50 years through planting, seeding, and/or the human-induced promotion of natural seed sources. While reforestation is the direct human-induced conversion of non-forested land to forested land through planting, seeding, or human-induced promotion of natural seed sources on land that was forested but has been converted to non-forested land. For the first commitment period (2008–2012), reforestation activities will be limited to reforestation occurring on those lands that did not contain forests on 31 December 1989.

Afforestation activities qualify for sink projects on lands that did not have forests before 1990. Much of the CFM that we see in India and Nepal are on land that did have forests before 1990, as they were common lands with some form of degraded forests. Hence, community-managed forests, such as those found in Nepal and India, cannot qualify for carbon sink projects for Afforestation. CFM is about avoided deforestation as community intervention has stopped deforestation in common lands through the deployment of strict protective measures. Avoiding deforestation for controlling emissions is not a recognised activity under the CDM.

In reality, however, carbon emission reduction strategies can be developed by managing forests. Bass et al. (2000) have identified three carbon management strategies in forests, which are also compatible with community-managed forests. These are carbon sequestration, carbon conservation, and carbon substitution. The strategies are described in Table 3.3 with an illustration of activities and forest management types. Given that community-managed forests also have livelihood options embedded in them, carbon management strategies can accommodate the complex relationship between livelihoods and forest management, as reflected in the third column, which can be used to develop carbon offset projects aimed at a specific carbon management strategy.

Table 3.3: Carbon management strategies under different forest management activities

Strategy	Land use type and forestry activity	Forestry/rural development project type
Carbon sequestration	• Silviculture in increased growth rates • Agroforestry • Afforestation, reforestation and restoration of degraded lands • Soil carbon enhancement (e.g., through alternative tillage practices)	• Community/farm/outgrower plantations • Forest rehabilitation or restoration • Agroforestry
Carbon conservation	• Conservation of biomass and soil carbon in protected areas • Change forest management practices (e.g., reduced impact logging) • Fire protection and more effective use of prescribed burning in both forest and agricultural systems	• 'People and Protected Areas' projects • Agriculture intensification • Rotational shifting cultivation • Community fire control schemes • Home gardens • NTFP production • Eco-tourism
Carbon substitution	• Increased movement of forest biomass into durable wood products, used in place of energy-intensive materials • Increased use of biofuels (e.g., introduction of bioenergy plantations) • Enhanced utilisation of harvesting waste as a biofuel feedstock (e.g., sawdust)	• Community fuelwood • Community farm fuelwood • Charcoal production

Source: Bass et al. (2000)

The important role played by forests in sequestering CO_2 from the atmosphere, and the livelihoods and environmental benefits that will be accruing to the local communities enable CF to meet the dual objectives of CDM of sustainable development and emissions reduction. Hence, the growing interest in linking community-managed forests to climate change.

The History of Community Forestry

Community-managed forests in the Himalayan region

Community-based forest management as a mainstream forestry policy started around the late 1970s as an approach to mitigate increasing deforestation and forest degradation and address the negative impacts on rural livelihoods. In Asia, this management approach quickly became widespread, and as shown in Table 3.4, different forms of community involvement in forest management and protection have evolved.

Table 3.4: Status of community forestry in Asian countries

Country	Management Approach	Forest (million ha)	User group	Population
China	Collective Forest	153	NA	NA
India	Joint Forest	14	62,000	75 million
Philippines	Community-based Forest	5.7	2,182	NA
Nepal	Community Forest	1.1	14,000	7.8 million

Source: Karky (2005)

CFM plays a prominent role in the Himalayan region, where agriculture, livestock rearing, and the forest are strongly interlinked. Joint Forest Management (JFM) in India is the product of severe forest exploitation and conflict between the users and management authorities more than a century ago. The formal forestry sector in India is much older and has undergone four stages in policy changes from colonialism, commercialism, conservation, to collaboration; while in Nepal, it has evolved from privatisation to nationalisation, to populism, according to Hobley's 1996 classifications. The Van Panchayats (VPs) or Forest Councils of Uttarakhand are democratic and autonomous local institutions which have been managing legally demarcated village forests for over 70 years. The VP can also be regarded as one of the earliest forms of devolution in common property management in collaboration with the state (Arnold and Stewart, 1991). The community forest user group (CFUG), a democratic autonomous grassroots level institution in Nepal, is much younger and started only in the late '80s, but the pace of its promotion has grown rapidly in Nepal, as shown in Table 3.4.

Community involvement in forest protection, management, and utilisation of resources became a government policy in the forestry sector in the Himalayan region as a result of earlier failures of the states to mitigate escalating deforestation and forest degradation taking place. It was thus realised that without the inclusion and collaboration of the local people, forest protection and management efforts of the state alone would be futile. Together, the VP and the CFUG are really about decentralised resource management.

Under state management in Nepal, unregulated livestock grazing and fodder collection were the major causes of forest degradation, preventing natural regeneration, while unrestricted fuelwood and timber collection were the major causes for deforestation. This was a classical case of the tragedy of open access: anyone and everyone had unlimited access anytime because the state owned the resources and it was managed by that state's staff.

Community-based management of forests is about avoiding deforestation, and also about avoiding forest degradation by implementing protective measures. Forest degradation has been checked and forest regeneration, which is mainly dominated by natural regeneration, has taken place after stringent protective measures were deployed by local people through CFUG interventions. By means of locally enforced strict forest protection measures, forests were recuperating ecologically and already becoming important habitat for wildlife outside protected areas. Communities have easier access to firewood, timber, fodder, forest litter, and grass from the forest's conservation and better management. Soil erosion has been mitigated and water sources have been conserved in such areas.

An example of a community-managed forest in Nepal

Community forests play a prominent role in the hills of Nepal, where agriculture and livestock rearing and the forest are strongly interlinked (Gilmour and Fisher 1991). To mitigate the growing deforestation and the deteriorating state of forests all over the country, the Government of Nepal made a policy, based on the 1976 National Forestry Plan, to involve local communities in forest management. As of 2004, about 25% of the total national forests covering around 1.1 million ha are being managed by 13,000 CFUGs distributed across 1.4 million households – i.e., 35% of the population (Kanel 2004). The bulk of this population lives in the hilly areas. The Federation of Community Forest Users Nepal (FECOFUN) has, over the years, become one of the largest organisations in the country, with eight million forest users as members.

The impact of CFM policy in the forestry sector has been positive. Where communities are managing their forests, the degradation trend in the hills has been checked. Forest conditions have improved in most places, with positive impacts on biodiversity conservation (Mikkola 2002; Springate-Baginski et al. 1998, as cited in Acharya and Sharma 2004). Numerous degraded forest ecosystems have improved due to decentralised and participatory development strategies (Banskota 2000). Communities have had easier access to firewood, timber, fodder, forest litter, and grass (Kanel 2004; Acharya and Sharma 2004). Soil erosion has been mitigated and water sources conserved in previously degraded forest areas where communities have been able to regenerate forest cover.

While members of the CFUGs pay a nominal fee for the various forest products they consume, these products have been able to fetch much higher prices when marketed. The estimated monetary value of timber extracted by the communities (NRs. 1.27 billion ≅ US$ 18 million) is higher than the value of fuelwood (NRs. 0.39 billion ≅ US$ 5.5 million, at the exchange rate of Rs 70.9=1US$), although in terms of volume, fuelwood extracted is about three times more than the harvested timber. Kanel (2004), in his study on community-managed forests, found that revenues collected by CFUGs were often invested in social infrastructure selected by the community members, such as for school maintenance, the construction of a drinking water facility, amongst others. Part of the revenues (about 28%) are also used for forest protection and management. More financial revenues from carbon could enable greater spending on rural development and better forest conservation and management.

CFM in the Himalayan region is a major source of energy for the rural population. Fuelwood is by far the largest source of energy in Nepal, accounting for 76% of the total consumption for 2002 (MoPE 2003), decreasing from 81% in 1995-1996 (Amatya and Shrestha 1998).

If cutting for fuelwood exceeds forest regeneration rate, the forest becomes a net carbon source. At the same time, sustainable harvesting of fuelwood makes it a net CO_2 sink by replacing fossil fuel or unsustainable harvested fuelwood (Watson et al. 1996). The figures from the Himalayan region on fuelwood use, by itself, mean little in terms of carbon emission, so each case must be analysed individually, taking into account the forest regeneration capacity and the extraction rate of fuelwood from the forest. Leakage must also be accounted for, althrough this is outside the scope of this research.

Why CFM is not Recognised under the Kyoto Protocol

CFM is about avoiding deforestation by including local communities in managing and protecting the forests in common lands. Avoiding deforestation in non-industrialised countries was not included in the CDM because leakage from avoided deforestation was considered to be a significant hazard difficult to estimate and monitor (Schlamadinger, et al. 2007). Leakage is the endogenous increase in carbon emissions as a result of emissions reduction elsewhere. Each CDM project has to address and account for potential leakage, and there are no clear ways to address leakage from avoided deforestation. An example would be from Uttarakhand in India, where it can easily be argued that a Van Panchayat (VP) may be protected at the cost of a rapidly degrading state forest. It takes detailed analysis to prove that a VP, managing a forest in one area, is not contributing to deforestation in another forest. (Refer to Chapter 5 for more details on VP management in Uttarakhand.) This research does not address the issue of leakage.

Another reason for its exclusion, as stated by Skutsch et al. (2007), was that at the time of policy negotiations in 2001 at Marrakesh, there was a strong opposition from many sectors to including large-scale land use change management because this would reduce the efforts in the energy sector. It was thought that by permitting avoided deforestation there could be a market glut of carbon credits (due to excess supply of carbon), bringing the price down so low that eventually CDM would be counterproductive (Trexler 2003). Hence, for the first commitment period, LULUCF options have been restricted to afforestation under CDM.

This is unfortunate since, in essence, the present CDM criteria permit large-scale monoculture plantations and ignore biodiversity-abundant and sustainable management practices, despite one of the twin objective of CDM being, to assist non-Annex 1, non-industrialised countries in achieving sustainable development. Sustainable development goals are better addressed in small-scale community-managed sustainable forests than in large-scale commercial monoculture plantations.

The Way Forward: Reduced Emissions through Deforestation Policy

Between 18-25% of global emissions remain unabated and outside the purview of the UNFCCC and the KP. There is now a growing interest to include these emissions in the second commitment period after 2012. As CDM fails to reduce emissions from deforestation in non-industrialised countries, there is a strong move to find ways to reduce CO_2 emissions from the terrestrial ecosystems by reducing the deforestation rates. Under a policy called 'Reduced Emissions from Deforestation' (RED) several approaches have been developed and are being discussed by the Parties. This is quite different from the existing CDM approach. CDM operates at project levels, whereas the proposed new approaches under RED are country-wide and use past deforestation rates as the baseline so that leakages are also accounted for. For the second commitment period, such mechanisms could be included under the KP, or directly under the UNFCCC, depending on future negotiations.

In 2003, at a side event in the CoP 9, 'compensated reduction' was introduced as a possible approach to account for deforestation. The idea behind this is that addressing emissions from deforestation is distinct from sequestering it by a sink project (AR). Under this mechanism, non-Annex 1, non-industrialised countries can reduce their national deforestation rates under a historical baseline and be allowed to acquire carbon offset credits by demonstrating reduced deforestation (Santilli, et al. 2005). In 2006, at CoP 11, this concept of compensated reduction was further refined by the Institute for Environment and Sustainability for the European Commission Joint Research Centre (Skutsch et.al. 2007). It uses the same baseline approach, taking the historical deforestation rate as compensated reduction, except that it starts from the global average rate of deforestation. A nation with a baseline deforestation rate above half the global average deforestation rate would be able to receive credits for the commitment period.

Under the proposed RED mechanism, the two approaches mentioned have several advantages as described by Skutsch et al. (2007). First, if accepted, they will account for a major source of emission from deforestation in tropical regions and enable market mechanisms to be used for mitigation measures. Second, they will address leakage since baselines at national levels would mean detecting and accounting for losses as well as gains. Third, transaction costs would be reduced significantly compared to individual projects. Finally, both approaches give much more authority and responsibility to the countries themselves in reducing emissions from deforestation.

At the CoP 11, a two-year process was started to explore this new option of RED, and the debate is ongoing. In May 2006, the UNFCCC Subsidiary Bodies (SB 24) met, where this option was further discussed. A side event titled, 'Reducing Emissions from Deforestation in Developing Countries: Methodology and Policy Issues' presented how this could be achieved. Discussions are ongoing to find the most effective and practical emissions reduction strategy for the second commitment period. At the CoP 12 in Nairobi in December 2006, the Subsidiary Body for Scientific and Technological Advice (SBSTA), at its 25th session, invited Parties to submit their views on RED to the secretariat by 23 February 2007. The secretariat has received 19 submissions from Parties including from India and Nepal. Hopefully, the global community will be able to agree on and implement a RED policy soon that will more effectively account for emissions outside of the coverage of the UNFCCC and the KP, and at the same time provide incentives for those that conserve and manage forests in non-industrialised countries.

Conclusion

The Kyoto Protocol is a commitment to reduce human-induced emissions of GHGs to the atmosphere, and was created with the objective to implement the UNFCCC after it had been scientifically proven that climate change was occurring. However, deforestation in tropical countries, which is a major source of CO_2 emissions, remains outside the UNFCCC.

Forests play a significant role in stabilising the concentrations of atmospheric CO_2 as they switch between becoming a source and a sink. Permanent loss of CO_2 from the terrestrial ecosystem by conversion of land use and loss of biomass can be reduced by avoiding deforestation. Community forest management, as undertaken in the Himalayan region, is becoming an important strategy for increasing carbon pool levels in the region from a climatic perspective, as these forests are beginning to show signs of regeneration in previously deforested areas.

The Clean Development Mechanism of the KP does not, at present, bring benefits to marginal communities living in the Himalayan region, vulnerable to the adverse impacts of climate change. However, as the scientific community has gained new insights into more effective ways to reduce global emissions, there is now a growing interest in finding ways to include reducing deforestation in non-industrialised countries in the post 2012 era. Therefore, it is important for authorities in the regions concerned with CFM to take early cognisance of the potentials and possibilities that CFM offers and be able to lobby for a mechanism that brings benefits to the locals that conserve forest locally, while extending the benefits globally.

The recent policy developments are concerned with innovative ways to tackle reduction of emissions from deforestation in non-industrialised countries. Mechanisms like the RED, that will have a global benefit of reducing emissions from deforestation and at the same time reward those in the non-industrialised world that clean up the pollution, will be welcomed by many.

Trained local communities can measure effectively and efficiently the changing carbon stock in their forests using standard forest inventory methods.

Community forest meeting in progress in one of Nepal's community-managed forests
(Bhaskar Singh Karky)

Carbon Measurement Methodology and Results

4

Ashish Tewari and Bhaskar Singh Karky

Introduction

This Chapter describes the methodology used for estimating carbon in forest land use according to the standards set by the IPCC (2003) for the LULUCF sector. The steps described in the estimation process are derived from the protocol developed by MacDicken (1997), which uses standard forest inventory principles and techniques. Hence, the carbon estimation methodology for India and Nepal is based on standard forest inventory principles and techniques, with minor differences to suit differing field conditions, forest types, local forest management, and available technical resources.

The methodology described is a simple step-wise procedure for carbon estimation in a given piece of community forest with local participation, as is being done by the project Kyoto: Think Global, Act Local in the India and Nepal Himalayan region. The methodology pertains to data collection and analysis of carbon accumulating in the biomass and soil carbon of forests using modern verifiable methods.

Research Sites in India and Nepal

In Uttarakhand, India, much of the altitudinal range between 1600-2200 masl consists of two major forest types: temperate oak, and subtropical pine. These forests are dominated by evergreen species of *Pinus roxburghii* (Chir pine) and *Quercus leucotricophora* (Banj oak). The dominants have a leaf life span of about one year, with older leaves falling as the new leaves expand, or a few weeks later (Singh and Singh 1992). Annual rainfall across the region varies from 1050-2690 mm (Dhar 1987).

There are three research sites in Nepal, located in different geographic regions. Ilam in the Churia range (low hills), at an altitude of 400-800 masl, has a subtropical broad-leaved forest dominated by bamboo, *Lannea grandis*, and *Schima wallichii*. Forests in Lamatar lie in the midhills at an elevation between 1830-1930 masl and are dominated by lower temperate broad-leaved species, particularly of *Schima-Castanopsis*. In Manang, the forest lies in the high mountain range at an elevation range of 3500-4200 masl, representing a temperate conifer forest dominated by *Pinus wallichiana*. This is the upper limit of forest vegetation, a transition between a temperate forest and an alpine grassland. A brief description of the forest sites in India and Nepal is presented in Table 4.1.

Table 4.1: Description of the research sites in India and Nepal						
	Van Panchayat Forest Sites in Uttarakhand, India			**Community-managed Forest Sites in Nepal**		
Research sites	Dhaili	Toli	Guna	Ilam	Lamatar	Manang
Area (ha)	58	103.5	50	47	96	240
Year established	1999	1955	1937	1998	1994	Mid '90s
Total members	1350	1246	204	1800	390	650
Rainfall (cu m)	162-180	162-180	160-180	200	160	40
Temperature	6 - 28^{0}C	6 - 29^{0}C	6 - 29^{0}C	6 - 30^{0}C	3 - 30^{0}C	-5 - 20^{0}C
Altitude (m)	1810 - 1960	1900-2100	1800-1920	400-800	1830-1930	3500 - 4200
Vegetation/ forest type	Himalayan temperate oak forest	Subtropical pine forest/ Himalayan temperate oak forest	Sub tropical pine forest/ Himalayan temperate oak forest	Subtropical broad-leaved	Lower temperate broad-leaved	Temperate conifer
Dominant species	Banj oak *(Quercus leucotrichophora)* mixed with under canopy species Burans *(Rhododendron arboreum)* and Kafal *(Myrica nagi)*	Banj oak *(Quercus leucotrichophora)* and Chir pine *(Pinus roxburghii)*	Banj oak *(Quercus leucotrichophora)* and Chir pine *(Pinus roxburghii)*	Various species of bamboo, *Lannea grandis,* and *Schima wallichii*	*Castanopsis tribuloides* and *Schima wallichii*	*Pinus wallichiana*
Size of permanent plots (m^2)	100	100	100	100	100	250
Number of permanent plots	7 - 15	9 - 15	8 - 10	14	8	9

Carbon Estimation Methodology

Selection of Sites

The criteria for the selection of Van Panchayat community forests user group-managed forest sites from among several surveyed community forests was based on the willingness of community members to participate in training exercises for carbon estimation. Selected sites represent the typical range of areas of VPs/CFUGs, average household size, year of formation, forest condition and type. At least one village-level workshop was held and the participating communities informed about the possible repercussions of climate change and some basic information about global warming. The workshop was participatory, taking inputs from the community in regard to the condition of their forest and forest types, and their views regarding the manner in which training should be conducted. Various rounds of consultations with the village communities in general, and the office bearers of the VPs and CFUGs in particular, were the basis for activities undertaken in community forest areas. The entire field exercise comprising the collection of data necessary for carbon estimation was done in collaboration with local people who were given training on forest survey techniques.

Identifying and stratifying the forest area

The following factors were considered in identifying the different forest strata (hereby referred to as forest type):

- *Dominant tree species.* Sites under a dominant species were regarded as one stratum or type.
- *Stocking density of trees.* Within a dominant type, sites were separated in case they differed substantially in stocking density.
- *Age of tree.* Sites of clearly different age classes were further stratified as carbon sequestration differs markedly with the age of the stand.
- *Aspect and position of hill slopes.* Within a dominant type, sites differing in aspect and position on a hill slope were further stratified because the rate of carbon sequestration varies in relation to these factors. For example, a stand on the south aspect would have far greater productivity than one on the north aspect.

Stratifying the forest ensures that measurements are more alike within each stratum compared to the sample frame as a whole. For the sake of convenience, several maps following detailed discussions were prepared by the community showing the presence of dominant species in different areas and aspects, which were cross-checked during actual field visits (Figure 4.1). In the fieldwork in Nepal, community-managed forests were not stratified because the area of forest was relatively small, with uniform forest cover within each community forest.

Boundary mapping

The identified forest types were mapped jointly by scientists and community members using a mobile GIS system (HP IPaq with NAVMAN GPS and Arc pad), which was logged/traced onto base maps. For this, the entire boundary of the forest type was visited and coordinates marked at all canopy openings. Ordinary Garmin GPS handsets were also used for mapping, where IPaq could not be used.

Pilot survey for variance estimation and sample plot size

A carbon inventory is more intricate than a traditional forest survey as each carbon pool could have a different variance (MacDicken 1997), hence a pilot inventory was carried out to estimate the variance of the main carbon pool, the trees.

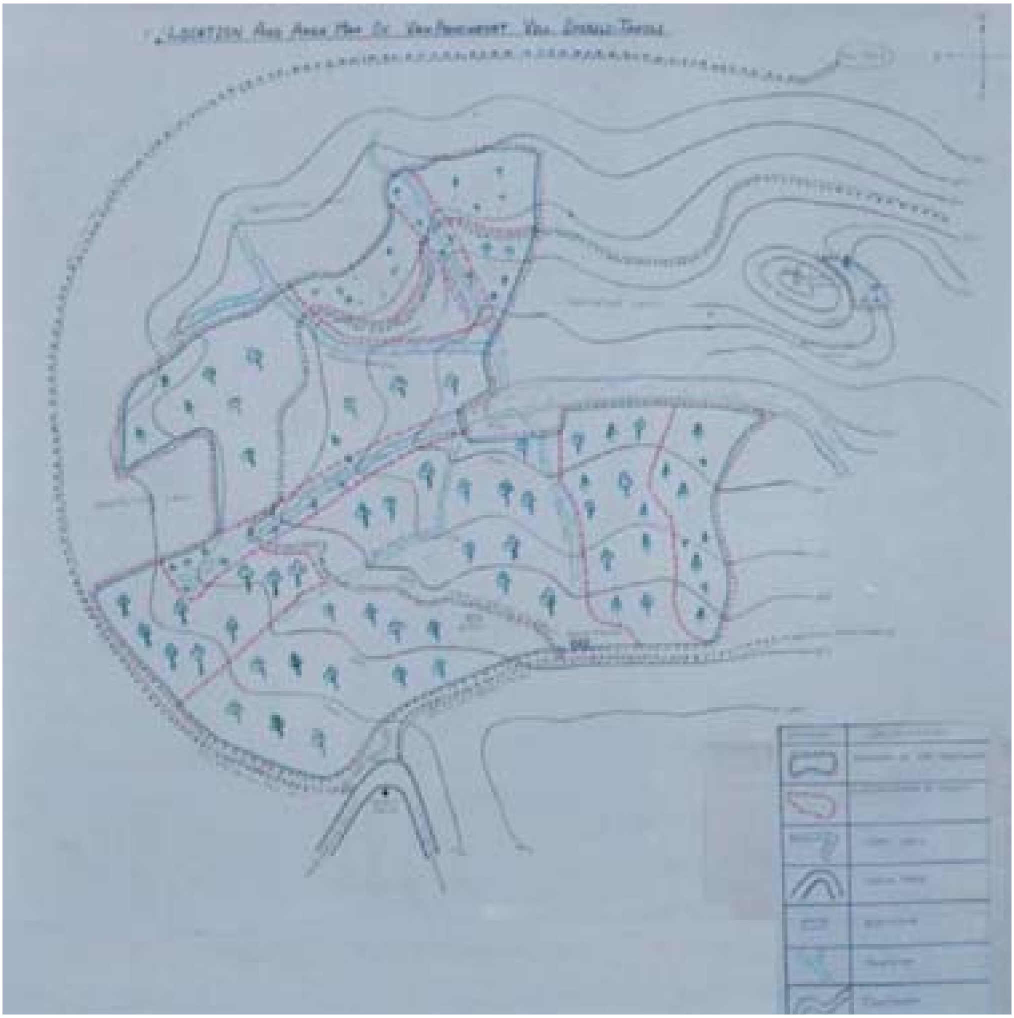

Figure 4.1: Location and forest map of Dhaili VP prepared by the community

In India, a pilot inventory was carried out by laying at least 15 random circular plots for each forest type stratum of 5.64m radius, as recommended by Saxena and Singh (1982), and measuring the circumference at breast height (1.3m). Circumference at breast height (cbh) of all saplings and trees above 4 cm was measured and recorded, while for Nepal, a diameter at breast height (dbh) tape was used to take the dbh recording for trees less than 5 cm.

In Nepal, the area of the circular permanent plots varied in different sites, as the area per tree determined the radii of the plots as described by MacDicken (1997) and as illustrated in Table 4.2.

Table 4.2: Plot radii for carbon inventory plots			
Plot size (sq m)	**Plot radius** (m)	**Typical area per tree** (sq m)	**This size of plot is usual for:**
100	5.64	0 - 15	Very dense vegetation, stands with large numbers of small diameter stems, uniform distribution of larger stems
250	8.92	15 - 40	Moderately dense woody vegetation
500	12.62	40 - 70	Moderately sparse woody vegetation
666.7	14.56	70 - 100	Sparse woody vegetation
1000	17.84	> 100	Very sparse vegetation

Source: MacDicken (1997)

Calculating Optimal Sampling Intensity

The following statistical formula was used to calculate the number of permanent sample plots (n) required for the inventory. Sampling intensity for different sites was shown on Table 4.1.

$$n = \frac{CV^2 t^2}{E^2}$$

where

CV = Coefficient of variation of basal area

t = Value of t obtained from the student's t-distribution Table at n-1 degree of freedom of the pilot study at 10% probability

E = Sampling error at 10%

Permanent plot layout

Locating sample plots. A 'sample design' extension for Arc pad was used to systematically locate the sample plots in the map. The plots were then marked in the field using a mobile GPS system.

Slope correction. While placing permanent plots, care was taken to do a correction for slope in areas where the slope was above 10°. (The slope was calculated using a clinometer). The correction factor used was: LS= L/cos S, where LS is the corrected plot radius, S is the slope angle in degrees, cos S the cosine decimal, and L is the plot radius.

In the CFUGs of Nepal, instead of using the mathematical process for slope correction, the stepping method of surveying on gradient ground was used, which avoids the need for slope calculation. Holding the measuring tape horizontally as illustrated in Figure 4.2 corrects the slope.

Permanent plot measurements

About seven to 15 permanent plots (depending on the calculated sampling intensity/ forest types) of 5.64m radius, as recommended by Saxena and Singh (1982) for the Himalayan forests, systematically laid out with a random starting point marked as 'S' for each forest type (Figure 4.3). Transects perpendicular to the longest side of the forest

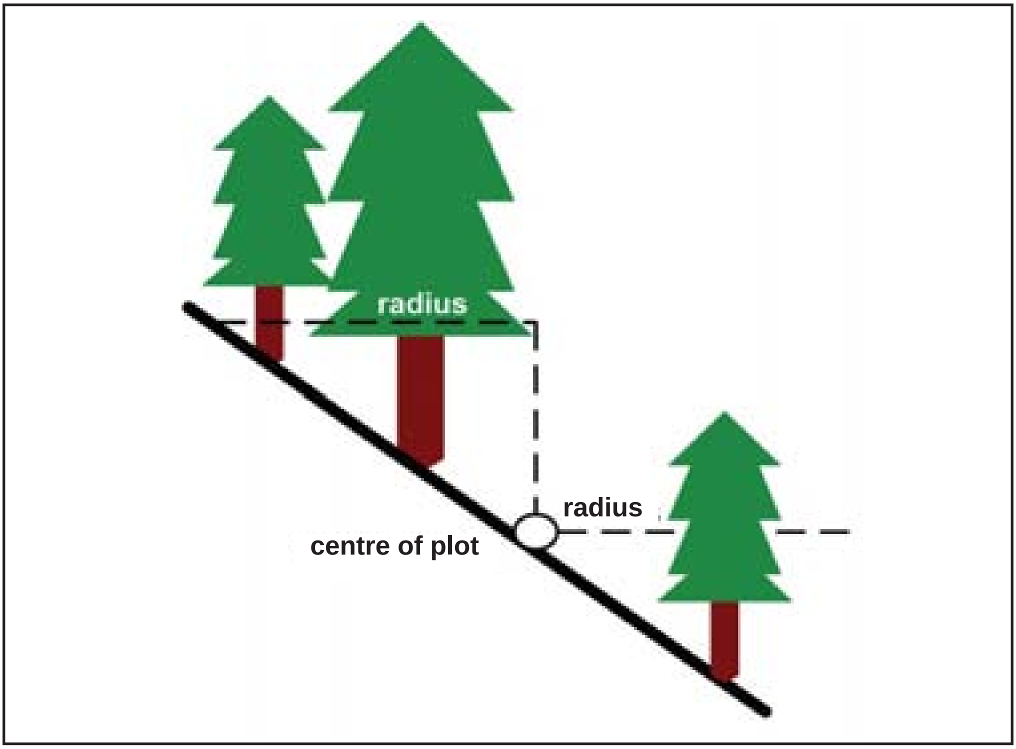

Figure 4.2: The stepping technique of surveying slope correction on a gradient ground

type were placed for a reasonable spread of the plots over the whole area. The transects were parallel to each other and the length of the transects and their bearing were recorded. Using GPS, plots were marked at a similar distance from each other and a map of their location was prepared. For the convenience of the community investigators, the centre of the plot was taken as a tree (marked with white paint) and the radius of the circular plot taken from the centre of this tree. The marking in the centre of the plots proved valuable in annual monitoring as GPS alone could give a few metres of variance in locating the centre of the permanent plot.

For Nepal, the size of permanent plots varied in different sites as the radii of the plots were dependent on distribution of trees, as described by MacDicken (1997), and as illustrated in Table 4.2.

Data recording

Individual trees greater than 16 cm in circumference were measured over the whole plot of 5.64m radius at 1.3 height from the ground for circumference, using a metre tape. Trees which were on the border were considered 'in' if > 50% if the basal area fell within the circle.

Individual trees between 4 and 16 circumference were considered saplings and their circumference determined at collar height in 1m radius plots located approximately in the centre of the large plot. Individuals greater than 1.3m in height and having less than

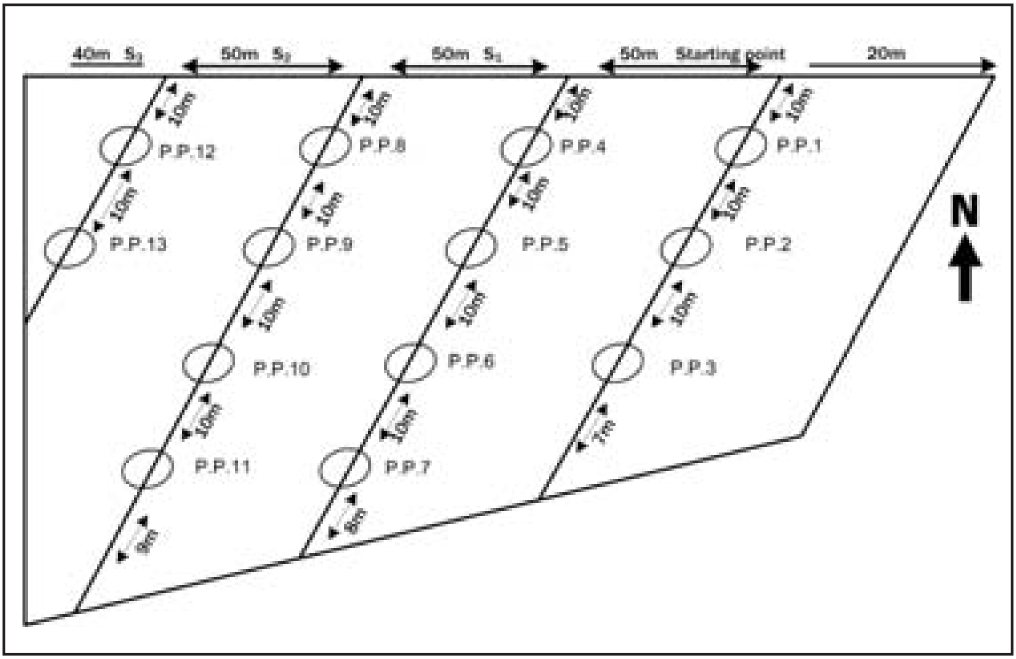

Figure 4.3: Location map of permanent plots of pure oak forest in Dhaili VP

4 cm circumference at collar height were considered seedlings, which were counted in 4 subplots of 1m^2 placed within the larger (5.64m radius) plot, as depicted in Figure 4.4. For Nepal, trees measuring >5 cm dbh were measured and recorded in the plot using dbh tape. The plot radius for Ilam and Lamatar was 5.64m, whereas for Manang it was 8.92m.

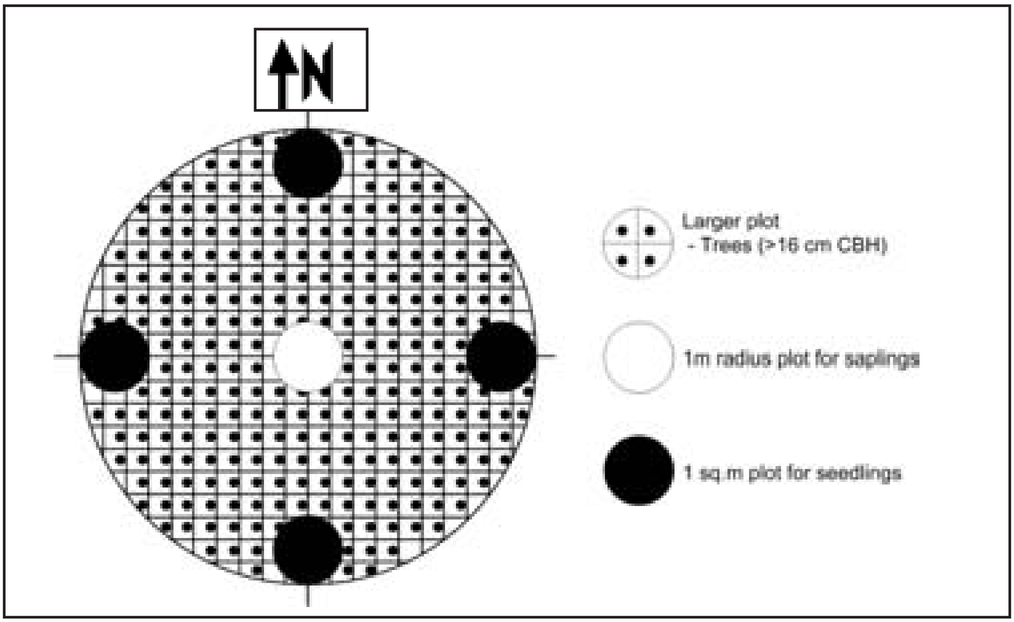

Figure 4.4: Location of plots for sapling and seedling measurements within a larger plot

Data on each measurement was recorded in data collection form and later entered into an Excel spreadsheet. The data was recorded along with species name by two persons, and measurements were redone in cases of discrepancy.

Biomass Estimation

Biomass estimation of trees and saplings

To estimate biomass of trees and saplings occurring in permanent plots, they were categorised into girth classes on the basis of their circumferences taken in October of Year One. The measurements were redone in the same month of Year Two. Using the allometric relations developed by Rawat and Singh (1988) for the Indian Himalayan species the biomass was estimated. In Nepal, the national allometry tables developed by the Department of Forest Research and Survey were used, which had simplified equations that required only dbh as single input variable to calculate volume. The net change in biomass ($\Delta Yr = Yr_2 - Yr_1$) between Yr_2 and Yr_1 was taken as annual biomass accumulation. Half of this change in biomass was taken as the carbon sequestration rate (MacDicken 1997), expressed in t/ha. To convert carbon to carbon dioxide, carbon is multiplied by 44/12 – the ratio of the molecular weight of carbon dioxide to carbon.

Biomass estimation of other plant forms and litter

Four subplots of $1m^2$ in each $100m^2$ plot (5.64 radius) were placed randomly and all above and below ground parts were harvested, placed in previously marked bags, weighed and brought to the laboratory, and oven-dried at 600°C up to constant weight. The biomass of herbs and shrubs were determined at their peak during the September-October months. Biomass was expressed separately for aboveground and below ground components in t/ ha.

The forest floor material was collected from 10, 0.5 x 0.5m quadrants placed randomly in each stratum. All herbaceous live and dead shoots at ground level were harvested. The material on the forest floor was then collected carefully, avoiding contamination with soil as much as possible, and categorised into (i) fresh leaf litter, (ii) partially decomposed litter, (iii) wood (including seeds) litter, and (iv) miscellaneous litter, consisting of material other than the above. The collections were brought to the laboratory, separated by category, and over dry weight determined (Rawat and Singh 1988) in t/ha.

Below Ground Biomass

Below ground biomass estimation is much more difficult than aboveground estimation. To simplify the process for estimating below ground biomass, MacDicken (1997) recommends the use of the root: shoot ratio value of 0.10 or 0.15, which is based on tropical forests. The IPCC (2003) also recommends the use of such default ratios based on root: shoot ratio for different types of forests. For Nepal, root: shoot ratio value of 0.125 was used. For India, allometric relations developed previously (Rawat and Singh 1988) were used.

Soil Carbon Estimation

Two methods are most commonly used for soil carbon analysis: the dry combustion method, and the wet combustion method. The IPCC (2003) recommends use of the dry combustion method for carbon projects, as this method separates organic and inorganic carbon as the latter is removed by acidification. But because of the lack of laboratory facilities and technical know-how, the dry combustion method was not available in Nepal and hence, soil carbon estimation data was referred from literature (Bajracharya et al. 2004) which summarise over 10 other studies carried out in Nepal estimating soil carbon from the midhills region, which is ideal for these research sites.

In India, the researchers' capacities enabled them to conduct soil carbon estimation based on rapid titration method of Walkey and Black (1958), as described by Misra (1968).

To estimate soil carbon percentage, five to seven pits of up to 150 cm depth were dug in different forest types to best represent forest type in terms of slope, aspect, vegetation, density, and cover. From each pit, soil samples were collected from five mineral soil layers (0-10, 10-30, 30-60, 60-90, and 90-150 cm). Misra's rapid titration method was used to measure soil carbon concentration.

Soil bulk density was calculated for each soil depth for which soil carbon was estimated. Soil samples were collected by means of a special metal core sampling cylinder of known volume without disturbing the natural soil structure. Soil samples were oven-dried at 105°C in the laboratory until they reached a constant weight. The weight of oven dried soil samples was divided by its volume to estimate soil bulk density, expressed in g/cc (Misra 1968).

Capacity of VP/CFUG Team Members in Making Measurements

Trained members of the communities have developed sufficient competency in doing field measurements, recording the readings, and using GPS for marking boundaries of forest stratum and permanent plots. Trained CFUG members in two sites in Nepal can do the entire exercise with confidence without outside assistance. However, experience shows that the data analysis part should be left to the experts.

Leakages

Leakage, in CDM terminology, is defined as an unplanned and indirect emission of GHG resulting from a project activity. Direct leakage occurs, for example, if establishing an afforestation or reforestation project on an agricultural land causes farmers farming on this land to move elsewhere to clear the forest in order to continue agricultural activities. All CDM projects must account for direct and indirect leakage, and credit is given only after deducting this amount.

The best approach to accounting leakage is by getting information from the project sites. To account for leakage, a livelihood approach survey was designed to collect data at the household level. This database would then be used for accounting for leakage and finding ways to address it. In the project sites, a random household survey amongst VP/CFUG members was conducted. Data from this survey were verified through focus group discussion. A forest resources use survey will triangulate data for estimating leakage. Currently, only the household surveys have been conducted in the research sites in both countries.

Results

Vegetational parameter

The tree density across the VPs studied in Uttarakhand in different forest types ranged between 83 individual trees/ha and 1271 individuals/ha. The density of trees in all the forest types was reasonably high, except in a degraded site in Dhaili which had a very low density (148 individuals/ha) because of natural factors (this is a rocky area). The basal area of trees was generally above 16 m^2 ha-1 (Table 4.3).

Table 4.3: Vegetation data by forest stratum in the VP forests of Toli, Dhaili and Guna in Uttarakhand, India

VP and forest type	Growth stage	Tree Density (individuals/ha)	Basal area (m^2 ha^{-1})
Toli			
Young banj oak with chir pine forest	trees sap	1016 42	18.8
Chir pine forest with bushy banj oak	trees sap	499 165	16.8
Young pure pine forest	trees sap	653.7 18	24.3
Dhaili			
Even-aged banj oak forest	trees sap	868.8 150	32.5
Mixed banj oak chir pine degraded	trees sap	148	3.8
Dense mixed banj oak forest	trees sap	1271 168	43.5
Guna			
Pure chir pine forest	trees sap	83 18	20.3
Mixed banj oak	trees sap	1222	18.0

In the CFUGs of Nepal, the tree density in Ilam (536 individuals/ha) and Manang (489 individuals/ha) was on the low side compared to Lamatar (2000 individuals/ha), which was also above those of Uttarakhand. However, it is evident that even this forest is young, as the basal area is below 20 m^2 ha^{-1} (Table 4.4). The temperate conifer forest of Manang has a high basal area on account of older trees.

Table 4.4: Vegetation data from three CFUGs of the Nepal Himalaya		
CFUGs	**Density** (individuals/ha)	**Basal area** (m^2 ha^{-1})
Ilam	536	13.4
Lamatar	2000	19.5
Manang	489	33.85

Biomass in community-managed forests of Uttarakhand, India and Nepal

The tree biomass in the community forests of Uttarakhand was much higher than tree biomass in the community forests of Nepal. The biomass of banj oak *(Quercus leucotrichophora)*-dominated forest types was generally above 308.0 t ha^{-1}, and the biomass of chir pine *(Pinus roxburghii)*-dominated forests was marginally lower (Table 4.5). The contribution of herbs and shrubs in the total vegetation biomass areas of all the forest types was between 1.6 and 6.7 t ha^{-1}.

Table 4.5: Above and below ground biomass variations across Van Panchayat forests in Uttarakhand, India			
VP and Forest stratum	**Above and below ground biomass** (t ha^{-1})		
Dhaili VP forest	**Year 1**	**Year 2**	**Year 3**
Even-aged banj oak forest	344.0 (3.4)	353.0 (3.3)	358.0 (2.7)
Dense mixed banj oak forest	511.0 (5.3)	520.5 (5.7)	528.0 (4.5)
Mixed banj oak with chir pine	38.0 (2.0)	42.0 (1.7)	46.5 (1.6)
Toli VP forest			
Young banj oak with chir pine forest	314.0 (6.7)	322.0 (6.5)	330.0 (6.6)
Chir pine with bushy banj oak	118.0 (3.9)	125.1 (3.8)	130.0 (2.9)
Young pure chir pine forest	139.0 (2.0)	148.0 (2.2)	156.0 (2.0)
Guna VP			
Young pure chir pine forest		20.6 (2.1)	28.2 (2.0)
Mixed banj oak forest		308.0 (5.2)	316.8 (4.9)

The values of herb+shrub biomass are given in parenthesis

In the community forests of Nepal, the tree biomass of Ilam and Lamatar was >100 t ha^{-1}, whereas for Manang, it was approximately half of this value (Table 4.6). These figures are considerably lower than in India, which suggests that the forests in Nepal are either younger (such as in Lamatar), or more sparse (such as in Manang). It must be noted that the figures for Nepal only account for aboveground biomass of trees >5 cm dbh and excludes biomass in herbs/grass and litter, and those <5 cm dbh. Below ground biomass is calculated by taking a default value of 12.5% of the aboveground biomass. The figures in parenthesis show aboveground biomass only.

Table 4.6: Annual variation in tree biomass in three CFUGs in the Nepal Himalaya			
CFUG	Above and below ground biomass (t ha^{-1})		
	Year 1	Year 2	Year 3
Ilam	115.88 (103)	121.5 (108)	128.25 (114)
Lamatar	102.38 (91)	104.63 (93)	108 (96)
Manang	61.88 (55)	NA	66.38 (59)

Note: The values for aboveground biomass of dbh >5cm are given in parenthesis

Carbon and CO_2 sequestration rates

Referring to Tables 4.7 and 4.8, the mean carbon stocks across all community forests studied for both Uttarakhand, India and Nepal varied between 30.94 $tCha^{-1}$ (Manang on the 1st year) and 155.4 $tCha^{-1}$ (Dhaili VP on the 3rd year). The mean for Uttarakhand, India was 117.29 $tCha^{-1}$ while for Nepal it was only half this value. In terms of CO_2, the mean CO_2 between the six sites in India and Nepal varied between 113.47 tCO_2ha^{-1} in Manang on the 1st year, and 569.85 tCO_2ha^{-1} in Dhaili on the 3rd year.

Table 4.7: Annual variation in carbon stock by forest type in the Van Panchayats of Uttarakhand, India and their mean carbon sequestration rates				
	Carbon mass (t ha^{-1})			Mean c sequestration rate ($tCha^{-1}yr^{-1}$)
	Year 1	Year 2	Year 3	
Dhaili VP forest				
Even-aged banj oak forest	172.1	176.5	179	3.4
Dense mixed banj oak forest	255.7	260.2	264	4.15
Mixed banj oak chir pine degraded	18.8	20.8	23.25	2.2
Mean C-stock			155.4	
Toli VP forest				
Young banj oak with chir pine forest	156.9	161.2	165	4.05
Chir pine forest with bushy banj oak	58.9	62.4	65	3.05
Young pure chir pine forest	69.5	74.0	78	4.25
Mean C-stock			110.26	
Guna VP forest				
Young pure chir pine forest	-	10.3	14.1	3.8
Mixed banj oak forest	-	154.0	158.4	4.4
Mean C-stock			86.2	
Mean C-sequestration rate across the VP forest				3.7(13.57$tCO_2ha^{-1}yr^{-1}$)

The community forests of both India and Nepal sequester carbon. The mean sequestration rate of community forests studied in India and Nepal is close to 2.79 $tCha^{-1}yr^{-1}$, which translates to 10.23 $tCO_2ha^{-1}yr^{-1}$. The sequestration rates for the community forests of Uttarakhand, India is close to 3.7 $tCha^{-1}yr^{-1}$ (average of three years) or 13.57 $tCO_2ha^{-1}yr^{-1}$, which is twice the rates of Nepal (1.88 $tCha^{-1}$ yr^{-1} or 6.89 $tCO_2ha^{-1}yr^{-1}$) but lower than the range reported for the Central Himalayan forests by Rana et al. (1989). Rana et al. reported a 4.5 to 8.4 $tha^{-1}yr^{-1}$ of carbon in chir pine

(Pinus roxburghii), mixed broad-leafed forest, and pure chir pine *(Pinus roxburghii)* forests. A study from the inner Terai region in Nepal shows carbon sequestration rates of 2 $tha^{-1}yr^{-1}$ from aboveground biomass (including under story biomass) and soil organic carbon (SOC) of up to 0-20cm depth (Aune, et al. 2005) which is closer to the mean of three sites sequestering 2.79 t C ha^{-1} yr^{1} (10.23 $tCO2ha^{-1}yr^{-1}$).

The carbon data for Nepal in Table 4.8 consists of biomass of aboveground plants with >5 cm dbh, and below ground biomass, but excludes SOC, carbon in herbs/grass and litter, and those <5 cm dbh.

Table 4.8: Annual variation in carbon stock in three community-managed forests of the Nepal Himalaya and their mean carbon sequestration rates

CFUGs	**Carbon mass** (tha^{-1})			**Mean c sequestration rate** ($tCha^{-1}yr^{-1}$)
	Year 1	**Year 2**	**Year 3**	
Ilam	57.94	60.75	64.13	3.1
Lamatar	51.19	52.32	54.00	1.41
Manang	30.94	NA	33.19	1.13
Mean C- sequestration rate across community forests				1.88 (6.89 $tCO_2ha^{-1}yr^{-1}$)

Soil carbon

Carbon in the deeper layer of the soil remains sequestered for years unless the aboveground forest is disturbed. Soil carbon is distributed in a deeper layer of soil, possibly due to (1) decrease in soil carbon turnover, with soil depth resulting in higher soil carbon accumulation per unit of carbon input in deeper layers; (2) additional soil carbon leaches from shallower to deeper layers to soil; and (3) carbon moves down vertically through soil organisms (Jobbagy and Jackson 2003).

Soil carbon concentrations across all forest types studied ranged between 1.6 and 3.7% at the topsoil layer (0-10 cm) (Tables 4.9-4.11). Carbon content in the topsoil layer was maximum in banj oak community forests of Uttarakhand. Species with deep roots hold a great potential for carbon sequestration in deeper soil layers. For example, banj oak forests with massive root systems and deep soil are expected to be far more effective in carbon sequestration than other species having shallow roots. The soil carbon in the forests types studied remained close to 1.0%, even at 150 cm depth. Evidently, we will miss a large amount of soil carbon if sampling is limited to top 30-40 cm soil, as is the general practice worldwide. All forests types in the community forests studied in Uttarakhand had soil carbon of over 200 t ha^{-1} up to 150 cm depth (Tables 4.9-4.11), which in CO_2 terms translates to approximately 733 tCO_2ha^{-1}. The data shows that forest soils in the Himalayan region can have up to two times more soil carbon than the amounts reported by sampling 20-30 cm soils.

Table 4.9: Vertical distribution of soil carbon by forest type in Dhaili Van Panchayat ($tCha^{-1}$)			
Soil depth (cm)	**Even aged banj oak forest** ($tCha^{-1}$)	**Mixed banj oak chir pine degraded** ($tCha^{-1}$)	**Dense mixed banj oak forest** ($tCha^{-1}$)
0-10	24.64 (2.2)	17.12 (1.6)	25.41 (2.1)
10-30	31.36 (1.4)	27.82 (1.3)	29.76 (1.2)
30-60	43.20 (1.2)	30.00 (1.0)	44.64 (1.2)
60-90	46.80 (1.2)	46.20 (1.1)	35.34 (0.95)
90-150	78.00 (1.0)	84.00 (1.0)	62.40 (0.80)
Total soil carbon ($t\ ha^{-1}$)	**224.00**	**205.14**	**197.55**

Note: The percent values for soil carbon are given in parenthesis.

Table 4.10: Vertical distribution of soil carbon by forest type in Toli Van Panchayat ($tCha^{-1}$)			
Soil Depth (cm)	**Young banj oak with chir pine forest** ($tCha^{-1}$)	**Chir pine forest with bushy banj oak** ($tCha^{-1}$)	**Young pure pine forest** ($tCha^{-1}$)
0-10	44.77 (3.7)	27.60 (2.4)	31.28 (3.4)
10-30	41.48 (1.7)	36.48 (1.6)	44.00 (2.2)
30-60	63.75 (1.7)	43.20 (1.2)	66.00 (2.0)
60-90	50.70 (1.3)	43.20 (1.2)	46.80 (1.3)
90-150	78.00 (1.0)	64.80 (0.90)	79.20 (1.1)
Total soil C ($t\ ha^{-1}$)	**278.70**	**215.28**	**267.28**

Note: The percent values for soil carbon are given in parenthesis.

Table 4.11: Vertical distribution of soil carbon by forest type in Guna Van Panchayat ($tCha^{-1}$)		
Soil depth (cm)	**Pure chir pine forest** ($tCha^{-1}$)	**Mixed banj oak forest** ($tCha^{-1}$)
0-10	22.00 (2.2)	25.41 (2.1)
10-30	44.00 (2.0)	31.36 (1.4)
30-60	46.80 (1.3)	50.40 (1.4)
60-90	39.60 (1.1)	35.34 (0.95)
90-150	79.20 (1.1)	62.40 (0.80)
Total soil carbon ($t\ ha^{-1}$)	**231.60**	**204.91**

Note: The percent values for soil carbon are given in parenthesis.

According to previous studies and literature (Bajracharya et al. 2004), the mean SOC pool to a depth of 1m in the middle hills is estimated for the forest to be 89.1 tCha-1 (227 tCO_2ha^{-1}), as shown in Table 4.12. The SOC values in the Nepal Himalaya are less than those of Uttarakhand, where the mean C pool is 154 $tCha^{-1}$ (565 tCO_2ha^{-1}) up to a soil depth of 90 cm. This may be because forest biomass is higher in the research sites of Uttarakhand, India than those of the Nepal research sites, and even for these sites where the soil tests were conducted the forest cover could be less than those for sites in India.

Table 4.12: Mean SOC pool and total stock for different land uses in the midhills of the Nepal Himalaya			
Soil Depth (m)	**SOC** (%)	**BD** (Mg/m)	**Mean C pool** ($tCha^{-1}$)
Forests 0-0.30m	2,31	0,7	48.5
Forests 0.3-1m	0,58	1	40.6

Source: Bajracharya, et al. 2004.

It would be interesting to link these results from biomass with existing CDM prices for CO_2, as stated by Ranganathan (2007), which is between US$ 12 to 15 per tonne of CO_2. The mean CO_2 sequestration rate for India of 13.57 t $CO2ha^{-1}yr^{-1}$ would be worth US$ 162.84 $ha^{-1}yr^{-1}$ at the rate US$ 12 per tonne CO_2, and US$ 67.85 $ha^{-1}yr^{-1}$, even if the prices were as low as US$ 5 per tonne of carbon. For Nepal, the 6.89 t $CO_2ha^{-1}yr^{-1}$ would be worth US$ 82.68 $ha^{-1}yr^{-1}$ at US$ 12 per tonne, and US$ 34.45 $ha^{-1}yr^{-1}$ at US$ 5 per tonne. These figures could be significant for the whole of the Himalayan region where local communities practice community forest management.

The prices for CO_2 represent prices for certified emissions reduction (CERs) issued for energy projects. The market for CERs from Clean Development Mechanism (CDM) forestry projects has not yet been developed. These projects do not receive regular CERs, only temporary credits (tCERs), and the market value of temporary credits is likely to be much lower than for regular CERs. The value of CERs from forest management projects such as these is completely unknown, as CERs are not yet tradable.

Some Constraints in Field Measurement in Estimating Carbon

One of the advantages of using a hand-held computer is that the map appears on the screen and it is much more participatory, as everyone can see the map. However, downloaded base maps from the Internet were not accurate. For instance, it would show the wrong location on the map. These maps, because they are large files, also made the computer crash much more frequently.

The iPaq batteries ran out within 45 minutes and recharging was a problem, especially in places where there was no electricity. Garmin handsets were much more reliable and durable as they had longer battery life and batteries were easily available.

The locals developed the competency to turn on the GPS, find permanent plots, and mark and track points, hence they preferred Garmin GPS handsets over hand-held computers which were more complex, requiring computer skills and ArcPad software skills.

Out-migration in the village is a common problem. Because handling GPS needed technical skills, literate community members were included in the research team. But they were the first ones to migrate from the village, making training new members in the next year a routine job.

Conclusion

From the study results data, the mean sequestration rate of the community forests in India and Nepal is close to 2.79 $tCha^{-1}\ yr^{-1}$, which is 10.23 $tCO_2ha^{-1}yr^{-1}$. It is clear that these community-managed forests, covering close to 7.5 million ha areas in the Himalayan region, are major carbon sinks. The data presented in the Chapter shows the level of carbon stored in forest biomass and soil. More important is the danger of losing this pool if communities convert their forests into agricultural use or urban expansion; the potential emission increment levels from deforestation would be significant. If these sinks are to be conserved, it is essential that poor and marginalised hill communities that have been conserving their forests on a sustainable basis without outside financial support be provided financial incentives for the global services they have rendered. This will reduce their opportunity cost. The methodology mentioned in this Chapter is an important means of quantifying carbon sequestration levels if communities decide they want to claim payments for their global ecological services. Carbon estimation is also necessary for monitoring the pool levels and in identifying strategies and management interventions to further improve efficiency. Witnessing the rise in human and livestock population in the Himalayan region in the past decade, carbon trade could be an incentive for forest conservation and management if recognition is provided to community forestry under the Kyoto Protocol.

Community forestry can be a viable strategy for reducing permanent emissions from deforestation.

Forest generation after community protection in Uttarakhand, India *(Kamal Banskota)*

Case Study: Dhaili Van Panchayat in Uttarakhand, India

5

Ngamindra Dahal, Ashish Tewari, Pushkin Phartiyal, and
Bhaskar Singh Karky

Introduction

Dhaili is a small village located at an elevation of 2000m in the Kumaon Hills, Almora district in the State of Uttarakhand, India – the hill-state where the Chipko movement to protect mountain forests took place. It is also one of 12,000 Van Panchayats (VPs) or councils of local forest managing communities of the state. Over 25% of the total forest area of Uttarakhand is under the management of these VPs. Dhaili VP has 173 households as members, who collectively manage a small forest patch of about 58 ha dominated by the Himalayan banj oak *(Quercus leucotrichophora)*. Lying in the western Himalaya, Dhaili receives about 1,700 mm annual rainfall. This Chapter sheds light on community forest management practices in India, taking the case of Dhaili VP.

Evolution of Van Panchayats as Community-managed Forests

In the hilly region of Uttarakhand, the history of community participation in forest management goes back to almost a century, when local people made collective efforts to protect their forests. The concept of managing the forest through community participation emerged in the mid-1920s, following agitation against the British colonial government's control over forest resources.

The VP, a village-level forest council or assembly, emerged in Uttarakhand following the introduction of the landmark Van Panchayat Act 1931, which allowed handing over of the management responsibility for designated community forests to the elected body of VPs. Forests were previously under the direct control of the State Forest Department. The evolution process of community forestry has never been smooth in India, despite various legal provisions and the support of the civil activist movement. Most of the VPs were initiated on degraded sites officially on Civil Soyam Forests, forests managed by the Gram Panchayat on behalf of the State Revenue Department, where villagers have free access to extract forest products for local use. Unlike Civil Soyam Forests, forests under VP management are well regulated and restricted. The case of Dhaili VP represents a typical forest management regime in the state of Uttarakhand.

The forests were undergoing a continuous state of degradation owing to over-extraction of fuel wood, fodder, and timber. The local people demanded that the government declare the forest a Van Panchayat and hand over management responsibility for these forests to them. The local people of the Kumaon Hills have always been the custodians of forest resources adjacent to their settlements. However, towards the end of the 19th century, restrictions on forest resources extraction by the colonial government created resentment among the locals. To assert the community's ownership to use and manage the forest, the local people began to guard the forest with sticks, and named this movement as 'Lath Panchayat' (lath, meaning stick, and Panchayat, the assembly of local people). The movement was effective in helping local people organise themselves and in raising their awareness to oppose the colonial government's control over the forests. For the people of Dhaili, the most important event they recall was in 1976, when they stood up collectively to protect the local forest. It was only after three decades of struggle that, in 1999, the Dhaili Lath Panchayat was formally recognised as a VP. There are two plots of forests under the management of Dhaili VP: one comprising 58 ha, and the other 10 ha at Bhatkholi Toke.

Interestingly, the reknown Chipko movement, which had a wide impact in the lower hills of Uttarakhand since the mid-1980s, had little influence on the Dhaili people. Nevertheless, they mention a number of protests organised favouring a pro-community forest policy. They also expressed that some recent forest policies namely, the Uttarakhand Panchayat Forest Rule 2001 and 2005, address their concerns and grievances to some extent. However, these policies are yet to be implemented properly to enable the community to realise tangible benefits.

Management Practice and a Legal Framework

The Uttarakhand Panchayat Forest Rules 2001 envisages the VP as a legitimate local institution with legal rights for managing designated forests. The forest officer of the region is responsible for providing the VP with training and resources for building VP capacity. One key support is to help the VP develop a five-year management plan called the Micro Plan, which is a community forest operation plan. Without the Micro Plan, a VP cannot exercise its legitimate right to use and manage the forest. Based on the Five-Year Micro Plan, the VP is also required to develop an Annual Work Plan. The elected committee is responsible for carrying out forest management activities in accordance with the approved Micro Plan. The plan clearly states provisions for operating a VP fund, a bank account, auditing and reporting, amongst others. To oversee the functions of VPs, VP inspectors are appointed through the government's Revenue Department. They report to a designated VP officer at the State Revenue Department.

A general assembly of all entitled households takes place every year, but the VP committee meets at least once a month or more, if required. The head of the VP is responsible for keeping all records: decisions, activities, income-expenditures, and all correspondence. The major management activities of the elected body include guarding the forest against illegal extraction of forest products, to ensure strict enforcement of the prohibition on cutting down standing trees, unless dead or fallen naturally, and to regulate extraction and distribution of fodder, fuelwood, litter, timber, and other products. For this purpose, a time is fixed, usually 15 days in each year, for the members to collect the forest products they need. A family is charged Rs 20. Out of 173 member households, 130 households which are entirely dependent on farming for livelihoods take this benefit regularly, whereas the other 43 households are involved in other professions and collect forest products on an irregular and limited basis.

Though households have a tendency to collect and store as much fuelwood as possible during the 15 allotted days, the VP forest is open, and the supply capacity of the forest is less than the demand. The shortfall is met by the Civil Soyam Forest[1], located several hours walking distance away from the village. The Civil Soyam Forests have become conflict zones between the government and local communities, as both claim their rights over these forests.

In Dhaili VP, community members are allowed to cut down dry trees for house construction purposes. However, in practice, much of the community's timber requirement is imported, but fuel wood, fodder, and litter demands are met from the VP forest. The adjacent Reserve Forest is also used for extracting litter and dried fuelwood. Even though illegal, women carrying head loads from the reserve forest are not restricted by the guards of the State Forest Department (SFD).

The State Forest Department also gives permission for limited access to extract forest products from government reserve forests, in recognition of local people's 'hak-hakuk' rights, but only from a designated site, usually beyond the reach of villagers. 'Hak-hakuk' is a provision since the Colonial Period to regard the age-old rights of the locals over the natural resources for allotment of timber from a Reserve Forest. The SFD, on the basis of a fixed allocation to a village and in accordance with the availability of dry/fallen trees, makes an allotment to the Gram Panchayats, the government administrative unit at the local level; each Gram Panchayat can have one or more VPs. But in Dhaili, no one has been able to fetch their share of timber from the hak-hakuk forests to date. To household members of Dhaili VP that fall under the Jageshwar forest range, this allotment is made in Morpatudi (Nathukhan forest range), which is 50 km away from the village. The Dhaili community has been unable to benefit from this allotment, as it is economically unfeasible. Although not clearly visible, this reflects a situation of conflict between villagers and the SFD.

The Dhaili VP performs management activities in accordance with the rules and guidelines prescribed by the Uttarakhand Panchayat Forest Rules 2001. A VP usually has a nine-member committee. Dhaili VP is managed by an elected committee composed of seven persons voted for by all 173 households who are the legitimate users. All the seven members are men, with one being the officiating member representing the Gram Panchayat Chief (Chief of the elected village-level government). Elections are held every five years. One member from among the elected members is the VP chief or Sarpanch. At least one such meeting is held as the General Assembly where all the villagers, including women, participate. It is in this meeting that the VP decides on collecting money, if required, for management practices such as appointment of a watchman, and also presents the VP's financial account. The VP can impose punishment for illegal logging. Mining and logging are banned, and the only timber extracted is from dry trees. For illegal logging, a fine of Rs 50 is imposed, plus the cost of the wood.

[1] Civil Soyam Forest: The Revenue Department has the administrative control over the Civil Soyam Forest. It has been observed that the district revenue administration lacks funds and is overburdened with official work and thus is unable to give adequate time and attention to forest matters. As a result, these forests are less regulated and guarded in comparison of Van Panchayat or Reserve Forests.

According to the committee members, each user household contributes to forest protection by providing volunteer labour service for a minimum of four days in a year. However, the number of days of labour contribution varies from house to house. Labour work involves plantation, fencing, and removing logs, amongst others. Those involved in special assignments for forestry work are paid through a waiver of the annual fee, or get a discount on the permit fee for collecting forest products. A few days of labour contribution reflects the minimum management activities in the forest.

The elected body is mandated to develop and implement the Five-Year Micro Plan consisting of all actions necessary for the protection and use of forest products. This is submitted for approval to the State Forest Department. Technically, the Micro Plan and the Annual Work Plan both require prior approval of concerned forest officers. Until and unless the plan is prepared and approved, the VP cannot do much other than to guard the forest.

Owing to resource constraints, the SFD has been unable to provide technical assistance to the majority of VPs, including Dhaili, to develop their Micro Plans. As a result, Dhaili does not have a Micro Plan, nor an Annual Work Plan. Thus, the committee is yet to practice its rights to carry out management activities of its interest other than protection and limited use of the forest. To the question why Dhaili had not developed its Micro Plan, the Sarpanch had this to say: "We neither have the idea nor the capacity to develop it".

Forest Condition and Use of Resources

The pressure on the forest is increasing as the population of Dhaili and the neighbouring areas has increased since India's independence. The general motives for forest protection and management are founded on the expectations of the locals of immediate returns from the forests and its resources. For the Dhaili community, becoming self-sufficient in firewood, leaf litter for compost, and fodder, and being able to prevent outsiders from using their forests, is an important motivation to protect and manage them. Another significant reason is to conserve the source of water on which the majority of households depend for potable water.

The availability of water from the local spring source has been declining for over a decade in Dhaili. There is a general perception that the continuous degradation of the forest upstream is the main reason behind the growing water scarcity in the village. This common problem has led local people to organise themselves as a collective effort to manage the local forest in the best interest of the community. As their elders did, the community planted oak species on the belief that oak would hold, absorb, and retain more water and for a longer period, thus, keeping the spring flowing even during the long dry season. The conservation effort is showing success and the spring is now able to provide drinking water to the entire Dhaili village through a 2-inch pipeline which has been laid out recently.

According to Dhaili people, the condition of VP forest has improved over time, where banj oak *(Quercus leucotrichophora)* is the dominant species. Some of the village elders mention that, until 30 years ago, the present forest area was almost a barren land due to poor management as well as conflict between government and local people. In contrast, the locals are now better aware of the need to conserve their forests. Illegal activities have been reduced over the years as more people participate in conservation efforts. The locals are also aware that the forest on the steep slopes has helped conserve the soil and has prevented landslides.

The major forest resources extracted from VP forest are fuelwood, fodder/litter, and dried timber. The main source of energy for cooking is fuelwood. Although LPG gas is sold at subsidised rates by the government, most of the villagers find it unaffordable as well as inaccessible. Grazing is allowed in the VP for legitimate user households. Animals grazed in the forest include goats, cows, and buffaloes. Lately, this VP is experimenting with selling moss and other NTFPs to a trader outside the village. Such sale, if carried out regularly, will provide an alternative cash income source to the VP.

Institutional Capacity and Sustainability

As long as the right to manage their forest resources are provided, the local people are capable to manage their forests. The VP members in Dhaili have their own parameters for monitoring the forest's status. They employ visual indicators such as density of biomass; type, size, and quality of trees; area of barren plots within a forest area; regeneration status; and signs of livestock grazing. With limited resources, the VP is able to prioritise the tasks of management in a cost-effective and efficient way. Their first choice of species for plantation is banj oak, which they have been traditionally using to augment water flow from small springs.

Gender and Equity

Traditionally, women go to collect fodder, forest litter, and fuelwood daily. However, they lack representation in the management committee. According to the VP Chief, women are not in the VP committee because they do not have the time, and also because they lack managerial skills. The general view of the VP members is that women should be included into the VP committee because they go to the forest more frequently, and thus need to be sensitised on the importance of protecting the forest from over extraction and from degradation. In addition, having women members in the VP would make it easier to convey messages to other women on VP activities, rules, and regulations, and conservation efforts.

To make forest products available to all, rich and poor alike, in Dhaili village, prices are fixed at the General Assembly. For example, Rs 20 is levied for the collection of dried leaves, which is permitted for 15 days; a dried pole is Rs 50, and a big chir pine pole Rs 200. These prices are affordable to even the poorest in the village, according to the locals. For larger dried timber, the VP determines the price only after inspection of the site. If the site contains a considerable number of poles, they are auctioned within the

Dhaili VP; exporting or selling timber and forest products outside the village is strictly not permitted.

The Importance of Livestock

Cattle in Dhaili are mainly kept for dung and dairy. Cows are the most common livestock despite their use being the least. Most cows are low-yielding local breeds living on low quality fodder and hence, are not specifically reared for milk. They are reared for their dung, which is the most valuable nutrient to the mountain agricultural system. Dung is composted with forest litter and applied into the fields and is the major source of soil nutrient. Leaf litter composted with dung is the main source of nutrients for rain fed-hill terraces. Two quintals of manure which consists of 0.5 quintal leaf litter, is applied in one 'nali' (50 nali = 1 ha) of land, the remaining 1.5 quintal being dung. This manure is also sold at Rs 1 per kg. Agriculture is mainly of a subsistence nature in Dhaili and inorganic fertilisers and pesticides are not widely used because they are expensive.

Crop and Livestock Depredation

With the increase in forest cover in and around Dhaili, frequency of wildlife sightings and damages to crops and livestock have increased. Like the community-managed forests in Nepal (CFUGs), VP forests in Uttarakhand are becoming increasingly important habitats for wildlife outside protected areas. Leopards, wild boars, porcupines, hog deers, and barking deers, are frequently sighted. Farmers are not compensated for the wildlife depredation. Langur monkeys and several kinds of pheasants are also found in this forest. There is no animal hunting in the village, following the Indian Wildlife Act of 1972. Possibilities for nature tourism, taking advantage of road accessibility to the village, remains an untapped potential.

Opportunity Cost and Environmental Services

The opportunity cost of managing the forest appears low because of the traditional management practice in which everyone is responsible for guarding the forest voluntarily. A security guard is paid for monitoring the forest, the rest of the committee members are required to contribute their time voluntarily, as and when required.

The VP generates a number of environmental services of local to global significance. The source of potable water is the number one benefit of the forest for local people. Carbon sequestration is another important service provided by improved forest management. Habitat to endangered wildlife at the high altitude region, source of medicinal plants and greenery, these other services remain untapped for income generation. Without government recognition of their contribution, both collectively and individually, the VPs will continue to face problems in enhancing their capability to mobilise resources. Helping the VPs to organise a functional council or federation so that they can bundle up the fragmented resources for a collective market approach could be a way to plan ahead. The responsible departments, the State Forest and Revenue departments, regard VP-related work as a low priority, as they are overburden with their routine official tasks.

Although the state government, appreciating the relevance and importance of the VPs, has taken significant steps to upscale the number of VP-managed forests, there remains a void in the functioning and efficiency of these local level institutions. The spirit of the law, as committed in the Uttarakhand Panchayati Forest Rules 2005, has to be incorporated in the routine functioning of VPs across the state. Timely elections, ensuring desired representation of women and marginalised sections of the community, feasible micro plans and annual action plans based on financial resources allocations, and a realistic distribution of responsibilities among government officials, are the major areas needing attention. There is also a need to define the role and responsibilities of the newly introduced concept of advisory committees at block, district, and state levels. To take advantage of their collective strengths these committees are required to perform a coordination role, conflict resolution efforts among the VPs, and financial resource mobilisation-related tasks. The required policy interventions and institutional arrangements in these areas would further strengthen environmental governance at local levels in the state on the one hand, that would create a replicable example for the rest of the country on the other.

Leakage

Dhaili VP community has three forested areas within its use: 1) the VP, directly under its management; 2) the Hak-hakuk Forest Reserve, under the management of the State Forest Department; and 3) the Civil Soyam Forest, under the State Revenue Department. Though a substantial portion of fodder and fuelwood needs of the community is met from the VP forest, this is far from enough. They have to meet their own needs by extracting forest products illegally from the surrounding government reserves forests and the Civil Soyam Forest, but not from the designated site of Hak-hakuk Forest, which is some distance. However, these forests outside VP management are visited only in periods of severe scarcity for fodder and firewood. Detailed research needs to be done to assess leakage.

Issues Pertaining to Dhaili Van Panchayat

Lack of a Five-Year Micro Plan has crippled the Dhaili VP from functioning as an autonomous local institution in a legitimate manner. For example, the Sarpanch's efforts to raise funds to fence the forest area and save new plants from livestock grazing has not been successful because of the absence of a Micro Plan. As a consequence, the VP finds itself spending more time guarding the forest than managing it. Local people have expressed willingness and a commitment to use the forest as a productive resource without compromising its long-term sustainability and environmental functions. However, without strengthening the capacities of the VP, it is not possible to generate additional benefits from the forest.

Financially, the VP is still not strong and self-sustainable. Dhaili VP's expenditure in last 12 month was Rs 7,500, which is almost equal to its annual income. The main source of income is selling dried leaves and grasses and dried/dead timber to local households.

The issue of sustainable management of the VP forest may be analysed against the following ground realities.

- Supply capacity of the VP is inadequate to meet local needs for forest products throughout the year, and the locals have to rely on the Civil Soyam Forests partially for 10% of their needs for fodder and fuelwood.
- Limited legal rights are given to the VP to carry out the required management functions, such as removing mature trees for the locals' needs for timber and fuel wood.
- Motivation to plant useful tree species is undermined by a law that forbids logging above 1000 masl unless the tree is dead. (The Indian Forest Act and a recent ruling of the Supreme Court prohibit cutting down of standing trees in hills above 1500 masl, unless they are dead or have fallen down naturally.)
- Government officials lack trust and a confidence on the capacity of the VP to enhance productivity of the forests.
- Inadequate recognition by government agencies of the community's efforts in protecting the forest for decades has raised public perception that government may reclaim its control over the VP, denying the community their rights to manage and use the forest resources.

Given the condition that VP forests sustain a subsistence economy on a day-to-day basis, management sustainability could suffer owing to financial constraints. With the global crude oil prices on the rise, reduced government subsidy on LPG gas makes LPG expensive, and the pressure on forests will continue unabated. However, promotion, adoption, and management of energy-efficient technologies such as improved cooking stoves and biogas plants, if done on a wide-scale basis throughout the region, could help reduce the pressure on forests.

Conclusion

The Van Panchayat is generally seen as a partnership of local communities and government for the sustainable management of local forests. The partnership is supposed to be a 'win-win' situation where both government and the communities' interests are fulfilled. Principally, the government intends to ensure the protection of the forest in its natural form and the communities' interest is to ensure their legitimate access to forest resources for meeting their local needs without jeopardising sustainable forest management. The study of Dhaili VP shows compelling evidence that building partnerships with communities can create opportunities for both the government and local people. But capitalising on the opportunity requires an initial investment from outside to build local capacity, which the community cannot afford.

The local people of Dhaili have been successfully managing and protecting a small forest patch over time. Despite population growth, the VP in Dhaili has been successful in avoiding forest degradation and conserving their forest. These efforts have been possible solely through the interest of the local community; without their commitment, conservation would not be achieved.

Although there is a strong local commitment and interest in managing VP forests in the future, challenges and uncertainties for management sustainability lie ahead. Without proper value addition to the services of the forests for generating revenue, the community finds it difficult to manage forest resources in a sustainable way. This is important, as the management style of the VP to date is rather traditional, with limited capacity to formulate plans. It needs technical support to better plan the management of forest resources to help in generating additional benefits, and also to undertake more effective conservation endeavours. These issues are likely to be more important as the role of forests in regulating climate change becomes a central issue in the coming decades.

There are local conflicts between the government and local interests. A policy constraint such as forbidding logging above 1000 masl is a severe disincentive for more intensive forest management. Although VPs are protecting, managing, and harvesting from their VPs, their legitimacy is in question without the formulation of a Micro Plan and Annual Work Plans. Similarly, granting forest use rights, such as Hak-hakuk forest use rights, at a distant site from the village is seen as government's hidden interest to deny the community legitimate access to forest resources.

Developing a carbon offset project could be one way for the VPs to claim payment for the environmental services their forests render as an incentive for reducing emissions from deforestation. However, this requires the collective approach of many VPs like Dhaili to bundle their products for marketing. If government level initiatives could reciprocate the efforts of VP communities, the mountain community at large will enhance its resilience to cope with the negative consequences of climatic impacts in the future.

Community forestry can be a viable strategy for reducing permanent emissions from deforestation.

Forest user group members patrol and inspect an area in the Kafle community forest *(Kamal Banskota)*

Case Study of a Community-managed Forest in Lamatar, Nepal

6

Bhaskar Singh Karky and Kamal Banskota

Background

Community forests play a prominent role in the daily livelihoods of people in the hills of Nepal where agriculture, livestock rearing, and forests are strongly interlinked. Based on the 1976 National Forestry Plan, the Government of Nepal (GoN) has made it its policy to involve local communities in forest management, with a view to tackle deforestation and the deteriorating state of forests all over the country. By 2004, about 25% of all national forests, or around 1.1 million ha of Nepal's forests, were being managed by community forest user groups (CFUGs). There are more than 13,000 CFUGs in Nepal involving 1.4 million households, or more then one-third of the population (Kanel 2004), mostly in the hilly regions. The Federation of Community Forest Users Nepal (FECOFUN) has grown over the years to become the single largest organisation in the country, a social movement on community forestry.

The impact of the policy in the forestry sector has been positive. Where communities are managing their forests the degradation trend in large tracts of accessible forests in the hills has been checked. This has not only contributed to overall improvement in forest conditions, but has also resulted in positive impacts on biodiversity conservation. In many places, communities now have easier access to firewood, timber, fodder, forest litter, and grass. Other additional environmental services provided by maintaining and protecting forests have been reduced soil erosion, and increased water supply from forest springs. All these benefits may be attributed to decentralised and participatory development strategies that have been adopted in this sector.

As a general rule, members of the CFUGs pay a nominal fee for the various forest products they consume, and they are restricted from commercial harvesting of forest products. Timber harvesting in particular is heavily regulated and only conducted under Forest User Committee (FUC) supervision; selling is done through an open bidding process. All income from such sale is retained by the CFUG. Revenues collected by the CFUG from the members and through selling products are mostly invested in social infrastructure requested by the community. About 28% of revenues generated from the community forest are expended on forest protection and management.

This case study looks at one example, the community forest in Lamatar, to demonstrate that in addition to the global benefits of carbon sequestration, community-managed forests are contributing significantly in raising livelihoods in rural villages.

Brief History of Kafle Community Forest

Lalitpur district has 15,253 ha of forest of which 9,993 ha are managed by 162 CFUGs. Within the Lamatar Village Development Committee (VDC) there are nine community-managed forests covering 525 ha and involving 670 households. The Kafle Community Forest (KCF), on which this case study is based, is one such CFUG. KCF manages a block of 96 ha involving 60 households of the VDC. This forest lies at an elevation of between 1830 and 1930 metres and is dominated by lower temperate broad-leaved species, particularly *Schima-Castanopsis* (katus-chilaune).

The tradition of community-managed forests is not new here. What is new is formalising this traditional management practice in modern terms. Villagers, recalling the history of their forest management, explain that the forest area in Kafle historically belonged to the Ghimire family who were Brahmins living to the south of the main valley. They had agricultural lands in the fertile valley below the hills; the hills themselves were unsuitable for agriculture and were covered with forests. They were granted this forest as a 'Birta' (land or forest grants by the state) for services rendered. It is told that the forest then was rich in biodiversity, as it was well managed and population pressure on the forest was far less than it is today. In 1957, however, this forest, like all forests in Nepal, was nationalised. After that, as narrated by the locals, the forest gradually decreased, both by outright deforestation (loss of forest area), and in terms of degradation (loss of biomass within the forest). Noticing this change, the Department of Forestry carried out

Figure 6.1. Satellite image of Kafle CFUG and Lamatar VDC
Source: Google Earth

a reforestation programme in 1978 by developing a sallo plantation *(Pinus roxburghii)* and putting forest guards in place to protect the plantation. But deforestation and forest degradation continued unabated, converting this entire hill to almost barren land by the early 1980s. Unregulated livestock grazing and fodder collection were the major causes of forest degradation as they prevented natural regeneration, while unrestricted fuelwood and timber collection were the major causes of deforestation. This was a classic case of the tragedy of open access: anyone and everyone had unlimited access because the state owned the resource and it was managed by state staff, to whom the local people did not feel answerable.

This scenario at Lamatar was occurring all over the country, which meant that Nepal was losing forests at a rapid rate, especially in areas adjacent to settlements. In the late 1970s, however, a paradigm shift occurred, when foresters realised that forest protection and management was not possible without involving local people. Between1975 to 1993, the community forestry policy, as widely practiced in Nepal today, brought about a series of milestone decisions. Handing over large tracts of forests to the local communities took place in the 1990s. In Lamatar, this took place in 1994, a year after the formation of the Kafle Community Forest User Group. Since then the forest has been managed effectively, with strict restrictions and user guidelines and norms. Forest degradation and deforestation have been checked, and forest regeneration, mainly natural regeneration, is taking place after stringent protective measures enforced by local people through the CFUG. Today, the forest is recuperating ecologically and already has a rich diversity in tree species. One of the most important resources from this forest is water. The forest has several springs which are carefully protected and used by the villagers for drinking purposes, at no charge to the users. The flow of water has increased markedly with the rejuvenation of forest biomass.

Forest Management Based on an Operational Plan

Generally, villagers become members of the user group to ensure the fulfilment of their forest product needs. The Kafle CFUG has a Constitution and a Five-Year Operation Plan that indicates how and for what purposes the forest will be managed. The Operational Plan is formulated by the members of the CFUG and approved by the District Forest Office. The process of formulating an Operational Plan is highlighted below.

- First, a CFUG meeting is called.
- Then, the group is divided into smaller groups by 'tole' or small settlements.
- Small group meetings and selection of one representative take place.
- Discussions focus on drafting an Operational Plan.
- Drafting the Plan evolves in small groups.
- Small group representatives meet and discuss the groups' outputs.
- Small group recommendations are compiled and synthesised.
- The draft Operational Plan is presented to the CFUG members and approval of the general assembly is sought.

The members of the CFUG also form a Forest User Committee (FUC), consisting of 11 elected executive committee members known as the Forest User Committee, which makes day-to-day decisions based on the Operational Plan. The primary mission of the Kafle CFUG is to increase the harvesting capacity for fuelwood, timber, and fodder through better management of Kafle's forest resources for the benefit of local CFUG members, and to make the CFUG a self-sustaining institution. The Operational Plan guides the Committee in moving towards this goal. In addition, the CFUG aims to conserve Kafle's spring water sources, soil and biodiversity, promote environmental stability in the village area, assist in raising livelihood conditions from the use and access forest resources, generate income, and try to develop the area for recreation and tourism.

Community management of the forest entails numerous tasks that the locals have to perform, including technical tasks with support from the government forest rangers. The community management practices witnessed in the Lamatar area can be broadly classified into forest protection, administration, harvesting, and silviculture.

Forest Protection

Protection is a major task and often also the most expensive. In Lamatar, the community divided itself into several groups to patrol their forests on a rotation basis. While working at home or in the field members vigilantly watch over their forests for irregular movements such as illegal logging, animal grazing, or forest fires. This approach has helped the community to control fire outbreaks in the past. It is mandatory for all members of the CFUG to participate in putting out fires, and non-participants are penalised. Penalties are also levied on members found adopting unsustainable forest resource extraction practices. The CFUG meeting decides when community members can harvest different types of resources and the quantities they can harvest. Those who do not abide are penalised based on monetary fines decided by the CFUG. The penalty rates vary for illegal fodder and litter collection; collecting sand, gravel and stones; timber and fuelwood extraction; and bamboo collection. Hunting, grazing livestock, and charcoal making activities are permanently banned. Fencing as a protective measure is not practiced. The rules and regulations, and effective enforcement, have been strong reasons for avoided forest degradation and deforestation in this forest patch.

The willingness of the community to implement forest protection measures that they themselves decide on is dependent on the payback they perceive and actually derive. It is clear to the people of Lamatar that without strict conservation measures, is it next to impossible to maximise natural regeneration or harvest forest resources in greater quantities. The community is realising tangible incentives for conservation. Across Nepal, such examples of success abound.

CFUG Administrative Work

Community forestry also entails administrative tasks such as calling and organising meetings, conducting elections, recording meeting decisions, maintaining accounts, getting accounts audited, amongst others, as well as tasks directly connected with forest activities such as setting dates for extracting resources, circulating the information, and developing a management and a Five-Year Operational Plan with the assistance of a ranger. The CFUGs of Lamatar are doing these administrative exercises professionally. Such professionalism cannot be expected among most CFUGs in Nepal, however, The CFUG maintains an inventory of estimated forest resources, as reflected in Table 6.1, which shows the cash flow of Kafle CFUG over the last four years. Cash flows are reflecting increases annually.

The financial book of Kafle CFUG reflects that 13% of the CFUG's cash income from 2004/05 was spent on establishing a school and financing village Red Cross activities. The year before that, 16% of CFUG income was spent on school building repairs. Such investments benefit not only immediate CFUG members but also others who live in the vicinity of the Kafle community forest.

Table 6.1: CFUG cash flow in Kafle, Nepal

Year	Income	Expenditure	Savings
2004/05	41,854	18,694	22,699
2003/04	40,537	33,627	6,910
2002/03	27,521	8,190	19,285
2001/02	9,896	6,975	3,081

The Forest User Committee consists of 11 members (six women and five men) and have each a two-year tenure. They are elected by CFUG members during the annual General Assembly. The voting system allots two votes per household, one for each gender. The Forest User Committee can be dissolved by the CFUG General Assembly.

Illustrated below are the latest decisions recorded in the meetings file of the Lamatar Forest User Committee. The Minutes reflect the administration system in managing Lamatar's forest resources.

Decision 1 - 2063/06/04 (August 2006)

This decision illustrates division of work among CFUG members to protect their forest. As forest protection is a major task and often also the most expensive, the CFUG cannot afford paid guards and CFUG members themselves carry out the task of patrolling the forest. Both women and men take up the responsibility and a roster is prepared in which the daily routine of the patroller is agreed upon. The group is responsible for patrolling the forest until a new group is formed by the CFUG.

Decision 2 -2063/06/04 (August 2006)

The CFUG and forest patrol groups were unable to control continuing illegal activities. Hence, the members formed a committee which consists of five members to monitor forest protection and curb the high rate of deforestation taking place.

Decision 3 - 2063/05/19 (July 2006)

As per the decision of the general meeting of the CFUG, this decision was taken to make available books and pencils free of cost to school children until they reach 3rd Grade.

Decision 4 - 2063/05/19 (July 2006)
The Range Post Coordinator position became vacant, so a new female member was nominated to coordinate between the CFUG and the Range post.

Decision 5 - 2063/04/14 (June 2006)
As suggested in the Operational Plan, dried trees are to be sold through auction. However, after securing the tender, the party changed its mind and did not claim the timber. So a decision was taken by the Forest User Committee (FUC) not to refund the bond deposit amounting to 10% of the total value of the timber extracted and to call for a re-auction.

Harvesting

Harvesting is done by the members. The main products from Lamatar's forests include timber, dried and green fuelwood, fodder, litter, nigalo (small bamboos: *Drepanostachyum intermedium, Drepanostachyum falcatum,* and *Sinarundinaria falcata*), and NTFPs. Of these, timber is the most heavily regulated. A decision to harvest is taken by the FUC together with the Range Post via an official process, and the timber is sold through a bidding process to anyone, including people from outside the village. On the other hand, fuelwood, fodder, litter, nigalo, and NTFPs can be collected by CFUG members when the forest is opened for collection activities. The FUC decides on the days and dates during the various seasons in which harvesting of these products is allowed and, accordingly, informs all CFUG members. Members pay a small fee for firewood and bamboo, but fodder and litter are free of cost. From records held by the CFUG, it appears that each household derives about 1000 kg of green fuelwood, 500 kg of dry fuelwood, 500 kg of grass fodder, 1000 kg of leaf litter, and 500 kg of nigalo every year. On special occasions such as during marriages, religious ceremonies, and funerals, CFUG members can harvest 350 kg of fuelwood for the same price.

Products extracted collectively after a thinning or clearing operation are distributed equally amongst users. CFUG members may sell their personal excess of these products to non-members within the village, but the products may not be sold commercially outside the village. While the financial returns from the sale of timber is the largest source of income for the CFUG, fuelwood, although financially lower in terms of volume, is the main resource extracted. With the increase in global oil prices, CFUG members rely more on fuelwood from their forests to meet their cooking and energy requirements.

Weeding, cleaning, pruning/branch cutting, singling, thinning, clearing, and regeneration management are the other activities CFUGs conduct on a regular basis. The CFUG has maintained demonstration plots using modern techniques to propagate a number of species such as Chilaune (*Schima wallichii*) and Jhingane (*Eurya acuminate*), as well as several additional varieties of NTFPs (such as cardamom and fodder grass). In the future, the Kafle CFUG intends to develop a forest nursery and increase the number of medicinal plants in the forest. Most of the people in Lamatar understand silviculture practices and are able to identify most of the tree species in their forests.

Environmental Services

Forests provide numerous environmental services, many of which often go unpaid. In Lamatar, the Kafle CFUG has realised increased flow of environmental services as a result of improved forest management. Not only have the users benefited directly from the increased flow, adjacent communities and downstream people have also benefited. The most visible service of improved forest management is increased water supply to the villages and downstream populations.

According to the locals, there has been a constant flow of good quality water throughout the year as a result of improved forest management and increased forest cover. Forest cover and the steep terrain have protected the streams from pollution, as people have no easy access to the springs. In the dry months, a six-inch deep stream flows constantly, a source of drinking and irrigation water for Lamatar and Lubhoo VDCs and other settlements in the vicinity. About 150 households use the water for drinking and domestic household uses. Another 200 households derive their irrigation needs from the increased water discharge. The CFUG has the potential to earn about NRs. 3000 per day by selling excess water to private water suppliers in the Valley. But this is not allowed in Kafle as the people using the water for irrigation further down Lubhoo VDC would oppose the sale of water to water suppliers.

Lakuri Bhanjyang, at 1930 masl, is at the highest point of the Kafle Community Forest. This hilltop provides a spectacular view of the entire Kathmandu Valley and a large segment of the Himalayan range. It is popular to view the sun rise from this vantage point during the winter months, when the Valley below is covered by thick fog. Tourism activities include overnight stay at a resort, day picnicking, hiking in the forest, and mountain biking. A few years ago, some monks tried to build a monastery by offering to lease a small patch of the forest, but the CFUG members declined the offer.

Despite being rich in stones and sand, for which there is high demand for construction materials, the local community has declined offers made by private parties to develop quarrying enterprises in the area. The locals are aware of the possible adverse impacts of quarrying, such as landslides, drying up of water sources, deforestation, and pollution, and have turned down attractive offers by private parties promising short-term labour and quick cash.

In the methodology Chapter, it was shown that Lamatar CFUG has a mean carbon sequestration rate of 1.41 $tCha^{-1}yr^{-1}$ (5.17 $tCO2ha^{-1}yr^{-1}$), with an average pool size of 52.5 $tCha^{-1}$ (192.52 $tCO2ha^{-1}$), excluding carbon stored in the soil. This indicates the C pool as an important additional environmental benefit service rendered by this community forest, but for which the community is not paid. Assuming the value for a tonne of CO_2 is US$ 12, Lamatar CFUG can earn US$ 62.04 $ha^{-1}yr^{-1}$ (NRs 4343 $ha^{-1}yr^{-1}$); the same carbon pool at US$ 5 would earn US$ 25.85 $ha^{-1}yr^{-1}$ (NRs 1810 $ha^{-1}yr^{-1}$). Even at a low price of $5/tonne per year the increment for Lamatar CFUG would still be substantial compared to the present financial income the community is realising from its community-managed forest.

Conclusion

Since community forest management has been promulgated for many years in Nepal, with about a quarter of all national forests now managed this way, it would be difficult to argue that the forest management activities of villages like Lamatar are truly ‘additional’ in Kyoto terms. On the other hand, it is clear that there is very little leakage since all the forests in the area are managed by other CFUGs under more or less the same terms.

Forests such as the one in Lamatar are managed by the locals in a sound way following operational plans which have been formulated by the villagers themselves in an inclusive manner. Apart from fuelwood and fodder benefits shared between CFUG members, the CFUG also has a steady cash flow, albeit small compared to the potential financial return from carbon trading. This forest provides numerous environmental services such as supply of drinking and irrigation water to a wide range of households beyond the CFUG. Other services like tourism do not benefit the locals, while quarrying and selling of water are not practiced. Carbon sequestration is another environmental service which community-managed forests like Lamatar extend globally as a byproduct of protecting and maintaining the forest.

Should Kafle CFUG be permitted to sell carbon credits in the global carbon market the financial revenue it could generate would be more than double its current financial income. Such potential revenue could serve as an incentive for them to better manage their forest by investing more in protection measures, thus generating more environmental and social gains for the community and beyond.

Unfortunately their contribution to reduce GHG emissions is not recognised or rewarded. In the future even if their efforts are recognised, the issue is: should they be rewarded for carbon that is being sequestered, and/or carbon that is being retained rather than lost through deforestation? Or should they be rewarded only for increases over and above what have been achieved in the past? These are issues that can be discussed further and options explored.

The world must address emissions from deforestation urgently, as huge carbon dioxide losses are taking place. The forestry sector offers an important solution.

School children discuss the importance of community forestry in a community in Nepal
(Bhaskar Singh Karky)

Lessons Learned and Future Directions

7

Kamal Banskota, Bhaskar Singh Karky and Margaret Skutsch

Climate change is occurring and its adverse impacts are being felt at an alarming rate across the globe. The main cause for this change is the increase in GHGs – mainly, carbon dioxide - brought about by human activities such as burning of fossil fuels and deforestation. Its effect is being felt globally, including by people of poorer countries and those living in the Himalaya who have contributed relatively little to the GHGs emissions. In fact, by maintaining forest ecosystems on mountain slopes, mountain people are contributing to reducing global atmospheric CO_2 emissions, let alone being paid for by the polluters.

This book highlights the rationale behind reducing emissions from avoiding deforestation if UNFCCC and the KP are to be more fair and effective. Hence, there is a need for the UNFCCC to address emissions from deforestation urgently, as huge CO_2 losses are taking place from the terrestrial ecosystems. However, there are numerous issues and uncertainties concerning what needs to be done in order for the UNFCCC to be able to tackle the problem of reducing emissions from deforestation in developing countries.

Within the last decade, community forest management (CFM) has been promoted in non-industrialised countries as a result of a paradigm shift in common property resource management, from state management by local communities. In the Himalayan region, common property resources such as forests are better managed by local communities than by the state. Degraded forests have started rejuvenating through natural regeneration from stringent protection measures deployed by the locals. But under the Kyoto Protocol, forests in non-industrialised countries are only recognised as sinks and not as sources, and hence avoiding further permanent emissions from deforestation is not credited.

One of the criteria for Clean Development Mechanism (CDM) is to promote sustainable development. Community-managed forests meet this criteria as they are protecting the forest, harvesting forest products sustainably, promoting biodiversity, and enhancing livelihoods. It is ironic however, that community-managed forests do not qualify under CDM, one main reason being the difficulty in accounting for leakage.

This research shows that CFM generates both environmental and social benefits. Environmental services provided by avoiding deforestation include the conversion of forests from a source to a sink, improved watershed management, and biodiversity conservation. Social benefits include providing sources of livelihood for the rural population from CFM. If payment for carbon credit is made to these communities, added benefits may provide communities relying on the forests incentive to halt deforestation and opt for longer-term benefits that are more sustainable in the long run and those that may enhance their livelihood conditions.

The case studies illustrate that community-based forest management can be a viable strategy for reducing permanent emissions from deforestation, as the data reveal that the mean carbon sequestration rate for India (3.7 t ha^{-1} yr^{-1}), and Nepal (1.88 t ha^{-1} yr^{-1}), are close to 2.79 t ha^{-1} yr^{-1} or 10.23 tCO2$ha^{-1}yr^{-1}$ under normal management conditions, that is, after local people have extracted various forest products to meet their sustenance needs. This figure translates to US$ 122.76 $ha^{-1}yr^{-1}$ of forested land at US$ 12 tCO_2 and US$ 51.15 $ha^{-1}yr^{-1}$, if the rates were as low as US$ 5 tCO_2. Carbon revenue could be an important income source and financial incentive that will assist communities further in better conservation practices and in promoting local community development.

Revenues from carbon sequestration could be valuable in reducing the opportunity cost in conserving and managing forests. We cannot overlook a scenario of rising land prices and increasing opportunity costs for avoiding deforestation – strong drivers that will pre-empt conversion of forested land to other, more profitable uses. Although revenues generated through carbon sequestration from community-managed forests are not likely to be high, given the small patch of forests communities manage, the incremental benefits may be large enough to encourage better conservation and management practices.

Driving down transaction costs will be important for the local communities to retain the maximum amount of the carbon market value. Complicated procedures will have to be followed to sell carbon in the international market, which means that various costs will have to be borne at different stages. The transaction cost to measure carbon pool in small patches of forests scattered over mountainous terrain would be high. Hence, a generalised baseline should be developed at the national level rather than at project levels, as suggested under the mechanism of Reduced Emissions from Deforestation. This research has shown that local communities can measure effectively and efficiently the changing carbon stock in their forests using standard forest inventory methods, as suggested in the *Good Practice Guide* (IPCC 2003). By involving local forest users in the primary stage where stored carbon have to be measured, it is possible to reduce the cost of carbon measurement. But ways to reduce the transaction cost must be explored in order to make carbon revenues an economic incentive for communities to conserve and reduce deforestation.

The main reason for not including community-managed forests under the Kyoto Protocol was the high risks of leakage from avoiding deforestation. Where deforestation has occurred in the Himalayan region, much of it has been as a result of gradual removal of biomass from the natural forests that exceeds the sustainable production rate. This has been done by communities living in the fringes of forests, extracting forest resources to meet their sustenance needs. This activity raises a fundamental issue of leakage, which the study has not been able to address yet. If Reduced Emissions from Deforestation

(RED) as a mechanism will be used in the post-2012 period, leakage from CFM can be managed and accounted for much more easily than under the existing CDM approach.

The two proposed approaches described by Skutsch, et al. (2007) under RED, taking the baseline at national or regional levels, provide numerous benefits for more effective emissions control but also for a fairer share for those who protect and manage the forests; they ultimately assists in reducing emissions. An approach like this, taken in the second commitment period, will be welcomed by both industrialised and non-industrialised countries.

Though CFM has quite successfully stopped the deforestation trend in the forests of Nepal, second generation issues related to equity in resource use and benefit-sharing among the heterogeneous community members are expected to emerge, with added benefits. If carbon as well as other ecosystem benefits are further added, this will have new implications on benefits sharing.

The Kyoto Protocol sets specified emission reduction targets up to 2012; what reduction commitments will be made after that is not yet known. What sort of international framework will evolve and its implications on non-industrialised countries and their forestry sectors remains uncertain. Also, what the trading price of credits in the forestry sector will be needs to be seen because that will determine if it will be an incentive to reduce deforestation or not. The European Union along with the US and Australia are pushing for countries like India and China to commit to emissions reduction in the second commitment period so that the effort to deal with climate change is more globally consorted. If this happens, India will have to make reduction commitments post 2012. This will have implications on emissions reduction through the forestry sector.

With the incidence of 9/11, global priorities have changed in industrialised countries, and new investments have started flowing towards sectors like security and defense. Climate change has been pushed further down the ladder of priority. How long will the communities managing forests have to wait for the global community to be convinced that CFM practices reduce permanent emissions from the terrestrial ecosystems and is an effective way to deal with climate change? These issues will have to be addressed as soon as possible.

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- The world's average temperature has risen more in the last 100 years than in the last 10,000 years.
- Of the 10 recorded warmest years in history, nine were recorded during the last decade.
- Greenhouse gases from human activities are among the major causes for the alarming trends.

Two of the most recent policy instruments devised to address these issues are the United Nations Framework on Climate Change and the Kyoto Protocol, which offers creative, market-based measures that allow emission producers to offset their emissions by paying others to carry out emission reducing activities. But the solutions offered under the Protocol fail to consider one important source of emissions in developing countries – deforestation and forest degradation.

The Kyoto Protocol commitments will be reviewed in 2012, and possible changes are now being debated. This book provides a timely addition to the discussions, and urges the inclusion of avoided deforestation in carbon offset measures in the Framework on Climate Change. Field studies in India and Nepal show how communities can carry out the measurements needed to calculate carbon sequestration, the basis for calculating the impact of avoiding deforestation. Including 'avoided deforestation' in climate change policy will not only help the global climate, it will provide a way for millions of poor people in developing countries to benefit directly, and will help stop the destruction of forests and encourage further conservation.

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